Repayment Frequency in Lending Contracts

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September 2016

Abstract

This paper analyzes the theoretical underpinnings of high-frequency repayment, a feature in nearly all microfinance contracts that has been largely overlooked by theorists. The pervasive belief among practitioners that frequent repayment is critical in achieving high repayment rates is puzzling. Classically rational individuals should benefit from more flexible repayment schedules, and less frequent repayment should increase neither default nor delinquency. This paper proposes a simple explanation based on present bias. For such individuals, more frequent repayment can increase the maximum incentive compatible loan size. However, the welfare effects are ambiguous. More frequent repayment can lead to over-borrowing, reducing welfare as it increases loan sizes.

JEL: O12, O16, D03

Keywords: Microfinance, Repayment Frequency, Present-Bias

1 Introduction

Microfinance continues to play a key role in approaches to poverty alleviation around the world, both in policy and academic discussions and in practice. Yet despite the attention paid to microfinance, some aspects of the design of credit contracts for small, uncollateralized loans remain a bit of a mystery. Much early academic work focused on joint liability—small groups of borrowers being held jointly liable for one another's repayments—as the key to high loan recovery rates (see, for example, Stiglitz, 1990; Varian, 1990; and Ghatak, 1999). But while joint liability remains a feature in the majority of microfinance loan contracts, it is no longer the sole focus. Several factors have contributed to this change. A number of large micro-lenders have expanded into or converted their portfolios to individual liability loans, although the evidence on the effects of these changes remains inconclusive.[1] At the same time, there has been a growing recognition of the potential costs of joint liability(Banerjee et al., 1994; Besley and Coate, 1995; Fischer, 2013). Attention is turning to other features of microfinance contracts.

This paper analyzes the theoretical underpinnings of a largely overlooked feature in nearly all microfinance contracts: high-frequency repayment.[2] The typical loan contract requires repayment in small, frequent installments beginning immediately after origination. Most lending contracts require weekly repayment, and there is a pervasive sense among practitioners that frequent repayment is critical to achieving high repayment rates. This belief is captured well in the following observation by Muhammad Yunus:

> "[I]t is hard to take a huge wad of bills out of one's pocket and pay the

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[1]Between 2001 and 2002, Grameen converted all of its branches to Grameen II, which eliminates the group fund and eliminates explicit joint liability (Yunus, 2010); BancoSol moved the majority of its borrowers from group to individual contracts (BancoSol, 2010); and ASA in Bangladesh has relaxed or eliminated joint liability(Armendariz and Morduch, 2005). Giné and Karlan (2009) conduct two randomized control trials with Green Bank in the Philippines testing repayment behavior under group versus individual liability loans, finding no increase in default rates with the elimination or random assignment away from group liability.

[2]Jain and Mansuri (2003), which we discuss later, is a notable exception.

lender. There is enormous temptation from one's family to use that money to meet immediate consumption needs...Borrowers find this incremental process easier than having to accumulate money to pay a lump sum because their lives are always under strain, always difficult." Muhammad Yunus, *Banker to the Poor*, p. 114.

The perceived importance of frequent repayment is theoretically puzzling. Classically rational individuals should benefit from more flexible repayment schedules, and less frequent repayment should increase neither default nor delinquency.

Empirical evidence on the effect of repayment frequency is both limited and mixed. BRAC, one of the largest MFIs with nearly six million clients, abandoned a move to bi-weekly repayment when an experiment showed increased delinquencies (Armendariz and Morduch, 2005). Satin Credit Care, an urban MFI targeting trading enterprises, saw delinquencies increase from less than 1% to nearly 50% when it tested a move from daily to weekly repayment.[3] In Bolivia, BancoSol has revised its repayment policy repeatedly in response to fluctuating arrears (Gonzalez-Vega et al., 1995; Westley, 2004).

Recently, the importance of this issue has attracted experimental and quasi-experimental investigation. McIntosh (2008) uses spatial variation in loan administration by FINCA Uganda to show that when groups of clients were allowed to select biweekly loan payment, group dropouts fell and repayment performance was actually slightly improved. However, as McIntosh notes, this tests the effects of allowing existing clients to decide from a menu of contract options and not the direct effect of changing repayment terms. Field and Pande (2008) conduct just such a test using the random assignment of clients to either weekly or monthly repayment schedules. They find no significant effect on delinquencies, with all treatment groups reporting extremely low default and delinquency rates. Nonetheless, microfinance practitioners share an almost universal belief that frequent repayment schedules

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[3]Greg Fischer interview with H.P. Singh, November 2005.

improve repayment rates.

This paper proposes a simple theory based on present-biased, quasi-hyperbolic preferences in order to capture the intuition in Yunus's quote and the belief of many microfinance practitioners that clients benefit from the fiscal discipline required by a frequent repayment schedule. The model is stark in order to highlight one particular effect: if borrowers are present-biased (β-impatient), frequent repayment can increase the maximum loan size for which repayment is incentive compatible. Intuitively, when borrowers are present biased, the immediate gain to defaulting on any large repayment is subject to significant temptation. When these payments are spread out, the instantaneous repayment burden at any time is smaller and thus less subject to temptation. However, frequent repayment also means that at the time of the first payment, which is when the incentive constraint is tightest, the rewards (typically access to future credit) are further away from the repayment decision and thus more heavily discounted. This is the core trade-off highlighted by our analysis.

The result is not simply a case of frequent repayment generically relaxing incentive compatibility constraints. We show that for classically rational discounters, the timing of payments should not affect willingness to repay. However, for present-biased borrowers, the repayment structure matters. Their present bias makes it harder to support repayment with the promise of future rewards—for any loan structure they support a smaller maximum loan size than classically rational individuals. But, smaller, more frequent repayments can increase the maximum loan size they are willing to repay.

While our basic model does not allow borrowers access to a savings technology, we extend our model to allow for savings and show that our results go through. Indeed, for classical discounters with access to savings, frequent repayment has no added benefits, since borrowers can replicate via their own savings behavior any frequency of repayment that the lender might want to implement.

Frequent repayment is not unambiguously good for repayment performance. It in-

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creases transaction costs incurred by both borrowers and lenders. This includes direct costs to the lender as well as the opportunity cost of meeting attendance, both of which can be substantial. Activity based costing exercises suggest that weekly collection meetings account for as much as one-third of direct operating expenses (Shankar, 2006; Karduck and Seibel, 2004). Women's World Banking (2003) found that meeting frequency was a factor in the drop-out decision of 28% of their clients in Bangladesh and 11% in Uganda. We therefore extend the basic model to incorporate per meeting transaction costs. These costs serve as a balancing force against the improved incentives of frequent repayment.

This paper examines one possible mechanism through which frequent repayment can increase the maximum incentive compatible loan size and perhaps account for the low default rates realized by MFIs. Apart from the current paper, Jain and Mansuri (2003) consider an alternative explanation for high-frequency repayment. They argue that tight repayment schedules force MFI clients to borrow from informal lenders in order to make their regular payments, thus allowing the MFI to utilize the superior monitoring capability of informal lenders. While this mechanism may be in place in some settings, we provide a more parsimonious framework focusing on borrower behavior, keeping the lending side of the story very simple. We are aware of no other attempts to formalize frequent repayment, and this paper strives to capture the "fiscal discipline" argument frequently put forth by practitioners.

Recent theoretical work on the borrowing and savings behavior of time-inconsistent borrowers is also related to our paper. Basu (2009) uses quasi-hyperbolic preferences to characterize when commitment savings products will be offered and, when offered, how they will affect consumer welfare. A related paper Basu (2008) shows that sophisticated, time-inconsistent agents, rationally choose to save their wealth and then borrow if necessary to fund future investment opportunities. The combination of savings and a loan generates incentives for their future selves to invest optimally by punishing over-consumption.

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Heidhues and Köszegi (2009) analyze contract choices, loan-repayment behavior and welfare in a competitive credit market setting when borrowers are present-biased. Our work complements these papers by focusing on a different issue: the effect of frequent loan repayment on incentives to repay, as well as welfare.

The remainder of the paper is organized as follows. In the next section, we describe the basic model and solve for the maximum incentive compatible loan size for contracts of different repayment frequency. Section 3 extend the model to include transaction costs and savings. Section 4 concludes.

2 The Model

We take a simple model of a credit market with ex post moral hazard. In period 0, a single, risk-neutral agent borrows an amount L from a profit-maximizing lender at a gross, per-period interest rate R that is determined exogenously. In periods 1 and 2, the agent receives a certain income w and decides whether or not to make repayments under the terms of the loan contract. In period 3, the agent receives a net continuation value of V, which can be thought of as the utility value of continued access to credit[4] or avoiding other forms of punishment, if she has met the repayment terms and 0 otherwise. With risk neutrality, the agent's instantaneous utility is simply her current period consumption, c_t. We model present-bias with quasi-hyperbolic discounting such that in any period t, her future lifetime utility is:

$$U^t = u_t + \beta \sum_{\tau=t+1}^{T} \delta^{\tau-t} u_\tau,$$

[4]Microfinance institutions typically punish default by denying future credit in perpetuity. This form of punishment maps naturally to the model in which the continuation value is realized a fixed interval after the initial borrowing. Section 3.1 considers the alternative possiblity of punishment being enforced a fixed interval after any default.

where $\beta \in (0,1]$ and $\delta \in (0,1)$. Note that for $\beta = 1$ these preferences collapse to standard, time-consistent utility. We assume the agent is sophisticated; she knows that her future selves discount the future exactly as she does.

We consider two possible credit contracts: single and two-period repayment. The former requires a single repayment of $M_1 \equiv LR^2$ in the second period. The latter requires two equal payments of $M_2 \equiv LR^2/(R+1)$ in each period.

To focus attention on the relationship between present bias and repayment frequency, we assume that the loan is used for consumption and does not affect income. We also assume that $w \geq LR^2$, such that savings is not required to make the required repayment for either type loan.

Using this framework, we solve for the maximum loan size for which repayment is incentive compatible, $\overline{L^n}$, where $n \in \{1,2\}$ indicates the number of repayment periods, taking R as given. Alternatively, we could take the loan size as given and solve for the maximum incentive compatible interest rate, but this would not change the thrust of the results.

2.1 Solution to the basic model

In any period, the agent only repays if doing so maximizes her expected future lifetime utility. For the single-period repayment, there is a single incentive compatibility constraint in the second period that determines the repayment decision. The agent will repay if and only if:

$$w - M_1 + \beta \delta V \geq w. \tag{1}$$

Incentive compatible repayment therefore requires

$$L \leq \frac{\beta \delta V}{R^2} \equiv \overline{L^1}. \tag{2}$$

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Now we consider the repayment decision for the two-period loan proceeding by backwards induction. The second period incentive compatibility constraint is similar to (1). The agent will repay if and only if:

$$w - M_2 + \beta \delta V \geq w. \tag{3}$$

This requires

$$L \leq \frac{(R+1)\beta \delta V}{R^2}. \tag{4}$$

Unsurprisingly, for any loan size, the repayment incentive compatibility constraint in the second period is less restrictive when payments are spread out. Regardless of the agent's degree of present bias, there is less immediate gain to non-payment.

Turning to the repayment decision in the first period, the first-period incentive compatibility constraint requires

$$w - M_2 + \beta \delta (w - M_2) + \beta \delta^2 V \geq w + \beta \delta w,$$

which implies

$$L \leq \frac{(R+1)\beta \delta^2}{R^2(1+\beta \delta)}V \equiv \overline{L^2}. \tag{5}$$

Note that the agent will only repay in the first period if she does not plan to default in the second. However, the first-period incentive compatibility constraint is strictly less than that in Period 2, and we can focus on the decision utility in Period 1.

We can now compare (2) and (5), the maximum incentive compatible loan sizes for one- and two-repayment period loans. The condition for two repayment periods to support a larger loan size is:

$$\overline{L^2} > \overline{L^1} \Leftrightarrow \beta < (R+1) - \frac{1}{\delta}. \tag{6}$$

When the interest rate equals the discount rate, $R\delta = 1$, this condition holds for all present-biased borrowers. More frequent repayment repayment supports a larger incentive-compatible maximum loan size. The intuition is as follows: With one-shot repayment, only the second period's decision counts, and in this period there is a large immediate gain to non-payment that is subject to temptation. With frequent repayments, the first-period decision matters. Splitting payments moves the reward, V, further away from the initial repayment decision, but some of the repayment burden is also borne by the borrower's future self. This in turn relaxes the incentive compatibility constraint. In the second period, the instantaneous repayment burden is smaller and thus less subject to temptation. While more tempted (β-impatient) borrowers can support a lower maximum loan size than time-consistent borrowers ($\partial \overline{L^n}/\partial \beta > 1$), the incentive compatibility constraint is less restrictive for the two-period loan when (6) holds.

2.2 Traditional Microfinance Loans

In this section we consider the traditional, non-amortizing microfinance loan. In most such loans, a flat interest expenses is calculated at loan origination and the gross amount, principal, fees, and interest, is repaid in equal installments over the term of the loan.[5] In line with this procedure, many microfinance institutions do not change the total interest expense when changing repayment frequency. We can incorporate this in the basic model by capitalizing total interest expense into L and setting R equal to 1.

In this setting, the relative loan size constraint becomes

$$\overline{L^2} > \overline{L^1} \Leftrightarrow \beta < 2 - \frac{1}{\delta}.$$

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[5]Thus, for example, a 52-week loan of Rs. 1000 at an 18% interest rate would be repaid in equal installments of Rs. 22.69 ($1000 \times 18\% \div 52$), representing an effective annual interest rate of 39.6%.

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We state this as:

Proposition 1. *The maximum incentive compatible loan size is greater under more frequent repayments for present-biased borrowers if and only if $\beta < 2 - \frac{1}{\delta}$.*

Let the condition $\beta < 2 - \frac{1}{\delta}$, or, equivalently, $\delta > \frac{1}{2-\beta}$ be referred to as **Condition 1**. For time-consistent agents ($\beta = 1$), $\overline{L^2} < \overline{L^1} \ \forall \ \delta < 1$, that is for classical discounters, the maximum incentive compatible loan size is smaller when payments are split. However, for borrowers that are sufficiently present-biased (low β) and not too impatient ($\delta \geq \frac{1}{2}$), the maximum incentive compatible loan size is greater under more frequent repayments.

2.3 Savings

In this subsection, we introduce savings to the basic model. First, we consider savings under the maintained assumption that $w \geq LR^2$, that is, that savings is not required to repay either loan. The economic environment is as above with one difference: in each of the first two periods, the borrower can save at periodic gross rate of ρ. Due to the linearity of preferences, the result is immediate. Individuals will save for consumption in the subsequent period if and only if $\beta\delta\rho > 1$. Because borrowers are sophisticated, they solve for the optimal consumption path by backwards induction, recognizing the present bias of their future selves and this is also the condition for savings in any period.[6] Unless required as security for loan repayment, accrued savings does not enter into the repayment incentive compatibility constraint.

Observation When $w \geq LR^2$ allowing savings has no effect on either $\overline{L^1}$ or $\overline{L^2}$.

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[6]This is not necessarily the case for naive borrowers. If $\beta \in [\frac{1}{\delta^2\beta^2}, \frac{1}{\delta\beta}]$ they would choose to save in period 0, expecting to consume in period 2, and be unpleasantly "surprised" when their period 1 self consumes the savings.

2.4 Welfare

The appropriate means to evaluate welfare under time-inconsistent preferences remains an open question. By construction, an agent's preferences at different times disagree with one another. Focusing on the agent's welfare in any particular period does so at the potential expense of the agent in other periods. We thus follow the long-run perspective of Akerlof (1991) and O'Donoghue and Rabin (1999) and consider the agent's utility from a fictitious period 0 in which the agent makes no decisions and weight utility as if she were time consistent.[7]

From this perspective, the lifetime welfare of the borrower under single-period repayment is

$$W^1 = L - \delta^2 L R^2 + \delta^3 V.$$

We evaluate this expression at $\overline{L}^1 = \frac{\beta \delta V}{R^2}$ and normalize V to 1 yielding

$$W^1 = \frac{\beta \delta}{R^2} + (1 - \beta)\delta^3,$$

where the measure of present-bias, β, reappears due to its effect on the maximum incentive compatible loan size. Similarly, the lifetime utility of the borrower under two-period repayment is

$$W^2 = L - \delta L \frac{R^2}{R+1} - \delta^2 L \frac{R^2}{R+1} + \delta^3 V,$$

which we evaluate at $\overline{L}^2 = \frac{\beta \delta^2 (R+1)}{R^2 (1+\beta \delta)} V$, again normalizing V to 1:

$$W^2 = \frac{\beta \delta^2 (1+R)}{(1+\beta \delta) R^2} - \frac{\beta \delta^3}{(1+\beta \delta)} - \frac{\beta \delta^4}{(1+\beta \delta)} + \delta^3.$$

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[7]For recent discussions of behavioral welfare economics, see Bernheim (2008), Bernheim and Rangel (2008), and Koszegi and Rabin (2008).

Comparing welfare under the two repayment schedules, we find that

$$\Delta W \equiv W^2 - W^1 = \frac{\beta\delta}{R^2}\frac{\delta R - (1-\delta) - \beta\delta}{1+\beta\delta} - \frac{\beta\delta^4}{1+\beta\delta}(1-\beta)\,.$$

Recall that

$$U^1 = L - \beta\delta^2 L R^2 + \beta\delta^3 V.$$

Evaluating this at $\overline{L}^1$ (and setting $V = 1$) yields:

$$U^1 = \frac{\beta\delta}{R^2} - \beta^2\delta^3 + \beta\delta^3.$$

Also,

$$U^2 = L - \beta\delta L\frac{R^2}{R+1} - \beta\delta^2 L\frac{R^2}{R+1} + \beta\delta^3 V$$

Evaluating this at $\overline{L}^2$ (and setting $V = 1$) yields:

$$U^2 = \frac{\beta\delta^2(R+1)}{R^2(1+\beta\delta)}\left(1 - \beta\delta\frac{R^2}{R+1} - \beta\delta^2\frac{R^2}{R+1}\right) + \beta\delta^3.$$

Comparing the decision utility of the borrower under the two repayment schedules, we find that

$$\Delta U \equiv U^2 - U^1 = \frac{\beta\delta}{R^2}\frac{\delta R - (1-\delta) - \beta\delta}{1+\beta\delta} - \frac{\beta^2\delta^4}{1+\beta\delta}(1-\beta).$$

Observe that unless $R \geq 1$ no one will lend. Similarly, when $\beta\delta R > 1$ even the present-biased borrowers will not want to borrow.[8] Therefore, we focus our attention on R in the interval $\left[1, \frac{1}{\beta\delta}\right]$.

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[8] Note that in the model as described, individuals may still want to borrow some minimal amount when $\beta\delta R > 1$ in order to capture the continuation value, V, even though borrowing reduces their utility in every period of the loan. We do not focus on this behavior because we implicitly assume that V is a function of the surplus the borrower receives from borrowing.

Let

$$A(R) \equiv \frac{\beta\delta}{R^2} \frac{\delta R - (1-\delta) - \beta\delta}{1 + \beta\delta}$$

and

$$B \equiv \frac{\beta\delta^4}{1 + \beta\delta}(1 - \beta).$$

We can then write:

$$\Delta W = A(R) - B$$

$$\Delta U = A(R) - \beta B$$

Note that when Condition 1 holds, i.e., two-period repayment supports a larger maximum loan size, $A(1) \geq 0$. This implies that for β sufficiently close to 1 and hence B close to 0, the two-period loan is preferred for both welfare and decision utility. Because $\beta \leq 1$, it also immediately follows that if $\Delta U < 0$, or, $\beta B > A(R)$, then $\Delta W < 0$. That is, if the individual prefers the single-period loan then it also produces higher welfare. Analogously, suppose $\Delta W > 0$, i.e., $A(R) > B$. In that case, $\Delta U > 0$. That is, if the individual's welfare is lower with a single-period loan compared to a two-period loan, then he will choose the two-period loan instead.

The remaining possibility is the most interesting one: suppose $B > A(R) > \beta B$. Then the individual would choose a two-period loan even though he would be better off with a single-period loan. That is, he is over-borrowing.

It is straightforward to verify that $A(\frac{1}{\delta}) = B$. Also, $A(\frac{1}{\beta\delta}) = \beta^2\delta^3(1-\beta) > \beta B$ as the condition simplifies to $1 + \beta\delta > \delta$, which is true. As $A(R)$ is continuous, there exists $R \in [1, \frac{1}{\beta\delta}]$ such that $B > A(R) > \beta B$.

Now we proceed to provide a tighter characterization. Notice that the sign of $A'(R)$ depends on the sign of $2(1 - \delta + \delta\beta) - \delta R$. Also, if it is negative for $R = \frac{1}{\delta}$, it is negative

for $R \in [\frac{1}{\delta}, \frac{1}{\beta\delta}]$. The condition for this is $\frac{1}{\delta} < 2 - 2\beta$, which is stronger than Assumption 1. Under this condition, $B > A(R) > \beta B$ for all $R \in [\frac{1}{\delta}, \frac{1}{\beta\delta}]$. However, as $A(R)$ is decreasing under the assumption $\frac{1}{\delta} < 2 - 2\beta$ and $A(\frac{1}{\delta}) = B$, it also follows that there exists $\frac{1}{\delta} > \hat{R} \geq 1$ such that $A(R) > B$ for $R \in [\hat{R}, \frac{1}{\delta}]$.

If this assumption does not hold, and $\frac{1}{2-\beta} < \delta \leq \frac{1}{2(1-\beta)}$ then $A(R)$ is increasing at $R = \frac{1}{\delta}$ and as it is strictly concave, there will be an interval $[\frac{1}{\delta}, R']$ where $R' \leq \frac{1}{\beta\delta}$ such that $A(R) \geq B$. In this case, two-period loans will be chosen by the borrower and are welfare enhancing.

This result leads us to the following proposition:

Proposition 2. *(1) If the single-period loan is preferred by the agent it is also the welfare maximizing contract, and conversely, if the individual's welfare is higher with a two-period loan, he will prefer it. (2) If $\delta > \frac{1}{2(1-\beta)}$ then: (i) for all $R \in [\frac{1}{\delta}, \frac{1}{\beta\delta}]$ the agent prefers the loan in which repayment is split into two periods; however, welfare is reduced relative to the single-period repayment loan; (ii) there exists $R' \in \left[1, \frac{1}{\delta}\right]$ such that $A(R) \geq B$ for $R \in [1, R']$ two-period loans are welfare enhancing and will be chosen by the borrower. (3) If $\frac{1}{2-\beta} < \delta \leq \frac{1}{2(1-\beta)}$ then there exists $R'' \in [\frac{1}{\delta}, \frac{1}{\beta\delta}]$ such that two-period loans are welfare enhancing and will be chosen by the borrower.*

Note that these welfare calculations do not rest on assumptions about whether or not the borrower is naive or sophisticated about her self-control problems. Rather, the lender recognizes the agent's present bias and limits the maximum loan size accordingly. In a sense, the resulting credit rationing protects the agent from herself, preventing large welfare losses that would occur if a future self succumbed to temptation and defaulted unexpectedly.

We can also characterize welfare for a given loan size L, when this amount is independent of the repayment structure. In this case ΔW is easy to calculate and the following proposition is immediate:

Proposition 3. *For a given loan size L, a borrower's welfare is higher under the two-period loan if and only if $\delta R > 1$.*

Intuitively, the borrower is trading off the discounted value of consumption against the cost of borrowing. When the cost of borrowing is relatively large, forgoing consumption to reduce the balance on her debt improves her utility.

2.4.1 Welfare and the Use of Proceeds

The preceding welfare calculations implicitly assumed that loan proceeds were available for consumption. For risk-neutral, quasi-hyperbolic discounters this implies that the entire loan proceeds will be consumed immediately. This assumption simplifies the analysis and highlights the tension between credit rationing and the welfare costs of present bias. It is also applicable to the increasingly prevalent consumption loans made by microfinance institutions as well as consumption loans (such as payday-loans and rent-to-own plans) common in developed financial markets. In keeping with the stated goals of many microfinance institutions, we also consider the possibility that loan proceeds are used to fund investment.

First, consider the case where the borrower has the opportunity to make an indivisible investment of fixed size k. If both loan types are sufficient to fund the investment ($\overline{L}^1, \overline{L}^2 \geq k$), then all excess proceeds, $\overline{L}^n - k$, will be consumed immediately. The calculations for ΔU and ΔW are unchanged, and the analysis of relative welfare proceeds as above. Similarly, if neither repayment structure can support a loan sufficient to fund the investment, all proceeds will be consumed.

Alternatively, it is possible that when Condition 1 holds $\overline{L}^1 < k \leq \overline{L}^2$. In this case, the alleviation of credit constraints can lead to potentially large welfare gains as any investment where all returns are realized in the future and which is preferred by the decision maker

is also welfare improving. Note that in this discussion, we retain the assumption the borrower's per period income w is sufficient to make any period loan payments and the repayment feasibility constraint never binds.

3 Extensions to the Basic Model

This section considers three extensions to the basic model. First, we alter the punishment structure by allowing the utility costs of non-payment to occur not only in a fixed future period but also one period after any default. Second, we augment the basic model to allow for per payment transaction costs, which act as a counterweight to the advantages of small, frequent payments. Finally, we relax the assumption of linear utility, showing that without access to savings, two-period repayment may be preferred as an consumption smoothing device even for time-consistent borrowers; however, with savings, time-consistent borrowers can duplicate the consumption stream of more frequent repayment.

3.1 Alternative Punishment Structure

In this section, we consider an alternative punishment structure under which when a borrower defaults she not only loses the continuation value in period 3 but is also subject to some punishment, ψ, enacted one period after any default. The incentive compatibility constraint for the one-period repayment is now determined by

$$w - M_1 + \beta \delta V \geq w - \beta \delta \psi, \tag{7}$$

which implies

$$L \leq \frac{\beta \delta (V + \psi)}{R^2} \equiv \overline{L^1}.$$

Because the immediate punishment for default and the lost continuation value happen contemporaneously, the punishment operates just as an increase in V.

For the two-period repayment, again it is the first-period constraint that binds. However, that constraint is now determined by

$$w - M_2 + \beta\delta(w - M_2) + \beta\delta^2 V \geq w + \beta\delta w - \beta\delta\psi.$$

This implies

$$M_2 \leq \frac{\beta\delta^2 + \beta\delta\psi}{(1 + \beta\delta)},$$

which leads to

$$L \leq \frac{(R+1)\beta\delta^2}{R^2(1+\beta\delta)}\left(V + \frac{\psi}{\delta}\right) \equiv \overline{L^2}.$$

Because the punishment is more proximate to the first-period repayment decision, it has a larger effect than a similarly sized increase in V. This leads immediately to Proposition 4.

Proposition 4. *If $\overline{L^2} > \overline{L^1}$ for $\psi = 0$, then $\overline{L^2} > \overline{L^1}$ for $\psi > 0$. Moreover, for any set of parameters R, β, δ, and V, there exists a $\psi > 0$ such that $\overline{L^2} > \overline{L^1}$.*

To see the intuition, think about the extreme case when $V = 0$. In the two-period loan, the punishment, ψ, needs only to balance out the temptation to default on half of the repayment, whereas in the single-period loan it needs to be sufficient to induce the individual to repay the full amount.

3.2 Transaction Costs

This section considers the addition of per-payment transaction costs. As a useful thought exercise, consider generalizing this model to multiple periods or rather dividing the loan

period into progressively smaller segments. If smaller, more-frequent repayments relax the repayment incentive compatibility constraint, in the limit the lender would want to collect a steady stream of payments from the borrower. Transaction costs are the balancing force. As noted above, weekly collection costs comprise the largest share of MFIs operating expenses and borrowers often report dissatisfaction with the demands of frequent meetings. We incorporate this feature by amending the basic model such that each payment costs the borrower t, where t reflects, for example, the cost of attending group meetings. Alternatively, t could reflect per meeting costs to the lender that are charged as loan fees or embedded into interest.

Now, the borrower's incentive compatibility constraint in Period 2 is $M_n + t \leq \beta \delta V$. Thus, for a one-period loan, the maximum incentive compatible loan size is

$$\overline{L^1} = \frac{\beta \delta V - t}{R^2}.$$

For the two-period loan, the borrower's incentive compatibility constraint in Period 1 is simply $-(M_2 + t) - \beta \delta (M_2 + t) + \beta \delta^2 V \geq 0$, therefore

$$\overline{L^2} = \frac{R+1}{R^2} \frac{\beta \delta^2 V - t(1 + \beta \delta)}{(1 + \beta \delta)}.$$

The relative maximum loan size, $\overline{L^2} - \overline{L^1}$ is decreasing in t, reflecting the intuition that variable transaction costs are a greater burden for more frequent payments.[9] This is formally stated as:

Proposition 5. *If $\beta < R(R+1) - 1/\delta$, there exists an interior solution ($t^* > 0$) such that $\overline{L^2} < \overline{L^1} \; \forall \; t < t^*$.*

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[9]One might wonder if per meeting transaction costs themselves are decreasing in meeting frequency, reflecting the possiblity that credit officers and borrowers may have more to do if meeting are less frequent. However, Field and Pande (2008) find no evidence of this.

Intuitively, whatever the advantages of more frequent repayment, for sufficiently large transaction costs the burden outweighs the benefit and a single-repayment loan is preferable. From a policy perspective, this setup also allows calibration of the optimal repayment frequency.

3.3   Concave utility without savings

The core model builds on the assumption of linear utility with the possibility of present bias. In the next two subsections, we examine the robustness of our results by relaxing linearity and eliminating the possibility of present bias. We consider the effects of loan repayment structure on a classical, risk-averse exponential discounting consumer. This section demonstrates that in the absence of savings, more frequent repayment can still relax the repayment incentive compatibility constraint. However, as shown in section 3.4, when savings is possible, a rational individual can do at least as well with a single-period repayment structure as she can duplicate the consumption stream of required repayments herself.

Now consider an individual with a utility function $u(c)$, where $u(\cdot)$ is a well-behaved—twice continuously differentiable, strictly increasing, concave, and satisfies the Inada conditions. She has standard, exponential preferences over time with periodic discount factor δ, and lives for four periods, indexed by $t \in \{0, 1, 2, 3\}$. At time $t = 0$, she decides whether or not to borrow an amount L at a periodic gross interest rate R. If she borrows, she receives an income w_t in each of the first three periods ($t = 1, 2, 3$). If she does not borrow, she receives some subsistence income whose utility we normalize to zero. For simplicity, we will set $w_0 = 0$ and $w_1 = w_2 = w$.

She is unable to save. One simple story behind this is, property rights are insecure and so she lives a hand to mouth existence. Therefore, when she gets the loan in period $t = 0$,

she immediately consumes it.

We consider two potential repayment schedules.

3.3.1 Case 1: Single-Period Repayment

With a one-period loan her incentive-compatibility constraint at time $t = 2$ is

$$u(w - R^2 L) + \delta V \geq u(w).$$

The following equation implicitly defines the maximum incentive-compatible one period loan size $\bar{L}_1$:

$$u(w) - u(w - R^2 L) = \delta V.$$

Let $u^{-1} \equiv f(.)$. Notice that $f(.)$ is strictly increasing and convex given our assumptions about $u(.)$. Then we get:

$$\bar{L}_1 = \frac{1}{R^2} \left\{ f(u(w)) - f\left(u(w) - \delta V\right) \right\}.$$

3.3.2 Case 2: Two-Period Repayment

In this case, loan repayment is divided into two equal installments of $LR^2/(R+1)$ due in periods 1 and 2. All other events and decisions are as in the single-period case. With a two-period loan her incentive-compatibility constraint at time $t = 2$ is

$$u(w - \frac{R^2}{R+1} L) + \delta V \geq u(w).$$

Since the individual is better off, the higher is L, the constraint will bind at the optimum, and can be rewritten as

$$u(w) - u(w - \frac{R^2}{R+1} L) = \delta V.$$

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The first-period incentive-compatibility constraint is

$$u(w - \frac{R^2}{R+1}L) + \left\{ \delta u(w - \frac{R^2}{R+1}L) + \delta^2 V \right\} \geq u(w) + \delta u(w).$$

The latter constraint will bind at the optimum and can be written as:

$$u(w) - u(w - \frac{R^2}{R+1}L) = \frac{\delta^2}{1+\delta}V.$$

As $\frac{\delta}{1+\delta} < 1$, the first-period incentive-compatibility constraint is tighter compared to the second-period one, and is therefore the relevant one. The above equation therefore implicitly defines the maximum incentive-compatible, two-period loan size $\bar{L}_2$. This can be written as:

$$\bar{L}_2 = \frac{R+1}{R^2} \left\{ f(u(w)) - f\left(u(w) - \frac{\delta}{1+\delta}\delta V\right) \right\}.$$

3.3.3 Comparing $\bar{L}_1$ and $\bar{L}_2$

Proposition 6. *For the case with no savings opportunities: (i) For $R = \frac{1}{\delta}$, $\bar{L}_2 > \bar{L}_1$. (ii) For $R = 1$ there exists $0 < \hat{\delta}_0 \leq \hat{\delta}_1 < 1$ such that for $\delta < \hat{\delta}_0$, $\bar{L}_2 < \bar{L}_1$ and for $\delta > \hat{\delta}_1$, $\bar{L}_2 > \bar{L}_1$. (iii) If $f'''(.) \geq 0$, then $\hat{\delta}_0 = \hat{\delta}_1 = \hat{\delta}$. (iv) There exists $\hat{R} \in (1, \frac{1}{\delta})$ such that $\bar{L}_2 = \bar{L}_1$ for $R = \hat{R}$, $\bar{L}_2 > \bar{L}_1$ for $R > \hat{R}$, and $\bar{L}_2 < \bar{L}_1$ for $R < \hat{R}$.*

Proof:

(i). For $R = \frac{1}{\delta}$, $\bar{L}_2 > \bar{L}_1$.

Proof:. The relevant inequality to be proved is

$$\frac{1+\delta}{\delta} \left\{ f(u(w)) - f\left(u(w) - \frac{\delta}{1+\delta}\delta V\right) \right\} > f(u(w)) - f(u(w) - \delta V).$$

Let $\frac{\delta}{1+\delta} = \alpha$. Then the above inequality can be written as

$$f(u(w)) - f(u(w) - \alpha\delta V) > \alpha\{f(u(w)) - f(u(w) - \delta V)\}$$

or,

$$(1 - \alpha)f(u(w)) + \alpha f(u(w) - \delta V) > f(u(w) - \alpha\delta V)$$

but this follows directly from the fact that $f(.)$ is convex.

(ii). For $R = 1$ there exists $0 < \hat{\delta}_0 \leq \hat{\delta}_1 < 1$ such that for $\delta < \hat{\delta}_0$, $\overline{L}_2 < \overline{L}_1$ and for $\delta > \hat{\delta}_1$, $\overline{L}_2 > \overline{L}_1$.

Let $u(w) - \delta V \equiv A$ and $u(w) - \frac{\delta^2}{1+\delta}V \equiv B$. As noted before, $A < B$. We have:

$$\frac{\partial \overline{L}_1}{\partial \delta} = \frac{1}{R^2}f'(A)V$$

$$\frac{\partial \overline{L}_2}{\partial \delta} = \frac{R+1}{R^2}f'(B)\frac{\delta(2+\delta)}{(1+\delta)^2}V$$

$$\frac{\partial^2 \overline{L}_1}{\partial \delta^2} = -\frac{1}{R^2}f''(A)V^2$$

$$\frac{\partial^2 \overline{L}_2}{\partial \delta^2} = \frac{V(R+1)}{R^2}\left[\frac{2}{(1+\delta)^3}f'(B) - f''(B)\frac{\delta^2(2+\delta)^2}{(1+\delta)^4}V\right].$$

Also, $\overline{L}_1 = \overline{L}_2 = 0$ for $\delta = 0$. For $\delta = 1$, $R = 1 = \frac{1}{\delta}$ and by Step 1, $\overline{L}_2 > \overline{L}_1$. Now, for $\delta = 0$, $\frac{\partial \overline{L}_2}{\partial \delta} = 0$ and $\frac{\partial^2 \overline{L}_2}{\partial \delta^2} > 0$. Therefore, $\overline{L}_2$ reaches a local minimum at $\delta = 0$. In contrast, $\frac{\partial \overline{L}_1}{\partial \delta} > 0$ and $\frac{\partial^2 \overline{L}_1}{\partial \delta^2} < 0$ for all $\delta \in [0,1]$. By continuity, therefore, there exists $\hat{\delta}_0$ and $\hat{\delta}_1$ such that $0 < \hat{\delta}_0 \leq \hat{\delta}_1 < 1$ and for $\delta < \hat{\delta}_0$, $\overline{L}_2 < \overline{L}_1$ and for $\delta > \hat{\delta}_1$, $\overline{L}_2 > \overline{L}_1$.

(iii). If $f'''(.) \geq 0$, then $\hat{\delta}_0 = \hat{\delta}_1 = \hat{\delta}$.

In Step 2 in principle $\overline{L}_2$ and $\overline{L}_1$ can intersect several times. This will not be the case if $\overline{L}_2$ does not change curvature more than once. It is strictly convex at $\delta = 0$ and so, if

we can find conditions for which $\frac{\partial^3 \bar{L}_2}{\partial \delta^3} \leq 0$ then we have sufficient conditions for there to be a unique $\delta = \hat{\delta}$ such that for $\delta < \hat{\delta}$, $\bar{L}_1 > \bar{L}_2$ and for $\delta > \hat{\delta}$, $\bar{L}_2 > \bar{L}_1$. The sign of $\frac{\partial^3 \bar{L}_2}{\partial \delta^3}$ depends on the sign of the following expression:

$$2f''(B)\frac{\delta(2+\delta)}{(1+\delta)^2}V - f'''(B)\frac{\delta^3(2+\delta)^3}{(1+\delta)^3}V^2 - f''(B)\frac{\delta(2+\delta)\left(4+3\delta^2+6\delta\right)}{(1+\delta)^2}V.$$

It is easy to verify that that the third term dominates the first term and so the whole expression is negative so long as $f'''(B) \geq 0$.(For the CRRA utility function $u(c) = c^\gamma$ the condition translates to $\gamma \leq \frac{1}{2}$).

   (iv).   There exists $\hat{R} \in (1, \frac{1}{\delta})$ such that $\bar{L}_2 = \bar{L}_1$ for $R = \hat{R}$, $\bar{L}_2 > \bar{L}_1$ for $R > \hat{R}$, and $\bar{L}_2 < \bar{L}_1$ for $R < \hat{R}$.
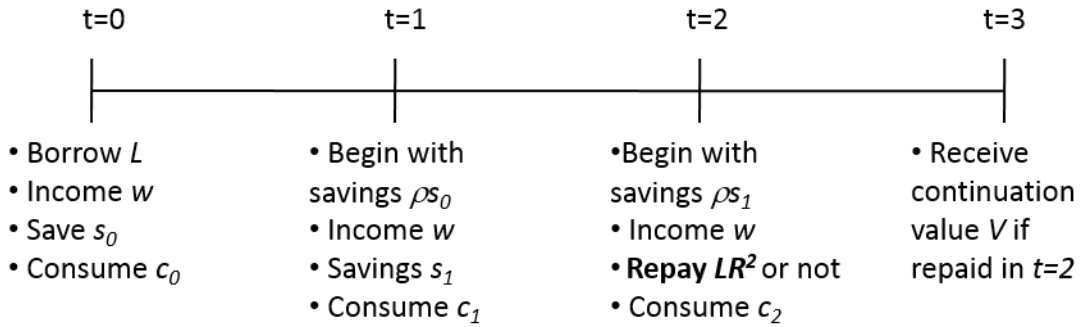
   The condition $\bar{L}_2 > \bar{L}_1$ is equivalent to

$$(R+1)\left\{f(u(w)) - f\left(u(w) - \frac{\delta}{1+\delta}\delta V\right)\right\} > \left\{f(u(w)) - f\left(u(w) - \delta V\right)\right\}.$$

Since the LHS is increasing in R and given Steps 1 and 2, for any δ there exists a $1 \leq \hat{R} < \frac{1}{\delta}$ such that for $R = \hat{R}$, $\bar{L}_2 = \bar{L}_1$. The rest of the argument follows by monotonicity of the RHS with respect to R immediately. ∎

3.4   Concave Utility with Savings

This section extends the preceding discussion of concave utility to allow for savings. The economic environment is as above with one difference. In each of the first two periods, the borrower can save (s_0, s_1) at periodic gross rate of ρ. A natural lower bound is $\rho = 1$; however, values of $\rho < 1$ capture the notion that savings mechanism may be imperfect (e.g., storage of grain) and savings may depreciate as well as grow. Similarly, a natural upper bound is $\rho = R$, but it is possible to think of situations where $\rho > R$. The obvious

Figure 1: Timing, Single-Period Loan

t=0	t=1	t=2	t=3
• Borrow L • Income w • Save s_0 • Consume c_0	• Begin with savings ρs_0 • Income w • Savings s_1 • Consume c_1	•Begin with savings ρs_1 • Income w • **Repay LR^2 or not** • Consume c_2	• Receive continuation value V if repaid in t=2

focal case of $\rho = R$ turns out to be analytically very tractable and so we focus our attention there.

We consider the two potential repayment schedules.

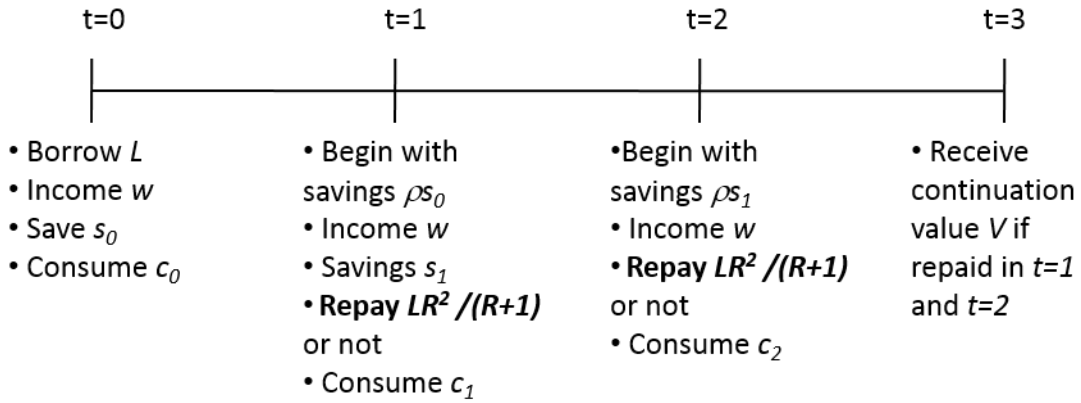### 3.4.1 Case 1: Single-Period Repayment

At time $t = 0$, she can borrow the loan L. If she borrows, she receives income of w. From this total cash on hand of $L + w$ she saves an amount $s_0 \in [0, L+w]$ and consumes the rest $c_0 = L + w - s_0$.

She begins period $t = 1$ with savings plus interest of ρs_0 and receives income of w if she has borrowed. From this amount she saves s_1 and consumes the rest, $c_1 = \rho s_0 + w - s_1$.

At time $t = 2$, the total loan plus accrued interest, LR^2, is to be repaid. She begins the period with savings plus interest of ρs_1 and receives income of w if she has borrowed. If she chooses to repay the loan, she consumes $c_2 = \rho s_1 + w - LR^2$. If she chooses not to repay, she consumes $c_2 = \rho s_1 + w$.

In period $t = 3$, she receives a continuation utility of V is she repaid the loan and zero otherwise. Figure 1 summarizes the timing of events and decisions for the single-period loan.

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Figure 2: Timing, Two-Period Loan

t=0	t=1	t=2	t=3

- Borrow L
- Income w
- Save s_0
- Consume c_0

- Begin with savings ρs_0
- Income w
- Savings s_1
- **Repay $LR^2/(R+1)$** or not
- Consume c_1

- Begin with savings ρs_1
- Income w
- **Repay $LR^2/(R+1)$** or not
- Consume c_2

- Receive continuation value V if repaid in t=1 and t=2

3.4.2 Case 2: Two-Period Repayment

In this case, loan repayment is divided into two equal installments of $LR^2/(R+1)$ due in period 1 and 2. All other events and decisions are as in the single-period case. At time $t = 0$, she can borrow the loan L. If she borrows, she receives income of w. From this total cash on hand of $L + w$ she saves an amount $s_0 \in [0, L+w]$ and consumes the rest $c_0 = L + w - s_0$.

She begins period $t = 1$ with savings plus interest of ρs_0 and receives income of w if she has borrowed. From this amount she can make the first payment on the loan, $LR^2/(R+1) \equiv M_2$, saves s_1, and consumes the rest, $c_1 = \rho s_0 + w - LR^2/(R+1) - s_1$. If she chooses not to repay, she consumes $\rho s_0 + w - s_1$.

She begins period $t = 2$ with savings plus interest of ρs_1 and receives income of w if she has borrowed. If she chooses to repay the loan, she consumes $c_2 = \rho s_1 + w - LR^2/(R+1)$. If she chooses not to repay, she consumes $c_2 = \rho s_1 + w$.

In period $t = 3$, she receives a continuation utility of V is she repaid the loan in both period 1 and 2 and zero otherwise. Figure 2 summarizes the timing of events and decisions for the two-period loan.

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3.4.3 Solution

The incentive-compatibility constraint in period 2 is

$$u(\rho s_1 + w - LR^2) + \delta V \geq u(\rho s_1 + w). \tag{8}$$

Without savings, this is the binding constraint. However, because the borrower has the ability to reoptimize her savings in each period, we must look at her incentive compatibility constraint in earlier periods as well. In period 1, her incentive compatibility constraint is

$$\max_{s_1}\{u(\rho s_0 + w - s_1) + \delta u(\rho s_1 + w - LR^2) + \delta^2 V\} \geq \max_{s_1}\{u(\rho s_0 + w - s_1) + \delta u(\rho s_1 + w)\}.$$

This constraint is *tighter* than the constraint in period 2. To see this, note that when s_1 is fixed, the period 1 incentive-compatibility constraint becomes

$$u(\rho s_0 + w - s_1) + \delta u(\rho s_1 + w - LR^2) + \delta^2 V \geq u(\rho s_0 + w - s_1) + \delta u(\rho s_1 + w),$$

which collapses immediately to (8). Define $\overline{s_1} = \arg\max_{s_1}\{u(\rho s_0 + w - s_1) + \delta u(\rho s_1 + w - LR^2) + \delta^2 V\}$, that is, the optimal savings choice in period 1 if the borrower were planning to repay the loan. The necessary and sufficient condition for the period 1 incentive-compatibility constraint to be more restrictive than (8) is

$$\max_{s_1}\{u(\rho s_0 + w - s_1) + \delta u(\rho s_1 + w)\} > u(\rho s_0 + w - \overline{s_1}) + \delta u(\rho \overline{s_1} + w).$$

This is true for all $L > 0$, therefore the period 1 incentive-compatibility constraint is more restrictive. The same argument extends to the period 0 incentive-compatibility constraint.

Therefore the operative incentive compatibility constraint for loan repayment is

$$U_1^{r*} \equiv \max_{\substack{s_0 \in S_0^1 \\ s_1 \in S_1^1}} U_1^r(s_0, s_1) \geq \max_{\substack{s_0 \in [0, L+w] \\ s_1 \in [0, \rho s_0 + w]}} U^d(s_0, s_1) \equiv U^{d*}, \qquad (9)$$

where

$$U_1^r(s_0, s_1) = u(L + w - s_0) + \delta u(\rho s_0 + w - s_1) + \delta^2 u(\rho s_1 + w - LR^2) + \delta^3 V, \text{ and}$$

$$U^d(s_0, s_1) = u(L + w - s_0) + \delta u(\rho s_0 + w - s_1) + \delta^2 u(\rho s_1 + w),$$

with $S_0^1 = [\max\left(\frac{M_1 - w(1+\rho)}{\rho^2}, 0\right), L + w]$ and $S_1^1 = [\max\left(\frac{M_1 - w}{\rho}, 0\right), \rho s_0 + w]$.

For the two-period loan, the incentive compatibility constraint is

$$U_2^{r*} \equiv \max_{\substack{s_0 \in S_0^2 \\ s_1 \in S_1^2}} U_2^r(s_0, s_1) \geq U^{d*}, \qquad (10)$$

where

$$U_2^r(s_0, s_1) = u(L + w - s_0) + \delta u(\rho s_0 + w - M_2 - s_1) + \delta^2 u(\rho s_1 + w - M_2) + \delta^3 V,$$

with $M_2 \equiv \frac{LR^2}{R+1}$, $S_0^2 = [\max\left(\frac{(1+\rho)(M_2 - w)}{\rho^2}, 0\right), L + w]$ and $S_1^2 = [\max\left(\frac{M_2 - w}{\rho}, 0\right), \rho s_0 + w - M_2]$. Note that the lower bound on s_0 is determined by the minimum amount of savings required such that repayment is feasible in both periods 1 and 2.

3.4.4 Comparing maximum loan sizes

We begin by comparing the maximum incentive compatible loan sizes supported by both repayment terms under the assumption that the incentive compatibility constraints bind, that is, under either loan, individuals would like to borrow more but are unable to do so

because repayment would no longer be incentive compatible for a larger loan. Here we consider the case where $\rho = R \in [1, 1/\delta]$. With little structure on individuals' preferences, closed-form solutions are not possible but a revealed preference argument allows us to characterize relative repayment incentives. To provide an analytical solution, we next solve the problem explicitly when preferences are described by the CRRA utility function. Finally, we return to the general formulation and characterize the region of the parameter space for which the incentive compatibility constraints are binding. This is not merely a mathematical novelty but provides some guidance as to when repayment frequency will affect repayment behavior and when it will be overshadowed by other loan characteristics.

We can simplify the comparison of the maximum incentive compatible loans under both repayment terms by noting that the right-hand sides of both incentive compatibility constraints, equations (9) and (10), are identical. They are simply the utility of not repaying and are independent of repayment terms. Therefore, which repayment structure supports the larger incentive-compatible loan will be determined by the utility obtained in the maximization problems with repayment for each loan type, that is, the left-hand sides of each equation.

Individuals are generally indifferent between the single and two-installment loans. The prefer the single-payment loan only when the repayment required in period 1 under the two-payment loan exceeds their optimal savings under the single-payment loan. The customary intuition holds: under the one-period loan, savings allows individuals to duplicate any cash flow stream possible under the two-period loan, and under certain circumstances they find the "forced savings" of the two-period loan too restrictive.

More formally, define the feasible range of savings in period t (s_t) for the i installment loan with repayment as S_t^i. For example, S_0^1 is the feasible savings set for period 0 under the one-period loan. Define the feasible range of consumption analogously as C_t^i. Thus, $S_0^1 = [\frac{M_1 - (1+\rho)w}{\rho^2}, L + w]$ and $S_0^2 = [\frac{(1+\rho)M_2 - (1+\rho)w}{\rho^2}, L + w]$. This implies that the feasible

ranges of consumption in period 0 for the one- and two-period loans are $C_0^1 = [0, Pw + (1 - R^2/\rho^2)L]$ and $C_0^2 = [0, Pw + \left(1 - \frac{R^2(1+\rho)}{\rho^2(1+R)}\right)L]$, where $P \equiv 1 + \rho^{-1} + \rho^{-2}$. When $\rho = R$, both expressions collapse to $[0, Pw]$. Carrying these limits forward, $C_1^1 = [0, L\rho + (1 + \rho)w - \max(\frac{M_1 - w}{\rho}, 0)]$ and $C_1^2 = [0, L\rho + (1+\rho)w - M_2 - \max(\frac{M_2 - w}{\rho}, 0)]$. In period 2, they are $C_2^1 = [0, L\rho^2 + \rho^2 Pw - LR^2]$ and $C_2^2 = [L\rho^2 + \rho^2 Pw - \frac{1+\rho}{1+R}R^2]$. As in period 0, when $\rho = R$, the bounds on consumption in period 2 are identical.

If $w < M_2$ (in terms of the exogenous parameters, $w < \beta\delta^2 V(1 + \beta\delta)^{-1}$), borrowers must save in period 0 in order to repay the loan under either repayment structure and the feasible ranges of consumption in period 1 are the same under both repayment terms. In this case, the optimization problems are identical for both the one-period and two-period loans. Hence, $\max U_1^r(s_0, s_1) = \max U_2^r(s_0, s_1)$, the incentive compatibility constraints are identical, and $\bar{L}_1 = \bar{L}_2$.

If $w \geq M_2$, then $C_1^2 \subset C_1^1$ and the flexibility of the single-period repayment structure will make it preferable to the two-period loan whenever optimal period 1 savings under single-period is less than M_2. That is, borrowers will prefer the single-installment loan whenever the period 1 repayment requirement of the two-period repayment structure prevents them from consuming as much as they would if unconstrained. This can be summarized in the following proposition.

Proposition 7. *If savings is possible at an interest rate $\rho = R$ and $w \geq M_2$, then $\overline{L_1} \geq \overline{L_2}$. If $w < M_2$, then $\overline{L_1} = \overline{L_2}$.*

The intuition of the preceding sections is informative. Even without present bias, when credit markets are subject to multiple distortions from both enforcement problems and a lack of savings, the structure of frequent repayment can serve as a proxy for savings and relax credit constraints. However, when savings is possible, the rigidity of frequent repayment adds no additional value. If more frequent repayment would increase utility,

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the borrower can do at least as well by replicating these payment streams herself through savings.

4 Conclusion

In this paper, we have proposed a simple theory based on present bias to explain a prevalent and poorly understood feature of microfinance lending contracts: high-frequency repayment. For classically rational borrowers, the pervasiveness of high-frequency repayment is theoretically puzzling. They should prefer more flexible repayment schedules. Less frequent repayment should increase neither default nor delinquency. When borrowers are present biased, the repayment structure matters. We show that more frequent repayment can increase the maximum incentive compatible loan size. This result supports the folk wisdom of many microfinance institutions; however, the welfare consequences are not clear cut. More frequent repayment can reduce welfare by facilitating the over-borrowing that occurs due to time inconsistency.

This paper also offers a theoretical structure with which to interpret and extend existing empirical evidence. For example, Field and Pande's (2008) randomized evaluation of repayment terms for the clients of a typical, urban microfinance institution in India found no effect of repayment frequency on default or delinquency. Repayment rates were nearly perfect for both groups. In the context of our model, this suggests that the incentive compatibility constraints may not have been binding for either group and is consistent with the relatively small loan sizes involved. Further experiments, specifically testing this and competing hypotheses, would help extend and generalize our understanding of microfinance contract design.

This paper considers the specific application of microfinance, where the issue of repayment frequency has particular policy salience. The core elements may also potentially

be applied to other contexts including mortgages, payday loans, rent-to-own services, and other consumer finance products where frequent repayment is also a typical and salient feature.

References

Akerlof, G A, "Procrastination and Obedience," *The American Economic Review*, 1991, pp. 1–19.

Armendariz, Beatriz and Jonathan Morduch, *The Economics of Microfinance*, Cambridge, MA: MIT Press, 2005.

BancoSol, "BancoSol: Our History," \url{http://www.bancosol.com.bo/es/historia.html} July 2010.

Banerjee, Abhijit V, Timothy Besley, and Timothy W Guinnane, "Thy Neighbor's Keeper: The Design of a Credit Cooperative with Theory and a Test," *Quarterly Journal of Economics*, 1994, *109* (2), 491–515.

Basu, Karna, "A Behavioral Model of Simultaneous Borrowing and Saving," 2008.

_ , "The Provision of Commitment in Informal Banking Markets: Implications for Takeup and Welfare," 2009.

Besley, Timothy and Stephen Coate, "Group Lending, Repayment Incentives and Social Collateral," *Journal of Development Economics*, 1995, *46* (1), 1–18.

Field, Erica and Rohini Pande, "Repayment Frequency and Default in Microfinance: Evidence From India," *Journal of the European Economic Association*, 2008, *6* (2-3), 501–509.

Fischer, Greg, "Contract Structure, Risk-Sharing, and Investment Choice," *Econometrica*, 2013, *81* (3), 883–939.

Ghatak, Maitreesh, "Group Lending, Local Information and Peer Selection," *Journal of Development Economics*, 1999, *60* (1), 27–50.

Giné, Xavier and Dean S Karlan, "Group versus Individual Liability: Long Term Evidence from Philippine Microcredit Lending Groups," Technical Report, Yale Economics Department Working Paper No. 61 2009.

Gonzalez-Vega, C, S Navajas, and M Schreiner, *A Primer on Bolivian Experiences in Microfinance: An Ohio State Perspective*, Ohio State Univ., 1995.

Heidhues, Paul and Botond Köszegi, "Exploiting Naivete about Self-Control in the Credit Market," *American Economic Review*, 2009.

Jain, Sanjay and Ghazala Mansuri, "A Little at a Time: The Use of Regularly Scheduled Repayments in Microfinance Programs," *Journal of Development Economics*, 2003, *72* (1), 253–279.

Karduck, Stefan and Hans Deiter Seibel, "Transaction Costs of Self-Help Groups: A Study of NABARD?s SHG Banking Program in India," Technical Report, University of Cologne Development Research Center Working Paper 2004.

McIntosh, C, "Estimating Treatment Effects from Spatial Policy Experiments: An application to Ugandan Microfinance," *The Review of Economics and Statistics*, 2008, *90* (1), 15–28.

O'Donoghue, Ted and Matthew Rabin, "Doing It Now or Later," *The American Economic Review*, 1999, *89* (1), 103–124.

Shankar, Savita, "Transaction Costs in Group Micro Credit in India: Case Studies of Three Micro Finance Institutions," Technical Report, Centre for Microfinance, IFMR Working Paper 2006.

Stiglitz, Joseph E, "Peer Monitoring and Credit Markets," *World Bank Economic Review*, 1990, *4* (3), 351–366.

Varian, Hal R, "Monitoring Agents with Other Agents," *Journal of Institutional and Theoretical Economics*, 1990, *146* (1), 153–174.

Westley, Glenn D, *A Tale of Four Village Banking Programs: Best Practices in Latin America*, Washington D.C.: Inter-American Development Bank, 2004.

Women's World Banking, *What do Microfinance Customers Value?*, Vol. 1, New York: Women's World Banking, 2003.

Yunus, M and A Jolis, *Banker to the Poor: Micro-lending and the Battle Against World Poverty*, New York, NY: Public Affairs, 2003.

Yunus, Muhammad, "Grameen Bank II," \url{http://www.grameen.com/index.php ?option=com_content&task=view&id=30&Itemid=0&limit=1&limitstart=1/} June 2010.