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The Creditworthiness of the Poor: A Model of the Grameen Bank*

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Abstract: This paper analyzes the role of expected income in entrepreneurial borrowing. We claim that poorer individuals are safer borrowers because they place more value on the relationship with the bank. We study the dynamics of a monopolistic bank granting loans and taking deposits from overlapping generations of entrepreneurs with different levels of expected income. Matching the evidence of the Grameen Bank we show that a bank will focus on individuals with lower expected income, and will not disburse dividends until it reaches all the potential borrowers. We find empirical support for our theoretical results using data from a household survey from Bangladesh. We show that various measures of expected income are positively and significantly correlated with default probabilities.

Keywords: Bank lending, deposits, microcredit, probability of default

JEL classification: G21 O12 O16

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1 Introduction

Muhammad Yunus and the Grameen Bank that he created in 1983 were awarded the Nobel Peace Prize in 2006. The Grameen Bank's main activity consists on granting loans to poor people in Bangladesh. Leaving aside the social implications of this activity, the most striking feature of this bank is the unusually high reported repayment rate, 98%, compared to that achieved in the US banking sector, 96%.[1] Although this repayment rate may be due to different accounting and reporting standards, the actual repayment rate of microfinance institutions, 92%, is high relative to other lending institutions in Bangladesh, 75%.[2]

Many empirical and theoretical studies have focused on group liability as the main reason for high repayment rates in microfinance programs. Borrowers from microfinance programs have usually been organized in groups, whose members are liable for each other's default. Group liability has been argued to increase borrowers' incentives to screen, monitor and repay the loans, exploiting their knowledge about the local conditions. It must be highlighted that, from a theoretical perspective, group liability also introduces a free rider problem in the repayment of the loan. Overall, evidence concerning the performance of group liability contracts is at best mixed.[3] It is important to note that, nowadays, the Grameen Bank and other microfinance institutions explicitly rule out group liability.[4]

Leaving aside group liability, our paper highlights a novel explanation for the high repayment rate of the microfinance programs. We build on the observation that borrowers in these programs have one common characteristic: they are poor individuals living in rural areas. This has two important implications: (i) poor individuals have current and future income and (ii) because they live in rural areas, accessing savings technologies from urban banks is not possible. A microfinance

[1] Sources: www.grameen-info.org and www.fdic.com.

[2] Source: Household Survey of the Bangladesh Institute of Development Studies.

[3] See Morduch (1999), Armendariz de Aghion and Morduch (2005), and Gine and Karlan (2006) for a summary of the empirical evidence.

[4] As stated on the Grameen Bank's web page "... there is no form of joint liability, i.e. group members are not responsible to pay on behalf of a defaulting member".

bank that lends and takes deposits increases the current income of the individuals by giving them the opportunity to undertake investment activities through borrowing. A microfinance bank also increases the future income of the borrowers, as it provides them with a savings technology that allows individuals to transfer part of their current income to the future.

We argue that deposit taking is an important, and frequently overlooked, side of the relationship between the microfinance bank and poor individuals.[5] In rural areas of Bangladesh saving outside the banking sector has been argued to be unprofitable due to causes such as the high probability of natural disasters, inflation, and theft.[6] We claim that poorer individuals in the population are the ones that value more the opportunity to increase their low future income by depositing their savings in the microfinance bank. From here we conclude that poorer individuals must have higher repayment rates on their loans in order to maintain their relationship with the microfinance bank and benefit from the savings mechanism.

We propose a theoretical model with overlapping generations of individuals living for three dates. Individuals receive a loan from the bank when they are young, and repaying the loan allows them to access the savings technology offered by the bank and increase their income when old. Our first theoretical result states that borrowers with worse future prospects (henceforth low outside options) are those most likely to repay the loan because accessing the savings technology is more valuable to them. Borrowers endowed with better outside options are more prone to default, as saving is less valuable for them and defaulting on the loan increases their current income.

Building on this result on borrowers' repayment behavior, we study its implications in an infinitely lived, risk neutral, monopolistic banking sector. We characterize the transition to steady state of a financially constrained bank financing its lending only with deposits taken from its borrowers and from retained earnings. During the transition to the steady state, the bank does not disburse any dividends and reinvests all the profits in increasing the loan supply. Our results

[5] One exception is the empirical study by Kaboski and Townsend (2005).
[6] See Banerjee and Duflo (2006).

closely match the evidence that the Grameen Bank has not paid out dividends since its foundation, and are in line with the high growth it has achieved. The first year in which the Grameen Bank paid dividends was 2006. At the end of this year the Grameen Bank was present in more than 95% of all the villages in Bangladesh.

Our second theoretical result highlights that a bank which is able to distinguish between borrowers' groups with different distributions of outside options obtains higher profits by lending to groups whose distribution is worse. It is straightforward to reason that in the context of our model the best performing borrowers, those with the worse distribution of their outside options, would be individuals from rural areas, and more specifically women from those rural areas. Individuals in rural areas of Bangladesh face a higher unemployment rate than those living in urban areas, and earn lower wages once they find a job. Among the rural inhabitants, women are the ones who face the lowest wages and the biggest difficulties in finding a job. The fact that currently 98% of all Grameen Bank's borrowers are women from rural areas supports our theoretical prediction regarding the composition of the bank's borrowers.

After stating our theoretical results we conduct an empirical analysis using data from a quasi experimental survey that was jointly conducted by the World Bank and the Bangladesh Institute of Development Studies during 1998 and 1999. In order to test our theoretical result about the effect of borrowers' future income prospects on the probability of loan repayment, we use three proxies for the future prospects of the borrower: the borrower's gender, the average wage by gender in the village in which the borrower lives, and the dowry received by the borrower's family at the time of the borrower's marriage.

First, we find evidence consistent with the idea that women repay more often than men. We claim that the fact that women face higher unemployment rates and lower wages than men drives this observation. Second, we find that the average wage by gender in the village is positively and significantly correlated with the default probability. Moreover, we find that including this measure of expected income reduces the estimated gender gap in loan repayment between female and male

borrowers. This is consistent with our claim that gender is a proxy of the economic conditions faced by the borrower. Finally, we argue that the size of the dowry is a good exogenous proxy for the future prospects of a borrower as higher dowries are positively associated with the wealth of the family.[7] Consistent with our theory, the amount of dowry is found to be positively and significantly related to the probability of default, reflecting that individuals with better prospects are more prone to default on their loans.

Next, we analyze the composition of borrowers by the different groups of lenders. We find that, compared to other lenders, the Grameen Bank and other microfinance institutions lend to a higher fraction of women and to individuals with lower levels of dowry. This backs our prediction that a bank that lends to individuals with poor prospects obtains higher repayment rates. However, we do not find that microfinance institutions lend in villages with lower average wages. We argue that microfinance institutions offer an option to poor individuals which increases their wages. Hence the observed wage in the village increases when the microfinance institution is present.

Finally, we analyze the effect of the presence of competing banks on the probability of default of a borrower. In our theoretical model increasing the number of banks allows individuals to access a profitable savings technology even after defaulting on their current loan. Hence, increasing the availability of banks increases the default rate of borrowers. We find that borrowers that have access to other banks have, in fact, a higher probability of default.

Our paper provides a novel reason for the success of the microfinance programs by abstracting from group liability issues and highlighting the deposit side of microfinance programs. Moreover, empirical evidence supports our main theoretical results. Our theoretical setup embeds the reasons of loan default in a dynamic equilibrium model with overlapping generations of households that borrow and save, which is a novel approach in the literature on banking for the poor. Moreover, we analyze the dynamics of a financially constrained bank in the context of microfinance lending.

The remainder of this paper is structured as follows. Section 2 presents the theoretical model.

[7] See Anderson (2007) and references therein.

Section 3 analyzes the equilibrium of the model. Section 4 presents the theoretical results on the optimal composition of bank's borrowers. Section 5 presents the data that we use in our empirical analysis. Section 6 presents the empirical results. Finally Section 7 concludes.

2 The Model

Consider a discrete time, infinite horizon economy where dates are denoted by $t = 0, 1, 2...$ The economy consists of an infinitely lived agent called the banker and overlapping generations of individuals living for three dates.

2.1 Individuals

At each date t, a continuum of measure N of penniless individuals are born. They all have the same preferences for consumption at dates $t+1$ and $t+2$ described by the function

$$u(c_{t+1}) + \delta u(c_{t+2})$$

where $u(c)$ satisfies $u'(c) > 0$ and $u''(c) < 0$, and $\delta < 1$ is an intertemporal discount factor.

Each individual i is characterized by a parameter θ_i which is constant during the individual's life and unobservable by third parties. The distribution of θ among the newborns is described by a time invariant, continuous distribution function $F(\theta)$ with support $[\underline{\theta}, \overline{\theta}]$. Let $f(\theta) = F'(\theta)$ denote the corresponding density function. Parameter θ_i should be understood as individual i's potential (labor or informal) income. To simplify the presentation we assume $u(\underline{\theta}) = -\infty$.

The date in which they are born, individuals have the possibility of investing in a project that has a unit cost and yields a time invariant deterministic return $1 + \alpha$ at the following date. In order to undertake the project, they require a unit loan from a bank at a (net) loan rate l.

At date t, newborn individuals decide whether to borrow in order to undertake the project or obtain their specific alternative income θ_i.[8] At date $t+1$ individuals decide whether to repay the

[8] To lighten notation, subindex i which identifies the borrower will be dropped when unnecesary.

loan and the amount of savings to deposit in the bank. At date $t+2$, individuals consume θ_i and the proceeds from savings if they have saved. Hence, parameter θ_i captures two different types of income. At date $t+1$, it captures the potential income the individual could obtain from the labor market, so this can be understood as the outside option of individual. At date $t+2$, it mainly captures the family care the individual expects to receive when old. Although θ_i could potentially be different in both periods, it is reasonable to assume that it will be positively correlated. Richer families give better opportunities to their young members and also provide better family care when old. In order to simplify the notation, we assume that this correlation is equal to one and, hence, θ_i is the same at dates $t+1$ and $t+2$. The model delivers the same qualitative results if we assumed positive correlation between θ_i at both dates. Henceforth, we will simply refer to θ_i as the outside option of individual i.

Defaulting on the loan increases the individual's current income as her earnings are $1+\alpha$ instead of $\alpha - l$. However, by defaulting the individual loses the opportunity to access the savings technology offered by the bank and use it to increase her consumption when old. The opportunity to save is lost because (i) the defaulting individual will not deposit her savings in the bank in order to avoid their seizure, and (ii) saving other than through bank deposits is not possible.[9] Hence, when the individual does not repay the loan, her income when old is equal to θ_i.

Formally, an individual with outside option θ does not default on the loan if the utility from repaying the loan and saving at a net deposit rate d, $U_r(l,d,\theta)$, is higher than the utility from default, $U_n(\theta)$. The utility of defaulting on the loan is

$$U_n(\theta) = u(1+\alpha) + \delta u(\theta).$$

[9]This assumption is supported by empirical findings in Banerjee and Duflo (2007). They note that savings outside of the banking system are not profitable in poor countries because of events such as inflations, natural catastrophes and thefts by strangers or by (male) family members. Our model could incorporate a cost of saving outside of the banking sector, $1-\lambda$. Parameter λ should be understood as the probability of losing the savings when saving outside of the banking industry. For exposition purposes we assume $\lambda = 1$. Appendix C presents a model with competing savings alternative.

The utility from repaying the loan is obtained by solving the following program:

$$U_r(l,d,\theta) = \max_{s\geq 0} \left[u(\alpha - l - s) + \delta u(\theta + s(1+d))\right]$$

where s are borrower's savings invested in bank deposits. The first term of the objective function is the utility from current consumption after the savings decision has been made. The second term is the discounted utility from consuming θ and the proceeds from savings tomorrow.

In order to simplify the analysis we assume that the gross return of the investment project is smaller than the gross discount rate, $1+\alpha < 1/\delta$. Since in equilibrium the deposit rate d, will not exceed the loan rate l, which in turn will not exceed the net return of the project α, this implies $1+d < 1/\delta$. From here it follows that $u'(\theta) \geq \delta(1+d)u'(\theta)$, so individuals who do not borrow will not want to save. We also assume that the upper bound of the support of the distribution satisfies $\overline{\theta} \leq 1+\alpha$. This guarantees that all individuals want to borrow from the bank because by doing so they can always get $U_n(\theta) = u(1+\alpha) + \delta u(\theta)$, which is greater than $u(\theta) + \delta u(\theta)$.

In Section 3 we show that there is a threshold $\widehat{\theta}(l,d)$ such that $U_n(\theta) \leq U_r(l,d,\theta)$ for all $\theta \leq \widehat{\theta}(l,d)$. In other words, poorer individuals, those with $\theta \leq \widehat{\theta}(l,d)$, are those who repay the loan. Hence, the fraction of performing loans is given by $F(\widehat{\theta}(l,d))$. Finally let $s(l,d,\theta)$ denote the optimal savings of individuals with $\theta \leq \widehat{\theta}(l,d)$.

2.2 The banker

The banker is assumed to be risk neutral and has an initial wealth $W < N$, which prevents him from lending to all individuals at the initial date $t = 0$. The banker maximizes the discounted stream of dividends

$$\sum_{t=0}^{\infty} \beta^t C_t \tag{1}$$

where β is the banker's intertemporal discount factor and C_t are the bank's dividend payments at date t.

At date $t = 0$ the banker sets up a bank by providing initial capital with his wealth. The bank supplies loans and offers interest bearing deposits to individuals. The bank operates in an economy with no other external sources of financing. Hence, it can finance loans only with deposits and accumulated reserves.

At each date t, the bank sets a loan rate l_t, and a deposit rate d_t, issues loans in amount L_t and collects deposits D_t. Loans are supplied to newborns and deposits are the total amount of savings from those who were granted a loan at date $t-1$ and repaid it at date t. When setting loan and deposit rates the banker takes into account that both variables affect the optimal decision of repayment and savings of its borrowers.[10] The bank also decides the amount of loans it grants at every date taking into account that, due to the cash flow constraint, granting an additional loan reduces the amount of money he is able to disburse as dividends.

Hence, the bank's problem at any date t can be stated as

$$\max_{\{L_t, l_t, d_t\}_{t=\tau}^{\infty}} \quad \sum_{\tau=t}^{\infty} \beta^{\tau-t} C_t$$

subject to the following constraints

$$C_t = (1 + l_{t-1}) F(\widehat{\theta}(l_{t-1,}, d_t)) L_{t-1} + D_t - (1 + d_{t-1}) D_{t-1} - L_t \tag{2}$$

$$D_t = L_{t-1} \int_{\underline{\theta}}^{\hat{\theta}(l_{t-1}, d_t)} s(l_{t-1}, d_t, \theta) f(\theta) d\theta \tag{3}$$

$$L_0 \leq W \tag{4}$$

$$C_t \geq 0 \tag{5}$$

The first constraint is the cash flow constraint. At any date t, dividend payouts C_t must be equal to the proceeds from loan repayments plus the new deposits that the bank obtains minus the deposit repayments the banker has to meet and the new loans that the bank grants.[11]

[10] The characterization of how the optimal decision of individuals are affected by loan and deposit rates is presented in Section 3.

[11] Recall that $F(\widehat{\theta}(l_{t-1,}, d_t)$ is the fraction of loans that do not default at date t.

The second constraint defines bank's deposits at every date as the optimal savings of the individuals who repay the loans granted the previous date. The third constraint states that, at the initial date $t = 0$, the bank cannot grant more loans than the banker's initial wealth. Finally, the fourth constraint indicates that the bank cannot pay a negative dividend at any given date t.

3 Equilibrium

The equilibrium of the model is defined as a sequence of loan and deposit rates as well as total loans at each date t that maximizes the discounted stream of dividends of the bank given the optimal decisions of the individuals.

3.1 Individuals' optimal decisions

Individuals, when deciding whether they default on the loan or not, take into account the amount of savings they deposit in the bank in the case of not defaulting. Hence in this subsection we first find out the amount of savings individuals would deposit in the bank if they repay and, once we characterize the optimal savings decision in the case of not defaulting, we analyze the decision of defaulting on the loan or not.

As previously described, optimal savings $s(l, d, \theta)$ result from the optimization problem of those individuals who repay the loan

$$s(l, d, \theta) = \underset{s \geq 0}{\arg\max} \ [u(\alpha - l - s) + \delta u(\theta + s(1 + d))]$$

Optimal savings are implicitly defined by the following first order condition

$$u'(\alpha - l - s) = \delta(1 + d)u'(\theta + s(1 + d)). \tag{6}$$

Let θ_s denote the level of θ for which optimal savings are 0, that is θ_s is the value of θ for which $u'(\alpha - l) = \delta(1 + d)u'(\theta)$ holds. Using the implicit function theorem, it follows that for individuals with $\theta < \theta_s$ we have

$$\frac{\partial s(l,d,\theta)}{\partial \theta} = -\frac{\delta(1+d)u''(\theta+s(1+d))}{u''(\alpha-l-s)+\delta(1+d)^2u''(\theta+s(1+d))} < 0.$$

As θ decreases individuals increase their savings since savings are used to smooth lifetime consumption and those individuals with a lower θ have higher differences in their earnings.

Once we have determined the optimal savings decisions when individuals repay the loan, we focus on determining the fraction of borrowers who repay the loan, which in turn defines the amount of bank deposits.

Taking into account that an individual decides to default when the utility of repaying, $U_r(l,d,\theta)$, is lower than the utility of defaulting on the loan, $U_n(\theta)$, we obtain the following result.

Proposition 1 *There exists a threshold, $\widehat{\theta}(l,d)$, for which the individuals with a lower θ repay the loan and the individuals with a higher θ do not. Moreover, it holds that $\widehat{\theta}(l,d) < \theta_s$.*

Proof. Let $\Delta(l,d,\theta) = U_r(l,d,\theta) - U_n(\theta)$ denote the difference in utility from repaying the loan or not:

$$\Delta(l,d,\theta) = \begin{cases} u(\alpha-l-s)+\delta u(\theta+s(1+d)) - u(1+\alpha) - \delta u(\theta) \text{ for } \theta \in [\underline{\theta},\theta_s] \\ \\ u(\alpha-l) - u(1+\alpha) \text{ for } \theta \in (\theta_s,\overline{\theta}], \end{cases}$$

where $s = s(l,d,\theta)$ are the optimal savings of individuals. Observe that Δ is continuous in θ, by the continuity of $u(c)$.

Moreover $\Delta(l,d,\theta)$ is strictly decreasing for all $\theta \in [\underline{\theta},\theta_s)$. Differentiating $\Delta(l,d,\theta)$ and using the envelope theorem, together with the fact that optimal savings in the range $[\underline{\theta},\theta_s)$ are positive and $u''(c) < 0$, we obtain

$$\frac{\partial \Delta(l,d,\theta)}{\partial \theta} = \delta\left[u'(\theta+s(1+d)) - u'(\theta)\right] < 0.$$

Finally, $\Delta(l,d,\theta)$ is positive for θ near $\underline{\theta}$ as $\lim_{\theta\to\underline{\theta}} \Delta(l,d,\theta) = +\infty$ by $u(\underline{\theta}) = -\infty$, and it is clearly negative for $\theta \in (\theta_s,\overline{\theta}]$. From the monotonicity of $\Delta(l,d,\theta)$ and its values on $\underline{\theta}$ and θ_s, we conclude

that there exists a threshold $\widehat{\theta}(l,d)$, such that $\Delta(l,d,\theta) > 0$ when $\theta < \widehat{\theta}(l,d)$, which means that borrowers with $\theta < \widehat{\theta}(l,d)$ repay the loan. On the other hand, for individuals with $\theta > \widehat{\theta}(l,d)$, it is satisfied that $\Delta(l,d,\theta) < 0$, which means that borrowers with $\theta > \widehat{\theta}(l,d)$ default on their loan.

The second result follows from the above proof because if $\Delta(l,d,\theta)$ is strictly decreasing on $[\underline{\theta},\theta_s)$ and $\Delta(l,d,\theta)$ is negative for θ_s then it must be that $\widehat{\theta}(l,d) < \theta_s$. ■

Proposition 1 states that individuals with a low future income θ, do not default on their loans. This is because these individuals place more value on an increase in their future consumption. In order to achieve this they have to deposit their savings in the bank, and if they do not repay the loan, the bank will seize their deposits as a way to have their loan repaid.[12]

When setting loan and deposit rates the bank takes into account how they affect the repayment behavior of its borrowers. Comparative static results for the threshold that determines the default rate, $\widehat{\theta}(l,d)$, are summarized in the following Lemma.

Lemma 1 *The threshold $\widehat{\theta}(l,d)$, and consequently the fraction of non defaulting loans in the economy $F(\widehat{\theta}(l,d))$, is decreasing in the loan rate l and increasing in the deposit rate d.*

Proof. The threshold $\widehat{\theta}(l,d)$ is implicitly defined by the equation

$$u(\alpha - l - s) + \delta u(\widehat{\theta} + s(1+d)) = u(1+\alpha) + \delta u(\widehat{\theta}).$$

Decreasing (increasing) the loan (deposit) rate increases the left hand side of the equation without any effect on the right hand side. Hence the previously indifferent individual is now better off by not defaulting on the loan. ■

Lemma 1 states that individuals with a higher θ start to repay their loans when the loan rate decreases or the deposit rate increases. In such cases the profitability of repayment increases

[12] In the context of our model the only way an individual can only increase his future income is by saving. Another approach which yields the same qualitative results would be the assumption of infinetly lived individuals who receive a loan whenever they do not default on their previous loan. This setup would however complicate the solution for the bank optimal decision of loan and deposit rates.

making it more attractive for the individuals to pay back the loan. The bank will take into account this effect when setting the equilibrium loan and deposit rates.

3.2 Bank's optimal strategy

To derive the optimal strategy of the banker we rely on the existence of two commitment devices. The first of them is that the banker is able to commit not to receive deposits from those individuals that do not repay the loan. The second is that the banker repays those deposits that have been deposited in the bank.

Concerning the first commitment, it can be argued that it is not optimal for the banker to repay deposits from individuals who defaulted on their loan. The banker when receiving deposits from those individuals, has the right not to repay them, as the individual has a debt with the bank, and by doing so, the banker increases his revenues. Hence, if the individual does not repay the loan, he wwill not deposit in the bank to avoid the seizure of her deposits.

The second commitment device relies on the assumption that at any given date the continuation value of the bank is higher than the amount of deposits it has to repay. When a banker does not repay its deposits the borrowers will not deposit their savings in the bank because they anticipate that in future dates the bank will do the same. This leads to all individuals defaulting if the bank does not pay back the deposits, so continuing with the bank will not be profitable.[13] Hence, we assume that at any given date the banker is better off by continuing with the bank than by defaulting on its deposit repayment obligations.

The optimal strategy of the bank is defined by the amount of loans it grants at each date as well as the loan and deposit rates that it sets. The first decision concerns the optimal amount of loans, which in turn defines the optimal dividend policy since the cash flow constraint establishes that by granting an additional unit loan the banker decreases his current dividend by one unit. It

[13]Note that if this condition did not hold the bank would not be established. Individuals would anticipate bank behaviour and, by backwards induction, the result would be that individuals would never deposit in the bank, which would make the bank not profitable in the initial date.

must be taken into account that, due to the banker's intertemporal discount factor, keeping cash without disbursing it in order to disburse it in the future is not optimal. Thus, all cash that is not used in granting new loans is paid as dividends to the banker.

When the bank considers granting a loan to a newborn at date t it acknowledges that this decreases the dividends at date t, but has two additional effects on future earnings. First, at date $t+1$ the bank has higher revenues from loan repayment as a higher number of individuals obtained a loan. Second, as more individuals get loans, the aggregate supply of deposits at date $t+1$ is higher at the given rates. This effect has a negative impact at date $t+2$ because the bank has to repay a higher amount of deposits.

The marginal effects on banker's payoff of increasing the supply of loans to newborns is then given by

$$-1+\beta\left[F(\widehat{\theta}(l_t,d_{t+1}))(1+l_t)+(1-\beta(1+d_{t+1}))\int_{\underline{\theta}}^{\widehat{\theta}(l_t,d_{t+1})}s(l_t,d_{t+1},\theta)f(\theta)d\theta\right]. \tag{7}$$

Note that the value of expression (7) does not depend on the amount of loans granted and that the existence of the bank is conditional on it being positive. If (7) were negative then the banker would refrain from investing any of its initial wealth in the bank. Hence, because expression (7) is positive when the bank exists, then it is optimal for the bank to increase the loan supply as long as it has the opportunity of granting a loan to a newborn. This makes constraint (5) in the banker's problem bind whenever $L_t < N$. Constraint (4) is also going to be binding, as initially the bank cannot grant loans to all of the newborns (because $W < N$).

Once the bank grants loans to all of the young generation N, no further loan disbursement is profitable as the bank can only grant additional loans to old individuals, who always default as they have no incentives to repay. Hence, whenever the available funds after bank's deposits have been repaid are higher than the amount needed for granting loans to the new generation, $(1+l_{t-1})F(\widehat{\theta}(l_{t-1},d_t))L_{t-1}+D_t-(1+d_{t-1})D_{t-1}>N$, the bank will grant N loans to the newborns and pay out the rest of the revenues as dividends.

We can summarize this discussion in the following result.

Proposition 2 *As long as there are growth opportunities, $L_t < N$, dividends are equal to 0. Once the growth opportunities are exhausted, $L_t = N$, dividends are positive.*

Proposition 2 establishes that when growth opportunities are exhausted (steady state) the bank is going to have positive cash flows, which it will pay out as dividends. These dividends are defined by the following equation:

$$C = (1 + l^*)F(\widehat{\theta}(l^*, d^*))N - (1 + d^*)D - N + D$$

where l^* and d^* are the equilibrium loan and deposit rates in steady state. In order to determine the optimal dividends we solve the optimal loan and deposit rates that the bank sets at each date.

The Euler equation that characterizes the equilibrium loan rate l_t set at each date t is:

$$\left[(1 + l_t)\frac{\partial F(\widehat{\theta}(l_t, d_{t+1}))}{\partial l_t} + F(\widehat{\theta}(l_t, d_{t+1}))\right] L_t + (1 - \beta(1 + d_{t+1}))\frac{\partial D_{t+1}}{\partial l_t} = 0. \tag{8}$$

When setting l_t the banker internalizes that increasing the loan rate decreases the repayment rate of loans, the first term in square brackets, but increases the payoffs from those individuals which repay, the second term in square brackets. Moreover, increasing the loan rate affects the amount of deposits the bank obtains in the next period, which it has to repay two periods after, the last term in equation (8).

The Euler equation that characterizes the equilibrium deposit rate d_t set at each date t is:

$$\left[(1 + l_{t-1})\frac{\partial F(\widehat{\theta}(l_{t-1}, d_t))}{\partial d_t}\right] L_{t-1} + (1 - \beta(1 + d_t))\frac{\partial D_t}{\partial d_t} - \beta D_t = 0 \tag{9}$$

When setting d_t the bank internalizes that increasing the deposit rate increases the repayment of loans granted at $t - 1$, which increases its revenues at date t, the first term in equation (9). The bank also takes into account that increasing the deposit rate affects the amount of deposits it receives at a given date and the amount it has to repay at the following date.

The first term in equation (9) highlights an interesting feature concerning the complementaries between loan and deposit rates in this model. As highlighted in Proposition 1, deposit rates have an incentivizing effect for the repayment of the current loans. This matches the observed empirical finding that the Grameen Bank offers a higher deposit rate to its borrowers than the rate offered by traditional banks in Bangladesh. The Grameen Bank reports to pay 8.5% deposits to its borrowers when the average deposit rate for deposits in the Bangladesh banking sector is 5%.[14] According to our model, the reason behind this fact is that the Grameen Bank obtains higher repayments using deposit rates as an incetivizing device. We argue that traditional banks in Bangladesh, as they operate in a more competitive environment (urban areas) in which individuals are able to deposit savings in other banks, do not benefit from this effect and, hence, set a lower deposit rate.

Equations (8) and (9) establish that the optimal loan and deposit rates are constant during bank's lifetime and hence, independent of the dividend payout policy. Recall that $D_t = L_{t-1}\int_{\underline{\theta}}^{\hat{\theta}(l_{t-1},d_t)} s(l_{t-1},d_t,\theta)f(\theta)d\theta$ and hence, equations (8) and (9) do not depend on L_t and L_{t-1} respectively. Hence, the bank solves the same system of two equations with two unknowns at each date t. The main objective when jointly setting l_t and d_t is to maximize the revenue of the bank independently of the final use of this revenue. We can summarize this discussion in the following result

Proposition 3 *Loan rates and deposit rates are constant during bank's lifetime and, hence, independent of the dividend payout policy.*

The fact that loan and deposit rates are constant sets expression (7) to be constant as well, which in turn results in an exponential growth of the bank. Recall that as long as growth opportunities are present the bank invests all of the revenues in increasing the loan supply.

This section has shown that a financially constrained profit maximizing bank will not pay any dividends. This is important to be highlighted as it has been argued that the non-disbursement of

[14]Sources: Central Bank of Bangladesh and Grameen Bank.

dividends is evidence that the Grameen Bank was not a profit maximizing agent. The conclusion that when profitable investment opportunities are available dividends are equal to zero, closely matches the fact that the Grameen Bank did not disburse dividends until 2006. From 1983, the year of its establishment, until 2006 the Grameen Bank has had an increasing presence in the rural villages of Bangladesh. By the end of 2006, the Grameen Bank was present in over 95% of the rural villages of Bangladesh. Hence, it can be argued that at this point the Grameen Bank had covered its entire objective market, and therefore exhausted all of the profitable investment opportunities. In line with our theoretical prediction, at the end of 2006 the Grameen Bank for the first time in its history paid dividends. Consistent with our predictions, dividends were also disbursed at the end of 2007.

Another important issue that our theoretical model highlights is the reinforcement effect that the deposit rates have on loan repayment. When such an effect is taken into account, the optimal deposit rate is higher which can account for the fact that the Grameen Bank pays a higher deposit rate than other banks in Bangladesh. This reinforcement effect, added to the importance of deposits in a financially constrained bank, highlights the importance of analyzing lending and borrowing decisions at the same time in a relationship banking setup.

4 Heterogenous distributions of outside options

Our previous analysis has assumed that the outside option θ of all individuals was drawn from the same cumulative distribution function $F(\theta)$. It may be argued that in fact there are different distributions of outside options among different types of individuals, for example men and women, or landowners and landless. As we show in this section being able to differentiate among types of individuals with different distributions of outside options can be the key to bank's survival, as only banks that focus on individuals with lower expected income are going to be profitable. We also discuss the difference between repayment rates and profitability when the bank grants loans and at the same time offers deposits.

In this section we relax the assumption of a unique distribution function and assume that there are two different distributions of outside options.[15] We assume that a fraction γ of individuals have their outside option drawn from a distribution F_1 and a fraction $1-\gamma$ from F_2. We assume that F_2 first-order-stochastically dominates F_1, hence $F_1(\theta) > F_2(\theta)$ for all θ. This fact, together with the results from the previous section, gives the following two Propositions.

Proposition 4 *For given l and d a banker who focusses on individuals whose distribution of θ is first-order-stochastically dominated will have higher repayment rates.*

Proof. Those individuals for whom their θ comes from F_1 have worse outside options on average than those whose θ comes from F_2. Using Proposition 1, we can show that for a given l and d the repayment rate is higher for individuals under F_1 than for those under F_2, i.e. $F_1(\widehat{\theta}(l,d)) > F_2(\widehat{\theta}(l,d))$. ■

At this point the difference between repayment rates and profits must be studied. Although Proposition 4 establishes that repayment rates are higher for banks that grant loans to individuals under F_1 the profits per loan of the bank focussing on such individuals may not be higher. Let $\pi_1(l,d)$ denote the the average profits per loan from individuals of type F_1. Using the exposition of Section 2 we can define $\pi_1(l,d)$ as

$$\pi_1(l,d) = -1 + \beta\left[(1+l)F_1(\widehat{\theta}(l,d)) + S_1\right] - \beta^2(1+d)S_1 \tag{10}$$

where $S_1 = \int_{\underline{\theta}}^{\hat{\theta}(l,d)} s(l,d,\theta) f_1(\theta) d\theta$ are the average savings per unit of loan and f_1 is the density function of F_1.

We have shown that the repayment rates, for given l and d, increase when the bank focusses on individuals of type F_1, which in turn increases the profits of the bank. However, by focussing on such individuals, the deposits that the bank has to repay also increase (recall that poorer individuals save more). This effect may in turn decrease the profits of the bank which focusses on

[15] The qualitative results hold if we assume a higher number of distribution functions.

individuals with worse outside options.[16] Hence, when analyzing the profitability of microfinance institutions the repayment rate is not be the only variable to be taken into account. Attention should also be paid to the effect that deposits have on the profits.

When deposits have a positive effect on the profits of the bank, it is obvious that focussing on individuals of type F_1 is optimal as repayment rates increase and also deposits increase. However, when deposits decrease the profits of the bank, the bank should impose a maximum amount of deposits per borrower equal to $s(l, d, \hat{\theta})$. This will not decrease its repayment rates, as individuals with $\theta < \hat{\theta}$ will continue to repay their loans (this follows immediately from the proof of Proposition 1) and it will decrease the amount of deposits it obtains. When this measure is taken into account, it is easy to show that focussing in individuals with the worse distribution of outside options increases the profitability of the bank.

Let l_2, d_2 denote the equilibrium loan and deposit rates that maximize $\pi_2(l, d)$. By the previous exposition, when deposits decrease the profits of the bank, the bank will set a maximum deposit amount equal to $s(l, d, \hat{\theta}(l_2, d_2))$. From equation (10) a bank focussing on distribution F_1 and setting the same loan and deposit rates, and the same maximum amount of deposits per individual will have higher profits. Note that the repayment rate increases and the amount of deposits per individual S_1 does not vary.[17] Hence we can conclude that by focussing on individuals with worse outside options the banker will increase his profits.

From the previous discussion we can conclude that the ability to distinguish between different types of individuals plays a crucial role in the existence of a bank. When F_1 and F_2 are not observable by the banker, the banker faces a distribution

$$F_m(\theta) = \gamma F_1(\theta) + (1 - \gamma)F_2(\theta).$$

Following the previous exposition, there may be cases in which a banker that focusses on F_1 has

[16] This occurs when in equilibrium $\beta(1 + d) > 1$.

[17] Also it must be take into account that the banker can always set the deposit rate to be 0 and not lose in deposits.

positive profits but the banker focussing on F_m has negative profits. In this cases the banker able to distinguish between $F_1(\theta)$ and $F_2(\theta)$ will set up a bank and lend only to individuals whose θ comes from $F_1(\theta)$. The banker who observes only $F_m(\theta)$ will not find it profitable to set up a bank. This can be an important issue when establishing a microfinance program. For the microfinance program to be profitable, the banker must have the ability of distinguishing those individuals with worse outside options. The banker with such ability will focus on individuals with low outside options and by doing so increase the profits of his bank.

5 Data description

To conduct our empirical analysis, we use data from a quasi experimental survey conducted jointly by the World Bank and the Bangladesh Institute of Development Studies. The survey's main purpose is to provide data for analyzing three microfinance programs in Bangladesh: the Grameen Bank, the Bangladesh Rural Advancement Committee, and the Rural Development-12 program of the Bangladesh Rural Development Board. We analyze the information from the 1998-1999 wave containing information on 15,553 individuals from 2,599 randomly chosen households. These households come from 96 villages of 32 thanas.[18] A detailed description of the survey can be found in Khandker (1998). The main characteristic that must be highlighted is that it is a cross section, and hence, we cannot apply panel data techniques to our data.

The survey contains details on personal and financial characteristics of the individuals in the surveyed households, as well as on the social and economic characteristics of villages in which these households live. For the purpose of our empirical analysis we mainly focus on those households which report taking loans. From the total number of 7,396 loans in the sample, we are able to use information regarding 6,385 loans. The main reason for this reduction is lack of information on the date of maturity of these loans, which precludes qualifying the loan as defaulted or not. We classify a loan as defaulted when one of the following conditions holds: (i) the borrower reported

[18] Thana is an administrative unit consisting of several villages.

a reason for default, or (ii) the loan has not been repaid in full 3 months after the due date.[19] According to this definition, we classify 768 loans as defaulted in our sample. We conduct our analysis with a base number of 6,385 observations, which vary depending on the control variables we use.

For the loans in our analysis, we have detailed information on the features of these loans, e.g. amount given and repaid, loan rate, dates when they were taken, due and repaid, the lender type, as well as on the personal and financial characteristics of the borrowers, like age, education, gender, number of people providing income in the household, income and savings. It must be taken into account that reported loans were taken in years ranging from 1993 to 1999. Personal characteristics of the borrowers (except of age) are available only for loans taken in 1997 and later, as the survey was conducted in 1998 and 1999, and only information regarding the 12 months preceding the survey was obtained. This reduces the sample when introducing personal characteristics in our regressions.

6 Empirical evidence

This section provides empirical evidence in favor of Proposition 1, which states that borrowers with lower outside options are more creditworthy, and Proposition 4, which states that banks focussing on individuals with lower outside options exhibit higher repayment rates.

6.1 Higher outside options result in higher defaults

In this subsection, we present evidence on the importance of outside options in determining loan repayment. Using a logit model with robust standard errors we estimate the impact of three proxies of borrowers' outside options on the probability of default. As proxies of outside options we use the borrower's gender, the average wage in the borrower's village by gender, and the amount of dowry received by the borrower's family at the time of the borrower's marriage.

[19] The standard period after which the loan is classified as defaulted is 3 months. Our results are robust to changes in the number of months that classifies a loan as defaulted.

When indicated we control in our regressions for the following variables: borrower's age and education, the borrower's and other household members' income, the ratio of household members without income to those providing it (called the dependency ratio), the number of children the borrower has and the source of loan. The full description of the variables is in Appendix A. The descriptive statistics are in Table 1.

6.1.1 Gender and expected wages

We claim that in Bangladesh the borrower's gender is a strong predictor of an individual's outside option. Being born a woman in rural areas of Bangladesh results in lower wages and lower chances of finding employment.[20] This allows us to conclude that the borrower's gender is a good proxy of the outside option in our model of loan default. We construct a dummy variable that takes a value 1 for female borrowers. Consistent with our theory we expect female borrowers to have lower probabilities of default.

Column (1) in Table 2 reports the estimates of the logit regression of default on the borrower's gender. As expected, the gender's coefficient is negative and significant. This finding is in line with the majority of studies on microfinance stating that female borrowers are more creditworthy.[21] Although several studies have documented this result before, these studies lack an economic explanation for the underlying causes of this effect. Various studies have stressed intrinsic characteristics of women, such as being more risk averse than men. In contrast, we argue that different economic conditions lead to different repayment behavior by female borrowers. More specifically, lower outside options imply higher repayment rates.

In order to better assess the importance of gender, we provide in column (2) of Table 2 estimates from a regression with an extended set of control variables. In this case our sample is reduced to 3,790 observations, mainly because we are only able to use those loans for which we have the data on

[20] Table 1 shows that the average female wage is smaller than the average male wage. We do not have data on the unemployment rate in each village needed to compute the expected wage. Statistics from the World Bank state that female unemployment in rural Bangladesh is 50% higher than male unemployment.

[21] See Armendariz and Morduch (2005) for a survey of this literature.

the controls; i.e. we only use loans taken from 1997 onwards. The set of control variables includes the borrower's age, education, income, income of other members of the borrower's household, dependency ratio, and number of children.

The impact of gender is still negative and significant reflecting, according to our proposed interpretation, the effect of women's lower outside options. The borrower's education, which can be regarded as a proxy for skills, also has a positive and significant impact on the default probability. The income generated by the borrower and other members of the borrower's household, as well as the dependency ratio, are meant to control for individual and household exposure to specific shocks such as natural catastrophes or medical needs. The coefficients on the income variables are not significant. The coefficient on the dependency ratio is positive and significant, reflecting that, when a higher fraction of members do not generate income, the borrower is more vulnerable to negative shocks such as a medical expenditure and more likely to default. Finally, we also introduce the number of children as a control variable, although it is not significant.

As we have previously argued, women have lower wages than men in rural Bangladesh, and this can be one important factor explaining the gender gap in loan repayment. To further address this issue, we create a variable which is the average wage that the individuals receive in each village by gender. This measure is a proxy for the expected wage of the borrower and, by construction, it is no longer borrower specific since all borrowers of the same gender who live in the same village are imputed the same wage. All individuals surveyed, independently of having borrowed or not, report the wages they earned while working as employees in the non-agricultural sector. By averaging these wages by gender in each village we construct a proxy for the outside option of the borrower.

Column (3) in Table 2 reports the results of the regression of default on the average wages in the village while preserving the gender dummy. It shows that for both men and women the coefficient on the average wage is positive and significant, which is in line with our Proposition 1. The following regression reported in column (4) confirms the previous results when we add the controls used in previous regressions. In this regression the education loses its positive and

significant sign. It may well be that education proxies for the effect of wages at least to some extent. It is reasonable to assume that villages with high wages will also have more education, as wages and education are known to be positively correlated.

As we have just shown, introducing economic factors such as the borrower's expected wage in the village helps to explain the gender gap in loan repayment. This is consistent with our explanation of gender being a proxy for the outside option of the borrowers, and differs from other informal explanations in the literature.

6.1.2 Dowry

In order to better assess the importance of borrowers' outside options for their repayment behavior we use the dowry exchanged in the marriage. The literature concerning dowry has documented that wealthier families pay higher dowries and that the dowry received by the borrower's family increases with her/his expected income.[22] In the context of our model, coming from a wealthier family increases the outside option of the borrower because wealthier families are able to provide better prospects for their relatives. This ranges from offering better labor opportunities to providing monetary and in kind transfers in case of need.

Our dowry variable is constructed in such a way that both spouses in the marriage have the same imputed dowry. Hence, it is not going to be suitable to explain the gender gap. However, it is suitable to test Proposition 1 regarding the importance of the outside options in loan repayment behavior.

Column (1) in Table 3 reports the estimates from a regression of default on dowry. The sample is reduced to 5421 loans as only for this number of loans we have reports on the amount of dowry exchanged. It must also be taken into account that not all borrowers are married. In this regression we also include the gender dummy. The coefficient on the dowry is positive and significant. As reported in column (2) of Table 3 this result is robust to including the controls used in the previous

[22] See Anderson (2007) for a survey of the literature.

regressions.

As we have previously argued, dowry can be interpreted as a measure of the expected future income of the individuals. Following such reasoning the current income of the individuals can be instrumented by dowry in order to control for unobservable shocks that are related to current income and default, like robbery and natural catastrophes. In such case dowry would capture the part of the individuals income which is not affected by the shocks, which can be seen as the expected outside option of the borrower. Column (3) shows the result of a probit estimation in which the variable income has been instrumented by the dowry exchanged by the individuals.[23] The results of such estimations is that higher income, once instrumented, leads to higher default.

6.1.3 Robustness check concerning dowry

One concern while using dowry as a proxy for outside options is the high percentage of reports of no dowry being received. Marriages reporting no dowry received account for around 50% of the sample. In order to control for different explanations why no dowry was given, such as being extremely poor and not being able to raise money for a dowry or having different marriage traditions, we run our regression on a constrained sample of borrowers reporting a positive dowry. Column (4) in Table 3 shows the results of this robustness check. It can be seen that restricting our sample only to individuals with a positive dowry does not change our results.

Another concern regarding the dowry is the possible existence of misbehavior by the borrowers receiving dowry. A dowry exchange is illegal in Bangladesh meaning that a person engaging in such a practice may be also prone to commit other illegal acts which may positively correlate with default, including strategic defaults. In order to test this explanation we generate a dummy reflecting whether a dowry was actually exchanged. This dummy proxies for the possibility that the individual may be prone to other misbehavior. We run a regression of default with the usual controls and the dowry dummy. Results are reported in column (5). The coefficient on the dowry

[23] Due to programming difficulties we could not conduct a logit estimation with instrumental variables. It must be highlighted that results of probit estimations do not have quantitative impact on the value of our regressors.

dummy is insignificant, meaning that the effect of a dowry is related to the levels of the variable and not to the existence or not of a dowry. This allows us to conclude that the channel through which the dowry affects repayment rates is related to the outside options of the borrowers.

Although the dowry exchange is nowadays illegal in Bangladesh, we do not expect to have a mismeasurement of the variable dowry. As the survey was not conducted by organizations capable of punishing the individuals, the incentives to lie are not clear. One of the main effects of having dowries misreported is that it would bias the coefficient of dowry towards 0, making it more difficult to find positive effects. The biggest concern would be that only individuals with high levels of dowry reported low levels of dowry and those with intermediate levels did not misreport. We argue that this is not the case in our sample as individuals have the same incentives to misreport independently of their dowry, and hence, we should not have non monotonicities in the misreporting. As we use the dowry mostly as a ranking mechanism the important assumption is that if misreporting of dowry exists in the survey, this does not affect the ranking. Hence, if misreporting exists, we assume that on average individuals with higher dowry have higher reported dowry.

6.1.4 All proxies

In the last column of Table 3 we report the estimates of a regression including all proxies for outside options and all controls. All coefficients used as proxies of outside options preserve their signs. The most important result of that regression is that the impact of the gender dummy is strongly reduced and it looses its significance. The loss in significance backs further our result that being a female borrower translates into low outside options. This supports Proposition 1 and goes against the informal explanations addressing the gender gap in repayment behavior. The loss of significance is in line with a claim posed by Armendariz and Murdoch (2005) who argue that, having controlled for sufficient amount of borrowers' characteristics, gender will not matter for the repayment behavior of the borrowers.

6.2 Borrowers' composition depends on institutions

Next, we focus on empirical evidence consistent with section 4. In order to support this result we conduct a test of difference in means concerning the percentage of female borrowers, the level of dowry of the borrowers and the expected wages by gender in the village. We also test if microfinance institutions have a lower fraction of defaulting loans.

Table 4 shows that, as predicted by our model, we find that the Grameen Bank exhibits higher repayment rates and focuses on borrowers with lower outside options. The microfinance institutions have a statistically significant higher amount of female borrowers and the average dowry exchanged by a borrower in the microfinance institution is lower than for the other lenders. Concerning the expected wage in the village, we see that the microfinance institutions do not focus on villages with lower wages. This however may be the result of the microfinance institutions' lending practices. By lending in those villages, the supply of cheap labor is reduced and the equilibrium wage of the village is increased.

6.2.1 Controlling for the lender type

It can be argued that, due to the different selection procedure followed by the institutions, our previous proxies for the outside options of the borrower were in fact proxies for the lender type, mainly those regarding female and dowry. The problem of selection in the microfinance programs has been previously treated in the microfinance literature by authors such as Khandker.[24] In order to test whether our results are stable after controlling for the lender type, we introduce a dummy indicating the type of the lender. There are several sources of lending indicated in the sample and we pool them into six groups, which indicate the common features of these lenders. These groups are microfinance institutions, relatives, moneylenders, cooperatives of credit, traditional banks and non-governmental agencies. Table 5 presents estimates of four regressions: three for each of the measures of outside options taken separately and one that contains all of them. We conclude that

[24] See Khandker and Pitt (1998).

our results do not change. In all regressions the gender coefficient becomes small in absolute value (and looses significancy in all but one regression), which can be attributed to the fact that the majority of borrowers of microfinance institutions are women.

In order to assess the importance of all of our regressions only for the Grameen Bank borrowers we report the results of our estimations when only the borrowers of the Grameen Bank are taken into account. Table 6 shows how the qualitative results remain unchanged. Interestingly, the signs of age and education do change because when individuals become older they receive a higher loan and also they receive education. Hence, these variables can be seen as predictors of being a previous Grameen Bank borrower and not having defaulted on the loan before. In order to study this point, we include the size of the loan, which increases with the years of membership and previous repayment behavior, and we see how these coefficients loose significance. Results of including the loan amount are shown in column (3) of Table 6

6.3 The impact of competition

The theoretical predictions about the repayment behavior in our model are based on the sole existence of a monopolistic bank. The enforcement mechanism which guarantees loan repayment relies on the existence of one unique source of profitable saving technology. In our model, the inclusion of a second bank offering a savings technology results in a lower repayment rate of the original bank.[25] Individuals would default on the loan and deposit their savings in the other bank. Hence, in the case of the microfinance industry, our model predicts that when additional channels of profitable savings are available, the repayment rate decreases.

Empirically the effect of bank competition on the repayment behavior of individuals can be tested by generating an indicator of the availability of profitable saving technologies in a given village. In order to proxy for the availability of another bank, we construct a dummy that takes the value 1 if any individual in the village took a loan from a traditional bank. Implicitly we are

[25] For a theoretical model that supports this claim see the Appendix C.

assuming that traditional banks offer deposits at a competitive rate to all individuals that are willing to deposit their savings in the bank. This allows us to proxy for villages that have access to other sources of saving technology than those of the microfinance institutions. Our model predicts villages with other sources of profitable saving technology should have higher default rates than those with out such options.

Consistent with our theory, we find how living in villages with accessibility to bank services has a positive and significant effect on the probability of failure of the individuals. These results are reported on Table 7.

6.4 Further tests

Our theoretical setup has other testable implications that can be tested in the data. To test these implications we conduct difference in means tests for such cases. Results of this tests are reported in Table 8.

One empirical prediction of our model is that individuals who default will have lower savings, as they will not deposit their savings in the bank in order to avoid seizure. This pattern is observed in the data because those individuals who default have on average lower savings than those who do not. Our model also predicts that defaulting borrowers have higher income in the date they default. This is an important feature which distinguishes our theoretical model of strategic default from competing explanations. If defaults were only due to exogenous shocks, we would expect borrowers receiving a negative shock, i.e. disease or bad climate, would default but also have less income. In our model, those who default strategically have higher income than those that do not default.

The empirical finding concerning the income of defaulting borrowers supports our model, as the average income of those who default is higher than of those that repay. The data show that borrowers who committed default in years before 1998 (the year when the survey was conducted) have higher income in the years after their default (1998 or 1999) than those who did not default.

This is in line with our theoretical setup as we show that borrowers with better outside options in the following years are more prone to default.

Consistent with our theory, and previous theories regarding borrowing and lending behavior, when individuals have options of depositing their savings, or receiving new credit from other institutions, defaulting on the loan affects less their future income. We find how among individuals that default, those who have access to alternative banks have higher income than those who do not have such options.

Also consistent with such theories when an individual does not default on the loan from the microfinance institution, the existence of other sources of credit does not affect its income as it continues to use the original source.

Regarding savings we find that those individuals who receive a loan by microfinance institutions have higher average savings than those who do not, this is also consistent with our theory as microfinance institutions have higher deposit rates and focus on those who have higher needs of savings. Also we find how the savings profile of the individuals follows the pattern predicted by our model. Young individuals accumulate savings that are used when they are old. This prediction is not new, as numerous studies studying the life cycle profile of savings predict such a pattern.

Another important result is that those individuals that are members of a microfinance program generally save inside such a program. In our sample 70% of those who are members have all their savings inside the program. It is interesting to note how, when other banks are available, the amount of savings of the microfinance programs' members out of the program increases. Moreover, individuals who do not repay their loans have a higher amount of their savings out of the microfinance programs. In addition, those that do not save at all inside of the microfinance program possess higher savings too. Such individuals can be characterized as being rich with better options of savings inside the traditional banking system.

7 Conclusions

Microfinance programs achieve high repayment rates although their borrowers are extremely poor and do not provide collateral. Recent studies have stressed that group liability, which has been the most common explanation for this observation, does not have an impact on microfinance repayment rates. Our paper provides a simple and tractable model of borrowers with different expected labor or informal income, henceforth outside option, and a monopolistic bank facing asymmetric information. We identify the optimal default strategy for borrowers and the optimal lending and deposit taking strategy for the bank. Then, we exploit theoretical predictions from our model to design empirical tests addressing two hypotheses: (i) does the probability of default increase with the borrowers' outside option? and (ii) do lenders with higher repayment rates focus on individuals with worse outside options? We test these hypotheses using the data from a quasi experimental survey from Bangladesh.

From a theoretical perspective we show how in a dynamic model in which the bank takes deposits and grants loans to the same set of individuals, the deposit rate plays a crucial role in enhancing loan repayment. Borrowers who repay are those with lower expected future incomes, as they place more value on the increase in future consumption that savings provide. Hence, higher deposit rates increase the profitability of the savings mechanism which increases the incentives for the borrowers to repay, as in the case of defaulting they will not have access to bank's deposits.

Empirically we find that those individuals with worse outside options are in fact those with higher repayment rates. We use three proxies for the outside options of individuals: the borrower's gender, the average wage by gender in the village, and the dowry exchanged in the borrower's wedding. We also find that, consistent with our theoretical model, microfinance institutions focus on borrowers with lower outside options and obtain higher repayment rates.

Our paper provides interesting policy implications. When designing a sustainable microfinance program the policy-maker should be able to identify and focus on those individuals with worse

outside options, which in turn are poorer individuals. By doing so the microfinance institution will obtain higher repayment rates which is crucial in obtaining a sustainable institution. However, depending on the equilibrium deposit rate, the microfinance institution may need to establish a maximum amount of deposits per borrower in order to increase his profits without decreasing his repayment rates

The placement of the microfinance program should take into account the existence of alternative institutions that provide credit and savings to the individuals, since we show how such presence reduces the repayment rate of the individuals. This highlights the risks that the expansion of microfinance may have on their profitability. Introducing microfinance programs in places where other institutions already offer credit and deposits would probably result in low repayment rates, and hence unsustainability, not only for the incumbent but also for the institution that was present before.

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Appendix A - Definitions of Variables

Default: is a dummy variable that takes the value 1 if the loan is not repaid 3 months after its due date

Female: is a dummy variable that takes the value 1 when the borrower is a woman.

Income: is the income of the borrower which he obtained in the last 12 months. Income is the sum of income from all the sources given in the data (self employment, dependent employment, obtained financial help and pensions).

Income others: is the sum of the income obtained by the other people in the borrower's household.

Savings: are the savings the borrower reported.

Average wage (female/male): is the average wage in non agricultural activities in the village of the borrower by gender.

Dependency ratio: is the ratio of the number of individuals not obtaining any income to those obtaining in the household.

Age: is the borrower's age when he was granted the loan.

Education: is a dummy variable taking the value 1 when the borrower reports positive number of years of attending the school or taking part in educational activities offered by e.g. NGOs. We use the dummy because these other education activities cannot be coded as a concrete number of education years.

Microfinance group: is a dummy variable taking value 1 if the loan comes from one of the microfinance institutions reported in the sample.

NGO group: is a dummy variable taking value 1 if the loan comes from one of the non governmental organizations reported in the sample.

Relatives group: is a dummy variable taking value 1 if the loan comes from one of the relatives.

Banks: *is a* dummy variable taking value 1 if the loan comes from one of the commercial banks

reported in the sample.

Bank availability: is a dummy variable taking the value 1 if someone in the village accessed commercial banking services

Table 1. Descriptive statistics of the variables

This table shows the descriptive statistics of the variables that are going to be used in our future analysis. The descriptive statistics are shown for those observations in which a loan was taken. It must be taken into account that for some of our analysis some variables are constructed using information of observations in which no loan was taken. Examples of this are the average wage of female and male individuals.

Variable	Mean	Std deviation	Min	Max	Observations
Default	0.120	0.325	0	1	6385
Female	0.748	0.434	0	1	6385
Dowry	0.161	0.391	0	5	5421
Average wage female	27.652	10.470	6	60	2188
Average wage male	76.464	26.454	35	150	1484
Age	37.766	11.151	5	85	6385
Education	0.349	0.476	0	1	6385
Income	0.086	0.268	-0.278	3.995	6385
Income others	0.411	0.633	-0.317	14.103	6385
Dependency ratio	2.482	1.779	0	12	6285
Microfinance group	0.521	0.499	0	1	6385
NGO group	0.077	0.268	0	1	6385
Relatives group	0.357	0.479	0	1	6385
Commercial lender group	0.038	0.192	0	1	6385
Cooperatives of credit	0.004	0.063	0	1	6385
Bank availability	0.488	0.499	0	1	21643
Savings	0.027	0.045	0	0.855	6385

Appendix B - Regression Tables

Table 2. Logit regressions of default

This table presents logit regressions with robust standard errors of the dichotomic variable Default on the reported variables. For an explanation of the construction of the variables please refer to Appendix A. For those regressions in which controls other than Female and Age are included the sample is restricted to those loans that were undertook from 1997 onwards as the control variables were not available for previous dates. We report robust standard errors in parentheses with *** ,**, * representing coefficients significant at the 1%, 5% and 10% level, respectively.

Variable	(1)	(2)	(3)	(4)
Female	-1.543***	-1.507***	-1.207**	-0.921
	(0.0797)	(0.133)	(0.544)	(0.565)
Average female wage			0.0371***	0.0307***
			(0.00894)	(0.00908)
Average male wage			0.0222***	0.0216***
			(0.00577)	(0.00618)
Age		0.0250***		0.0254***
		(0.00442)		(0.00734)
Income		-0.0533		-0.126
		(0.162)		(0.227)
Income others		-0.188		-0.0938
		(0.134)		(0.159)
Dependency ratio		0.109***		0.121***
		(0.0295)		(0.0389)
Number of children		-0.00578		-0.0778**
		(0.0221)		(0.0316)
Education		0.192*		-0.0360
		(0.107)		(0.173)
Constant	-1.020***	-2.434***	-2.638***	-3.738***
	(0.0565)	(0.261)	(0.453)	(0.570)
Observations	6385	3790	1678	1654
Pseudo R^2	0.0792	0.126	0.133	0.164

Table 3. Regressions using dowry as a proxy of the outside option

This table presents logit regressions with robust standard errors of the dichotomic variable Default on the reported variables. This table shows the positive correlation between the variable Dowry and Default. For an explanation of the construction of the variables please refer to Appendix A. For those regressions in which controls other than Female and Age are included the sample is restricted to those loans that were undertook from 1997 onwards as the control variables were not available for previous dates. Column (3) reports the estimates of an instrumental probit regression where Income is instrumented by Dowry. We report robust standard errors in parentheses with *** ,**, * representing coefficients significant at the 1%, 5% and 10% level, respectively.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Female	-1.565***	-1.605***	-0.0402	-1.809***	-1.606***	-0.986
	(0.0900)	(0.157)	(0.399)	(0.277)	(0.157)	(0.602)
Dowry	0.345***	0.364***		0.416***	0.314**	0.221
	(0.0915)	(0.119)		(0.145)	(0.131)	(0.152)
Average male wage						0.0294***
						(0.0105)
Average female wage						0.0220***
						(0.00645)
Age		0.0121	-0.00260	0.00600	0.0129	-0.00347
		(0.00878)	(0.00504)	(0.0168)	(0.00885)	(0.0144)
Income		-0.0921	1.993**	-1.137***	-0.0982	-0.0774
		(0.184)	(0.793)	(0.287)	(0.184)	(0.236)
Income others		-0.305*		-1.142***	-0.300*	-0.304
		(0.181)		(0.416)	(0.182)	(0.241)
Dependency ratio		0.0134	0.00789	0.0108	0.0155	-0.0118
		(0.0356)	(0.0170)	(0.0661)	(0.0357)	(0.0577)
Number of children		0.0845***	0.0493***	0.149**	0.0852***	0.0358
		(0.0326)	(0.0163)	(0.0693)	(0.0325)	(0.0460)
Education		0.235**	0.0253	0.281	0.248**	0.00682
		(0.117)	(0.0591)	(0.195)	(0.118)	(0.188)
Dummy Dowry					0.114	
					(0.145)	
Constant	-1.160***	-2.062***	-1.457***	-1.528***	-2.139***	-2.749***
	(0.0670)	(0.348)	(0.198)	(0.579)	(0.364)	(0.698)
Observations	5421	3221	3221	1186	3221	1401
Pseudo R^2	0.0859	0.120	0.125	0.139	0.120	0.137

Table 4. Means of the variables depending on the lender type

This table presents the means of Default Female Dowry Average wage female (awagef) and average wage male (awagem) depending on the source of the loan. We report the ttest of the difference in means when the source of the loan is a microfinance institution or not.

Group	Default	Female	Dowry	Awagef	Awagem
Non microfinance	0.25	0.48	0.22	27.65	73.54
Microfinance institution	0.07	0.83	0.14	27.64	79.01
t-statistic	15.16	-25.75	5.57	0.03	-4.46

Table 5. Regressions controlling for different sources of credit

This table presents logit regressions with robust standard errors of the dichotomic variable Default on the reported variables. For an explanation of the construction of the variables refer to Appendix A. We report robust standard errors in parentheses with *** ,**, * representing coefficients significant at the 1%, 5% and 10% level, respectively.

Variable	(1)	(2)	(3)	(4)
Female	-0.191	-0.487**	-0.00233	-0.412
	(0.182)	(0.204)	(0.679)	(0.686)
Dowry		0.297**		0.249
		(0.141)		(0.177)
Average wage female			0.0306***	0.0308***
			(0.00940)	(0.0108)
Average wage male			0.0197***	0.0189***
			(0.00718)	(0.00694)
Age	0.0144***	-0.000377	0.00933	-0.0251
	(0.00469)	(0.00944)	(0.00872)	(0.0163)
Income	0.0341	-0.0267	-0.271	-0.267
	(0.163)	(0.180)	(0.224)	(0.238)
Income others	-0.111	-0.220	0.0324	-0.0715
	(0.121)	(0.170)	(0.164)	(0.228)
Dependency ratio	0.0915***	-0.000827	0.0485	-0.0828
	(0.0296)	(0.0377)	(0.0421)	(0.0590)
Number of children	-0.00188	0.0917**	-0.0557	0.0836
	(0.0229)	(0.0368)	(0.0352)	(0.0530)
Education	-0.0165	0.0383	-0.253	-0.151
	(0.118)	(0.129)	(0.190)	(0.206)
microfinance	-2.000***	-1.211**	-1.946***	-1.387
	(0.376)	(0.516)	(0.541)	(0.874)
NGO	-2.292***	-1.614***	-2.301***	-1.724*
	(0.435)	(0.568)	(0.635)	(0.951)
Relatives	0.536	1.059**	0.616	1.022
	(0.368)	(0.511)	(0.499)	(0.847)
Banks	0.0629	0.614	0.0728	0.568
	(0.378)	(0.521)	(0.509)	(0.855)
Constant	-1.455***	-1.585**	-2.138***	-1.427
	(0.451)	(0.617)	(0.801)	(1.102)
Observations	3790	3221	1654	1401
Pseudo R^2	0.228	0.204	0.259	0.228

Table 6. Logit regressions of default for Grameen Bank borrowers

This table presents logit regressions with robust standard errors of the dichotomic variable Default on the reported variables only for borrowers of the Grameen Bank. For an explanation of the construction of the variables please refer to Appendix A. For those regressions in which controls other than Female and Age are included the sample is restricted to those loans that were undertook from 1997 onwards as the control variables were not available for previous dates. We report robust standard errors in parentheses with *** ,**, * representing coefficients significant at the 1%, 5% and 10% level, respectively.

Variable	(1)	(2)	(3)
Female	-0.559*	-1.019***	-1.077***
	(0.289)	(0.321)	(0.317)
Dowry		0.664**	0.626**
		(0.303)	(0.303)
Loan amount			-0.000192***
			(5.94e-05)
Age	-0.0102	-0.0288	-0.0125
	(0.0109)	(0.0186)	(0.0181)
Income	-0.368	-0.723*	-0.670
	(0.318)	(0.403)	(0.427)
Income others	-1.212**	-0.997**	-0.477
	(0.501)	(0.483)	(0.409)
Dependency ratio	-0.00455	-0.00996	0.0541
	(0.0610)	(0.0677)	(0.0682)
Number of children	0.0581	0.137**	0.0894
	(0.0471)	(0.0617)	(0.0598)
Education	-0.147	-0.119	-0.0742
	(0.213)	(0.223)	(0.227)
Constant	-1.730***	-1.211*	-0.793
	(0.519)	(0.729)	(0.729)
Observations	1966	1683	1683
Pseudo R^2	0.0288	0.0419	0.0718

Table 7. Regressions controlling for availability of banks

This table presents a logit regression with robust standard errors of the dichotomic variable Default on the reported variables. For an explanation of the construction of the variables please refer to Appendix A. For those regressions in which controls other than Female and Age are included the sample is restricted to those loans that were undertook from 1997 onwards as the control variables were not available for previous dates. This table shows the positive correlation between bank availability and Default. We report robust standard errors in parentheses with *** ,**, * representing coefficients significant at the 1%, 5% and 10% level respectively.

Variable	(1)
Female	-1.511***
	(0.163)
Dowry	0.336***
	(0.119)
Bank availability	0.815***
	(0.137)
Age	0.0120
	(0.00887)
Income	-0.0585
	(0.187)
Income others	-0.366*
	(0.201)
Dependency ratio	0.0194
	(0.0356)
Number of children	0.0633*
	(0.0336)
Education	0.145
	(0.119)
Constant	-2.503***
	(0.358)
Observations	3221
Pseudo R^2	0.138

Appendix C - Model with competing alternative savings

This section analyses the individuals decision in a context in which the individual has the opportunity of accessing a savings technology different for that of the monopolistic bank of our main section.

In this section the individual has the opportunity of accessing a savings technology different from that of the monopolistic bank. With this savings technology the individual receives $1 + r$ for every unit of savings. We assume that the realization of this opportunity of savings is not observable by the original bank. If not the original bank would offer different deposit and loan rates to those individuals which have the opportunity to save.

Hence the decision of defaulting on the loan granted by the original bank, following the same intuition as in the main section, can be characterized as

$$u(\alpha - l - s_o) + u(\theta + s_o(1 + d)) - [u(1 + \alpha - s_z) + u(\theta + s_z(1 + r))] < 0$$

where s_o are the optimal savings of the individual in the monopolistic bank and s_z are the savings under the new alternative.

The threshold for the individual that defaults is defined as $\tilde{\theta}$. Where $\tilde{\theta}$ is such that

$$u(\alpha - l - s_o) + u(\theta + s_o(1 + d)) = u(1 + \alpha - s_z) + u(\theta + s_z(1 + r)).$$

Hence, in a model with alternative savings technologies the fraction of individuals that do not default will be $F(\tilde{\theta})$.

Recall that $\hat{\theta}$ is the threshold of default for those individuals that do not have an alternative savings technology. It can be proved that $F(\tilde{\theta}) \leq F(\hat{\theta})$, so when a profitable source of savings is included the default rate of the monopolistic bank increases. This is because individuals can default on the monopolistic bank and deposit their savings in the other savings technology.

Lemma 5 *When an alternative savings technology is introduced the default rate of the monopolistic*

bank (weakly) increases.

Proof. When $r \geq d$, or in other words, when the alternative technology offers the same or higher deposit rate as the monopolistic bank, then the default rate of the economy increases. More precisely in our setup the default rate goes to 1, which would in equilibrium mean that no bank would grant loans to the individuals in the first period.

It is direct to show that, when $r \geq d$, then

$$u(\alpha - l - s_o) + u(\theta + s_o(1+d)) < u(1 + \alpha - s_z) + u(\theta + s_z(1+r)).$$

When $s_z = s_o$ then $u(\theta + s_o(1+d)) \leq u(\theta + s_z(1+r))$ and $u(\alpha - l - s_o) < u(1 + \alpha - s_z)$. Therefore the above inequality holds. The individual can always have the same income when old and increase his income when young by defaulting. Hence, the individual is better off defaulting on the loan of the monopolistic bank and saving in the alternative technology independently of its outside option θ.

When $r < d$ the default rate of the economy may not increase. But it will never decrease as the individuals can always choose not to save through the new savings mechanism and then he would in fact react as if the new savings mechanism was not present. The default rate increases if the individual previously indifferent in defaulting now prefers to default. This happens when the following condition holds

$$u(\alpha - l - s_o) + u(\hat{\theta} + s_o(1+d)) < u(1 + \alpha - s_z) + u(\hat{\theta} + s_z(1+r)) \tag{11}$$

When $r < d$ this condition (11) may not hold. If the alternative strategy offers a low savings rate then individuals with $\hat{\theta}$ may continue to find it profitable to repay and save with better deposit rates than to default and use the new savings mechanism. Condition (11) holds whenever $s_z(l, r, \hat{\theta}) = 0$, that is when individuals with $\hat{\theta}$ do not find it profitable so save under the alternative technology. When $s_z(l, r, \hat{\theta}) = 0$ then by definition it is satisfied that $u(1+\alpha-s_z)+u(\hat{\theta}+s_z(1+r)) =$

$u(1+\alpha)+u(\hat{\theta})$, which recall defined $\hat{\theta}$ in the first place. On the other hand if $s_z(l,r,\hat{\theta})>0$ then it is satisfied that $u(1+\alpha-s_z)+u(\hat{\theta}+s_z(1+r))>u(1+\alpha)+u(\hat{\theta})$. In this case the individual with $\hat{\theta}$ is better off by defaulting and therefore the default rate of the economy increases. In such case the indifferent individual will be defined by $\tilde{\theta}$ such that

$$u(\alpha-l-s_o)+u(\tilde{\theta}+s_o(1+d))=u(1+\alpha-s_z)+u(\tilde{\theta}+s_z(1+r)).$$

Where $\tilde{\theta}<\hat{\theta}$. ■

Appendix D - Difference in means tests

Table 8. Further tests of the model

This table presents the results of doing difference in means tests of the reported variables. We denote as 1 those individuals for which the described condition is satisfied.

Description	0	1	p-value
Level of savings if the individual defaulted	0.029	0.017	1
Level of income if the individual defaulted	0.073	0.179	0
Level of income if the individual defaulted on a loan expected prior to 1998	0.061	0.11	0.002
Level of income when the individual committed early default by bank presence	0.065	0.15	0
Level of income when the individual did not default by bank presence	0.072	0.075	0.35
Savings when individual committed early default on a Grameen loan by bank presence	0.008	0.012	0.03
Savings when no default was committed on a Grameen loan by bank presence	0.034	0.036	0.13
Income when early default was committed in Grameen loan by bank presence	0.049	0.107	0
Income when no default was committed in a Grameen loan by bank presence	0.076	0.03	1
Savings if the individual has a loan from the Grameen Bank	0.02	0.033	0