Micro-finance Competition: Motivated Micro-lenders, Double-dipping and Default

Brishti Guha*
(Singapore Management University),
Prabal Roy Chowdhury
(Indian Statistical Institute).

January, 2013

Abstract

We develop a tractable model of competition among socially motivated MFIs, so that the objective functions of the MFIs put some weight on their own clients' utility. We find that the equilibrium involves double-dipping, i.e. borrowers taking multiple loans from different MFIs, whenever the MFIs are relatively profit-oriented. Further, double-dipping necessarily leads to default and inefficiency, and moreover, borrowers who face relatively higher transactions costs optimally decide to double-dip. Interestingly, an increase in MFI competition can increase the extent of double-dipping and default. Further, the interest rates may go either way, with the interest rate likely to increase with more competition if the MFIs are very socially motivated.

Key-words: Micro-finance competition; socially motivated MFIs; double-dipping; default; subsidized credit; interest cap.

JEL Classification No.: C72, D40, D82, G21

*Department of Economics, Singapore Management University,
90 Stamford Road, Singapore 178903.
E-mail: bguha@smu.edu.sg.
Phone: (65)68280289.
Fax: (65)68280833.

1 Introduction

One of the salient features of the micro-finance movement is its rapid expansion. In India, for example, the average year-on-year increase in the portfolio of the Indian micro-finance sector over the period 2004-2009 was 107% (as compared to a 4% increase in commercial bank lending in 2008-09, see Parameshwar et al., 2009). Other countries also witnessed similar expansions.[1] With increased micro-finance penetration, there has been a concomitant increase in competition among micro-finance institutions, with many areas being served by multiple MFIs.

One of the central issues in this context, and the one we focus on in this paper, is that of 'double-dipping', i.e. borrowers taking loans from several MFIs, and the closely connected issue of borrower default. Several studies confirm the importance of double-dipping, and also find evidence to suggest that double-dipping may be linked to the phenomenon of borrower default.

In the South Indian state of Karnataka, for example, there were 7.31 million micro-finance accounts by the end of 2009 (Srinivasan, 2009). Even assuming that all the poor were covered, this comes to 2.63 accounts per household. In fact Srinivasan (2009) argues that such an increase in MFI competition is happening all across India, including the Northern and Eastern states, and not just in the South (which traditionally lead in micro-finance development) and, moreover, that borrowers often use loans from one MFI to repay other MFIs.[2] In the context of Bangladesh, the Wall Street Journal (27.11.2001) reports that "Surveys have estimated that 23% to 43% of families borrowing from micro-lenders in Tangail borrow from more than one."[3] For Bangladesh, McIntosh and Wydick (2005) find that in spite of the fact that competitive pressures among microlenders reduced interest rates for some borrowers, 32% of the Grameen Bank's loan portfolio in Tangail was overdue by 2 years or more.

One motivation for this paper comes from the fact that recently MFI competition appears to have triggered extreme reactions from borrowers. In the Indian state of Andhra Pradesh, there were recent claims that over-indebtedness and aggressive loan recovery procedures led to farmer suicides, leading to public outcry and politicians urging borrowers not to repay. Similarly, in Nicaragua there was a "No Pago" (I am not paying) movement in 2009 (see Quidt et al., 2012). A theoretical motivation comes from the fact that the effect of an increase in MFI competition, and the resultant double-dipping, is conceptually not very clear-cut, especially in so far as the efficiency and welfare implications are concerned. It is of course clear that such double-dipping can weaken borrower discipline and increase default (Hoff and Stiglitz, 1997). Others have argued though that competition, by reducing interest rates, may improve borrower welfare.[4] As we argue later, this paper provides a partial reconciliation of these divergent viewpoints.

In this paper we seek to develop a tractable model of MFI competition that incorporates two facts, first, that money is fungible, thus allowing for double-dipping,[5] and, second, that the MFIs

[1] Between 1997 and 2005, the estimated number of microfinance institutions (MFIs) worldwide grew from 618 to 3133 (Hermes and Lensink, 2007).

[2] A survey by the Grameen Koota staff covering 200 borrowers (including 105 defaulters), suggests that 25 per cent of these borrowers had taken loans from 6 or more MFIs. In another extreme example, one woman was found to have borrowed Rs. 4 million from different MFIs (Srinivasan, 2009).

[3] McIntosh and Wydick (2005) provide evidence of increased MFI competition in Uganda and Kenya in Africa, and Guatemala, El Salvador and Nicaragua in America.

[4] See the Malegam Committee Report, 2011, pp. 16, for an example of the first stance, and the Malegam Committee Report, 2011, pp. 32, for an example of the second stance.

[5] Policy makers acknowledge that it is difficult for MFIs to assess whether borrowers are borrowing from other sources or not (Srinivasan, 2009). Similarly, Janvry et al. (2010) also find, using Guatamalan data, that borrowers did not disclose past defaults or total liabilities to lenders on their own.

are *socially motivated*, i.e. not only interested in their own profits, but also in the utility of the borrowers. That many NGOs (including MFIs) are socially motivated is well known in the literature. The United Nations Interagency Committee on Integrated Rural Development for Asia and the Pacific (1992) (henceforth UNICIRDAP) for example, defines NGOs as organizations with six key features: they are voluntary, non-profit, service and development oriented, autonomous, *highly socially motivated and committed*, and operate under some form of formal registration.[6]

Formally we adopt a variation of the Salop circular city model populated by borrowers, as well as socially motivated MFIs, where the distance between an MFI and a borrower captures the transactions cost incurred by the borrower in accessing a loan from the concerned MFI. We consider a framework with asymmetric information, in that there is fungibility of money; the MFIs cannot ascertain whether, in addition to investing, which is socially efficient, the borrowers are also spending on consumption, which is not. This in turn generates a moral hazard problem whereby a borrower can borrow from multiple MFIs without the concerned MFIs being aware of this. Since borrowers have no assets, only the return from the productive project can be claimed by MFIs; however, under the present framework, this amount is insufficient to cover the interest payment to two MFIs. Thus double-dipping necessarily leads to default. There is another asymmetric information which arises out of the fact that the MFIs are unaware of the transaction costs facing different borrowers, and hence cannot offer loan contracts which are tailored to the needs of the individual borrowers. Note that in our framework, MFIs will never deliberately encourage double dipping. This is because they know that the borrower's returns from investment are insufficient to cover the interest charges of two MFIs, so that double dipping will necessarily lead to default and losses for the MFI.

Turning to the results, we find that the implications of an increase in MFI competition are quite nuanced. Consider equilibria with double-dipping (henceforth DDE). We demonstrate that increased MFI competition necessarily leads to an increase in default, both at the aggregate level, as well as in default per MFI. This shows that we need to qualify the popular wisdom that an increase in competition would, by causing a lowering of interest rates, necessarily reduce default. We find that an increase in competition increases default, irrespective of whether the interest rate increases, or decreases. In fact in the present framework, note that an increase in competition actually *reduces* transactions costs, thus making single-dipping more attractive. Why should then default increase? The intuition has to do with the fact that while a reduction in transactions costs makes both single-dipping and double-dipping more attractive, double-dipping becomes relatively more so as multiple loans are involved. This increases double-dipping, and consequently default, and also reduces efficiency since consumption increases. Furthermore, it should be emphasized that given that there is full market coverage in equilibrium, this result does *not* rely on the argument that, with increased competition, the MFIs reach out to less credit-worthy borrowers, thereby reducing the average quality of the borrower pool.

Second, turning to the effect of increased competition on the equilibrium interest rate under a DDE, we find that the interest rate is *increasing* in the level of competition if the MFIs are sufficiently socially motivated, and decreasing in the level of competition otherwise. The fact that the interest rate is decreasing in competition for profit oriented MFIs, is of course because of the standard industrial organization argument that the business-stealing effect gets stronger with an increase in competition. Given the business stealing effect however, the fact the interest rates may *increase* for socially motivated MFIs is however somewhat surprising. This follows from

[6] See Besley and Ghatak (2005, 2006), and Ghatak and Mueller (2011) for studies on incentive provision to socially motivated agents.

an interaction of the business stealing effect with a second effect that arises because increased competition leads to an increase in default (as argued earlier), which in turn increases the negative externality that borrowers exert on the MFIs, providing an incentive to increase the interest rate.[7] Further the second effect dominates when the MFIs are highly socially motivated becuase in this case the interest rate is going to be low to begin with, so that the MFIs will be just breaking even, and the business-stealing effect is kept in check by feasibility considerations. [8] This argument also shows the importance of allowing for motivated agents, as this effect cannot arise in case the MFIs are very profit oriented.

Given the preceding results regarding the impact of increased MFI competition on interest rates, it is therefore intriguing that the empirical evidence also appears to be mixed. For example, Porteous (2006) and Fernando (2006) provide evidence of a decrease in MFI interest rates in response to increased MFI competition (over the 1990s in Bolivia in Porteus (2006), and over 2003-2006 in Cambodia for Fernando (2006)). On the other hand, Porteous (2006) finds that interest rates increased with competition at certain points of time in Bangladesh and Uganda. Interestingly, in this context he mentions that "the strong poverty alleviation focus of the major Bangladeshi MFIs...ensured that initial microlending rates were relatively low..so there was not much headroom for rate reductions...". This is in line with our theoretical finding that, for more socially motivated MFIs, the business-stealing effect is kept in check by feasibility considerations.

Turning to the welfare implications of an increase in competition, we find that there are several effects at play here. While there is a reduction in aggregate transactions costs, which benefits borrowers on average, the interest rates may, as argued earlier, also go up in some cases. Thus the single-dipping borrowers may be adversely affected in case competition leads to an increase in the rate of interest. The double-dipping borrowers however necessarily gain since, with all their verifiable income being taken up in loan repayments, the interest cost effect is absent.

Thus our analysis provides a partial reconciliation of the two conflicting viewpoints on MFI competition. Given the plausible assumption that increased competition lowers transactions costs for borrowers, we however find that this apparently positive affect can have negative implications, in that there will be increased double-dipping, with resultant loss in efficiency. At the same time, the utility of all double-dipping borrowers will increase. The impact on the utility of the single-dipping borrowers is, however, ambiguous.

We then discuss some properties of a double-dipping equilibrium, i.e. DDE. First, we demonstrate that a DDE exists whenever the MFIs are not too socially motivated. Intuitively, the MFIs are likely to charge higher interest rates when they are relatively more profit-oriented. This reduces the payoff from single-dipping, whereas that from double-dipping is not affected. This makes double-dipping relatively attractive, at least for those borrowers who are not too close to any one MFI. Second, borrowers who double-dip do so as their transactions costs are relatively large.

Further, we find that an increase in competition can lead to a transition from a single-dipping equilibrium (in which no borrower double-dips, henceforth SDE), to a DDE, whenever the MFIs are somewhat socially motivated. We also derive some interesting policy implications. We find, for example, that in case an interest subsidy by the government encourages entry into the micro-finance sector, then such a subsidy could increase default and inefficiency, and even increase interest rates.

Finally, we argue that allowing for socially motivated MFIs generates new insights. For one,

[7]The negative externality exerted by agents in the presence of non-exclusive contracts has been examined in the literature, viz. Kahn and Mookherjee (1995, 1998). We relate the present paper to this literature in somewhat greater details later on.

[8]As mentioned in the next paragraph, there is some evidence suggesting such effects.

an SDE or no-default equilibrium cannot emerge unless the MFIs are relatively socially motivated. Neither can the result that under a double-dipping equilibrium an increase in competition can lead to an increase in interest rates, nor the result that an increase in competition can cause a regime switch from single-dipping to double-dipping.

1.1 Related Literature

We start with a brief review of the empirical literature. McIntosh et al. (2005) find evidence for double-dipping using Ugandan data, showing that multiple lending increases and repayment worsens with an increase in the number of competing MFIs. Similarly, Vogelgesang (2003) finds multiple loan-taking to be an important trigger in borrower defaults in Bolivia and also to result in high interest rates, at least for some clients. In the Bolivian context, Marconi and Mosley (2005) find that the rapid increase in MFI competition played a role in worsening the microfinance loan portfolio, with over-indebtedness affecting 15-17% of the portfolio of leading MFIs.

Thus our theoretical results are consistent with the empirical evidence which seem to suggest, broadly speaking, that MFI competition may increase multiple lending, as well as default. Further, as discussed earlier, we find that the results in the present paper are consistent with the fact that an increase in MFI competition may, or may not lead to an increase in the rate of interest (Porteous, 2006, and Fernando, 2006).

We next briefly relate our paper to the growing theoretical literature on MFI competition. As mentioned earlier, the issue of multiple lending is related to a broader literature on non-exclusive contracts, viz. Kahn and Mookherjee (1995, 1998), with the central theme that such contracts impose an externality on the other agents. In the present paper, for example, whenever default increases (say, because of a rise in competition), the interest rate increases, thus creating an externality for the other borrowers. This follows since the fact that some of the borrowers default means that the MFIs will have to recoup their losses on the other borrowers, thus pushing up interest rates for *all* borrowers.

The theoretical literature on MFI competition includes, among others, Hoff and Stiglitz (1987), Kranton and Swamy (1999), Van Tassel (2002), Navajas et al. (2003), McIntosh and Wydick (2005), Janvry et al. (2010), Guha and Roy Chowdhury (2011), Quidt et al. (2012), and Dam and Roy Chowdhury (2012).[9]

The papers closest to the present one are Navajas et al. (2003) and McIntosh and Wydick (2005, henceforth MW), with both papers analyzing the interaction between a client-maximizing incumbent MFI, and a profit-oriented entrant. MW show that increased competition can reduce the MFIs' ability to cross-subsidize, so that poorer borrowers may be screened out. A similar effect may arise in case increased MFI competition makes information sharing more difficult (in the presence of asymmetric information regarding discounting). Navajas et al. (2003) find that with increased competition, the profit-oriented MFI may screen off the more productive borrowers, leaving the socially motivated MFI to supply the less productive borrowers, with negative implications for these borrowers.

Guha and Roy Chowdhury (2011, henceforth GRC) examine MFIs that compete over donor funds (but not for clients), and focus on how competition affects the MFIs' *targeting decisions*, and, consequently, the poorest borrowers' access to microfinance. While GRC (2011) allows for

[9] In the context of NGO competition, Aldashev and Verdier (2010) examine a model where the NGOs allocate their time between working on the project and fund-raising. They find that with free entry of NGOs the equilibrium number of NGOs can be either larger or smaller than the socially optimal one.

double-dipping, it is driven by the need to exploit scale economies, and does not allow for default. Moreover, GRC take the interest rate to be exogenously given. Janvry et al. (forthcoming, 2013) examine the implications in case credit bureaus are set up. Finally, Dam and Roy Chowdhury (2012) examine the implications of MFI competition for incentives for credit agents.

The present paper however differs from both MW (2005) and Navajas et al. (2003) in several respects. First, the possibility of cross-subsidization plays a critical role in both these papers. In the present paper however, type specific contracts with cross-subsidization are not possible. Second, while both MW and Navajas et al. (2003) allow for client-maximization, they do not allow for socially motivated MFIs, with the borrowers' utility entering the objective function of the MFIs directly. It may perhaps be argued that depending on the context, either client-maximizing, or socially motivated MFIs, may be of interest. Next, unlike in MW (2005), we obtain multiple-lending in a static framework and do not introduce the possibility of repeat loans. Further, in MW (2005), the negative effect of MFI competition in the presence of multiple lending is driven by the fact that such competition may worsen information sharing among the MFIs. In contrast, in our model it is driven by the fact that increased competition may reduce transaction costs, thus identifying a new channel through which the negative effect may operate. Finally, double-dipping is not the focus in either Navajas et al. (2003), or Janvry et al. (2010).

Hoff and Stiglitz (1987), Kranton and Swamy (1999) and Van Tassel (2002) also examine the issue of lender competition, though for lenders in general, rather than MFIs in particular. Both Hoff and Stiglitz (1997) and Kranton and Swamy (1999) argue that competition may have negative implications. While in Hoff and Stiglitz (1997) the result arises out of the fact that in a monopolistically competitive market, entry by new lenders leads to a loss of economies of scale (among other reasons), in Kranton and Swamy (1999) it stems from the fact that competitive lenders cannot afford to roll over loans as they are not assured of repeat relationships with the same borrowers. Van Tassel (2002) develops a model where the threat of future entry may provoke the incumbent lender to dilute the quality of information available to its competitors by charging a low interest rate. In related work, Quidt et al. (2012) examine the issue of market power among MFIs, though they do not directly address either multiple lending, or MFI competition.

In contrast to the preceding papers however, the present paper not only explicitly grapples with the issue of double-dipping but, moreover, allows for socially motivated MFIs. Also, while some of these papers also generate negative implications for MFI competition, the channels identified in these papers are different from those in the present paper.

Further, the specific MFI context allows for more structure, generating some additional results of interest. For example, several of the results hinge on the fact that the MFIs are socially motivated. For one, an SDE or no-default equilibrium cannot emerge unless the MFIs are relatively socially motivated. For another, the result that under a double-dipping equilibrium an increase in competition can lead to an increase in interest rates, also emerges only when the MFIs are socially motivated. So does the result that an increase in competition can cause a regime switch from single-dipping to double-dipping. These results will not arise therefore, in a model that deals with lenders in general, who are unlikely to be socially motivated.

There is also a recent literature that seeks to analyze over-borrowing from a behavioral perspective, e.g. Fischer and Ghatak (2010), Heidhues and Koszegi (2010) and Basu (2012). These papers analyze the implications of present-biased preferences on various aspects of credit-contracts, including the issue of over-borrowing. Fischer and Ghatak (2010) provides a theory of frequent repayment in micro-finance based on present-biased preferences, and also relate their framework to the issue of over-indebtedness. In contrast, we do not assume hyperbolic discounting; as mentioned earlier, we generate our results in a static framework. Our focus, moreover, is on multiple loan-taking and not on commitment savings, or frequent repayments.

We then relate our paper to the literature on credit cards, another kind of unsecured loans. Both Heidheus and Koszegi (2010) and Meier and Sprenger (2009) connect credit card debt with present biased preferences. While Heidheus and Koszegi (2010) adopt a theoretical framework where borrowers sign exclusive contracts with a single lender, so that double dipping is ruled out, Meier and Sprenger (2010) test whether present biased preferences correlate with credit card borrowing. Ausubel (1991) finds that the interest rates charged by credit card companies seemed insensitive to changes in the cost of capital, though the market was competitive. This seems in line with our theoretical prediction that the interest rate under double-dipping is insensitive to costs of lending. For the credit card market, Brito and Hartley (1995) provide an explanation for this phenomenon based on low transactions costs, and the fact that credit card also provides liquidity services by allowing consumers to avoid some of the opportunity costs of holding money.

The present framework differs from the credit card market in one significant respect, namely that due to the lack of credit records and databases in developing countries, it is difficult for MFIs to share information. Indeed, this lack of information sharing is one important reason why increasing competition leads to an increase in default in our setup. Later in the paper, we however briefly consider an extension allowing MFIs to detect multiple borrowing with some probability, and show that many of our results go through.

2 Framework

We frame the problem using a variation of the Salop circular city framework. The model is populated by borrowers of mass one, as well as several micro-finance institutions (MFIs). The borrowers are uniformly distributed over a circle of unit circumference, whereas the MFIs, n in number, are located symmetrically along the circumference of the circle. Let us denote these MFIs as $M_1, M_2, \cdots, M_n$, and let these MFIs be located in the same order on the circle.

Every borrower has access to one productive project that requires a setup cost of 1, and yields a return of F. She can also spend 1 unit of money on consumption, when she obtains a utility of u. These two activities are however fundamentally different in that while production is socially efficient, consumption is not, so that $F > c' > u$, where c' is the opportunity cost of capital. The MFIs however can access capital at a subsidized gross interest of $c < c'$.[10] Such subsidies are typically provided by the government since MFIs have high operational expenses, arising because (i) they target the poor, thus incurring targeting costs and (ii) offer small loans, which increases average transactions costs. A borrower cannot undertake more than one productive project; nor can she undertake more than one consumption "project".[11]

The borrowers however have no money, or assets, so that in case they want to invest, or consume, they must borrow the required amount from some MFI. In case a borrower borrows one unit of capital from an MFI located at a distance of x_i from her, she also incurs a "total transportation

[10] In Remark 6, we later discuss the implications if the subsidy is small, e.g. if $c' = c$.

[11] This may, for example, happen if each productive project, in addition to a fixed capital requirement, also requires entrepreneurial labor, so that one individual cannot run two or more productive projects at the same time, even if she obtained the requisite capital. The restriction on consumption projects formalizes the idea that there are decreasing returns to consumption, in particular "unsanctioned" consumption, since such consumption may attract unwarranted attention and scrutiny. We use the term "unsanctioned" because borrowers in our model can only consume if they borrow from MFIs under the pretext of a production loan.

cost" of tx_i, with t being the "marginal" transportation cost. While the notion of transportation cost is compatible with a purely physical interpretation of distance, one can interpret tx_i as a non-monetary total transactions cost of borrowing for a borrower, which captures the fact that the loan product offered by the lender may not be exactly tailored to her needs. With this interpretation, an increase in the number of MFIs corresponds to an increase in product variety. For convenience, though, we use the term "distance" through most of the analysis.

We then impose a series of conditions so as to focus on the case of interest. We first assume that the productive project is efficient enough even after allowing for transportation costs, i.e. $F > c + t/2$. Note that this ensures that even when there is only one MFI, it is efficient for *all* borrowers to take a loan for productive purposes. In that case taking a production loan will certainly be efficient when there is MFI competition ie when $n \geq 2$.

The project however is not too efficient relative to the cost of capital, in the sense that $F/2 < c$. This ensures that double-dipping - taking loans from two lenders and using one for investment and the other for consumption - will lead to default. Further, it also captures the ground reality that, for various reasons, productive projects may not be too plentiful in less developed countries.

Finally we assume that the subsidy received by the MFIs is not too small, in the sense that $u > c$. Collecting all these assumptions together, we have

A1. $min\{F - t/2, u\} > c > F/2$.

Our second assumption essentially states that consumption should be reasonably attractive and that the average transaction costs are not too small.

A2. (i) $u > 2c - F/2$, and (ii) $t > 4(u + c - F)$.

A2 is sufficient to ensure, as we later argue, that it is always profitable for at least two MFIs to operate, so that MFI competition is meaningful.[12]

These assumptions entail that borrowers have access to projects that are productive, though not excessively so relative to the cost of capital, so that multiple lending leads to default. Moreover, transactions costs are not so large that borrowing is inefficient, neither are they so small that is provokes too much double-dipping and default, making loans unprofitable. Both these assumptions seem reasonable in the context of LDCs (where micro-finance flourishes), since, given the quality of infrastructure, the poor are unlikely to have access to very productive projects in such environments. Similarly, transaction costs are unlikely to be very low given that many of these MFIs themselves may lack adequate technological, or administrative support, and operate in far flung villages. Further, the fact that consumption utilities are taken to be relatively large captures the fact that this is an environment where moral hazard problems abound.

The MFIs can observe whether the productive project is being undertaken or not. Whether the borrowers consume or not is, however, unobservable. This moral hazard problem has important implications for the borrowers' investment decisions. Thus if a borrower takes a single loan from a MFI, then the concerned MFI can ensure that the borrower invests productively, and thus recover its money. However a borrower may take two loans, of 1 unit each, from two different MFIs, investing one unit in the productive project, but consuming the other unit of capital. [13] She can

[12] In fact one can replace A2 with the weaker assumption that $(u-c)^2 - (c-F/2)^2 > t[u+c-F-\frac{t}{4}]$, and the analysis goes through. Example 1 later shows that there exist parameter values such that A1 and A2 hold simultaneously, so that A1 and A2 are consistent.

[13] Given that she cannot undertake more than one production or consumption project, this is her only possible

do this by showing the same productive project to both the MFIs she borrows from. In that case the MFIs may not be able to recover their capital. It is this moral hazard problem that lies at the heart of the present paper.[14]

Each MFI lends exactly one unit of capital to a borrower who approaches it. The transactional costs of borrowing are not observable, so that the MFIs can only charge a uniform interest from all borrowers who approach them. Let r_i denote the gross interest rate being charged by the i-th MFI. Without loss of generality, let $F \geq r_i \geq c$, for all i.

All MFIs maximize their utility subject to a break-even constraint. As discussed in the introduction, we are interested in analyzing MFIs that are socially motivated, so that the utility of the i-th MFI is a weighted sum of its profits, denoted by $\pi_i(r_1, \cdots, r_n)$, and the aggregate utility of its own borrowers, denoted by $W_i(r_1, \cdots, r_n)$. Note that the presence of motivated MFIs, along with the fact that loans are unsecured, makes this framework more suited to analyzing MFIs, as opposed to lenders in general. Thus the utility of the i-th. MFI can be written as

$$U_i(r_1, \cdots, r_n) = \mu W_i(r_1, \cdots, r_n) + (1 - \mu)\pi_i(r_1, \cdots, r_n), \tag{1}$$

where $0 \leq \mu \leq 1$ denotes the motivation level of the MFIs.

An alternative interpretation of μ is that by varying μ one can trace the Pareto frontier of the borrower-lender contract. For example, with free entry of MFIs, all the surplus go to the borrowers, and the optimal contract can be obtained by maximizing the borrowers utility subject to a zero profit constraint for the MFI. The other polar case would involve a monopoly lender maximizing its own profits. By varying μ one can solve for the intermediate cases.[15] M_i therefore maximizes (1) subject to the constraint that $\pi_i(r_1, \cdots, r_n) \geq 0$.

We consider a scenario where the MFIs simultaneously decide on their gross interest rates. Given the configuration of interest rates, the borrowers then make their borrowing and investment/consumption decisions, with the MFIs giving out a loan of 1 unit of capital to all borrowers that approach them.

While it may be argued that the moral hazard problem could be taken care of if MFIs shared information regarding their client lists, in reality, however, MFIs do not appear to do so. McIntosh et al. (2005) report, for example, that there is very little information sharing among the MFIs. Moreover, in the context of our model, MFIs are unlikely to truthfully report their client lists as they have an incentive to overstate their clientele so that other MFIs avoid these supposed "clients". This is one aspect where the present problem differs from the credit card market, since, given the presence of credit bureaus, information sharing should be much more prevalent in such markets.[16]

We look for subgame perfect Nash equilibria of this game in pure strategies. Let $\overline{U}_i(r_1, \cdots, r_n)$ and $\overline{\pi}_i(r_1, \cdots, r_n)$ denote the utility and profit respectively of the i-th MFI, i.e. M_i, when the interest vector is $(r_1, \cdots, r_n)$ and the borrowers are responding optimally to the announced interest rates, i.e. $(r_1, \cdots, r_n)$.

Definition. We say that $(r_1, \cdots, r_n)$ constitutes a subgame perfect Nash equilibrium if $\forall\ i$

choice about loan use.

[14]In later extensions, we examine scenarios where MFIs can appropriate only a part of F, or there is loan seniority, and show that most of the results go through qualitatively.

[15]We are indebted to an anonymous referee for making this point.

[16]See, however, Janvry et al. (2010) for a model with information sharing. In the context of our model, in the presence of complete information sharing, no MFI would want to lend to a borrower who has already obtained a loan from another MFI, since that would lead to default. In sub-section 8.3, we very briefly consider a framework where there is partial information sharing, and the MFIs can actually prevent the borrower from consumption in case they get to know that there is multiple borrowing by some borrower.

(i) $\overline{\pi}_i(r_1, \cdots, r_n) \geq 0$, and

(ii) there is no r_i' such that $\overline{U}_i(r_1, \cdots, r_i', \cdots, r_n) > \overline{U}_i(r_1, \cdots, r_i, \cdots, r_n)$ and $\overline{\pi}_i(r_1, \cdots, r_i', \cdots, r_n) \geq 0$.

A subgame perfect equilibrium is said to be a *double-dipping equilibrium* (i.e. *DDE*) if a positive mass of borrowers take loans from multiple sources. We can similarly define a *single-dipping equilibrium* (*SDE* for short) as a situation in which all borrowers take a loan from a single source.

3 Preliminary Analysis

We focus on symmetric equilibria where all firms charge the same rate of interest r. In an effort to pin down r, we proceed by examining if one of the MFIs, say M_1, has an incentive to deviate to a different gross interest rate, say r'. Depending on (r, r'), there are two possible scenarios, one where all borrowers approaching the deviant MFI are single-dipping, and another where at least some of these borrowers are double-dipping.[17] We next turn to deriving the utility functions of the borrowers and the MFIs under the two scenarios, which are used to solve for SDE and DDE later on in the paper.

3.1 All clients of the deviant MFI are single-dipping

Under single-dipping, recall that the MFIs can ensure that the productive project is undertaken, so that there is no default. Thus the utility of a borrower who takes a single loan from an MFI located at a distance x from her is

$$F - r - tx. \tag{2}$$

We first solve for the demand for loans facing the deviant MFI. Such a deviation will affect the borrowing decisions of the borrowers located on both sides of M_1, i.e. those in between M_1 and M_n, as well as M_1 and M_2. Solving for the demand facing M_1 involves identifying the borrower who is indifferent between borrowing from M_1 and M_2. Let us consider the borrower who is located at a distance of d from M_1 and is indifferent between borrowing from M_1 and M_2. Using (2) we find that

$$d(r', r) = \frac{r - r'}{2t} + \frac{1}{2n}. \tag{3}$$

Thus M_1's utility when all its clients are taking a single loan is given by

$$\overline{U}_1^{sd}(r', r) = 2\mu[\{\frac{r - r'}{2t} + \frac{1}{2n}\}(F - r') - t\int_0^d x dx] + 2(1 - \mu)[\frac{r - r'}{2t} + \frac{1}{2n}](r' - c). \tag{4}$$

Using (4), we observe that

$$\frac{\partial \overline{U}_1^{sd}}{\partial r'}(r', r) = 2\mu[-\frac{F}{2t} + \frac{3r'}{4t} - \frac{r}{4t} - \frac{1}{4n}] + 2(1 - \mu)[\frac{r}{2t} - \frac{r'}{t} + \frac{c}{2t} + \frac{1}{2n}]. \tag{5}$$

Finally, from (5) we find that $\overline{U}_i^{sd}(r', r)$ is concave in r' if and only if $\mu < 4/7$.[18]

[17] In each of these two scenarios, we express the deviant MFI's utility as a function of r' and r. Then, we derive the deviant's first order condition, deriving the optimal r' as a function of r and model parameters. Setting $r' = r$ in this first order condition then helps us arrive at the unconstrained interest rate charged in a symmetric equilibrium. In later sections we will prove that these interest rates - $r^*(\mu)$ in the single-dipping case and $r^{**}(\mu)$ in the double-dipping case do, indeed, represent equilibrium interest rates under certain parameter restrictions.

[18] This is useful since concavity simplifies the task of finding global optima in some of our proofs.

Finally, setting $r' = r$ in the preceding equation, and denoting the solution by $r^*(\mu)$, we find that

$$r^*(\mu) = \frac{(1-\mu)c - \mu F - \frac{(3\mu-2)t}{2n}}{1-2\mu}. \tag{6}$$

3.2 Some clients of the deviating MFI are double-dipping

First consider the utility of a borrower who double-dips. Given that money is fungible, a borrower who takes a loan from two MFIs will spend on both the productive project, as well as consumption. She can then show the productive project to both the MFIs, claiming that she has taken only a single loan from that particular MFI. Given that $r \geq c \geq F/2$, the MFIs cannot of course both be repaid out of the project income. We assume that in that case the two MFIs will share the project return symmetrically, obtaining $F/2$ each. Clearly, the borrower's utility in this case is:

$$u - t/n. \tag{7}$$

This is because in this case the whole of the return F from the productive project is taken away by the MFIs, so that the borrower is only left with her consumption utility net of total transaction costs. Further, the total transaction cost of borrowing from two lenders is constant at t/n and independent of the borrower's location.

Consider borrowers located in between M_1 and M_2. The utility of a double-dipping borrower is given by (7), i.e. $u - t/n$. Next recall that in case a borrower takes a single loan from an MFI located at a distance x_i from her, her utility is $F - r - tx_i$. Consequently when there is double-dipping, it is intuitive that borrowers who are close to M_1 (respectively M_2) will take a single loan from M_1 (respectively M_2), whereas borrowers who are at an intermediate distance from both the MFIs will indulge in double-dipping. In terms of the product variety interpretation, the borrowers who double dip are those whose loan requirements do not correspond too closely with the loan varieties offered by the MFIs whose products are "closest" to their loan requirements.

The total demand for loans facing M_1 consists of two elements, that from those who single-dip, and that from double-dippers. We then identify two borrowers, A and B, located in between M_1 and M_2, and at distances a and b respectively from M_1. Let A be indifferent between borrowing from M_1 alone, and borrowing from both M_1 and M_2. Similarly, let B be indifferent between borrowing from M_2 alone, and both the MFIs. It is clear that the total demand for loans for M_1 is $2a$ from single dipping borrowers, and that from double-dipping borrowers is $2(b-a)$.

Equating the payoffs from single-dipping and double-dipping (using (2) and (7)), it is straightforward to see that

$$a(r', r) = \frac{F - u - r'}{t} + \frac{1}{n}, \tag{8}$$

$$b(r', r) = \frac{u - F + r}{t}. \tag{9}$$

Thus, the 'number' of borrowers in between any 2 MFIs who are double-dipping is given by

$$b(r', r) - a(r', r) = \frac{2u - 2F + r + r'}{t} - \frac{1}{n}. \tag{10}$$

Thus $b - a$ denotes the zone of default. Consequently the profit of M_1, the deviating MFI, is

$$\pi_1(r', r) = 2[ar' + (b-a)F/2 - bc], \tag{11}$$

and the aggregate utility of its clientele is given by

$$W_1(r', r) = 2[a(F - r') - t\int_0^a xdx] + 2(b - a)(u - t/n), \tag{12}$$

where the term in square brackets denote the aggregate utility of those borrowers who take a single loan from M_1, and the second term represents the aggregate utility of those borrowers who double-dip. Substituting these expressions into (1), we have

$$\overline{U}_1^{dd}(r', r) = 2\mu[a(F - r') - t\int_0^a xdx + (b - a)(u - t/n)] + 2(1 - \mu)[ar' + (b - a)F/2 - bc]. \tag{13}$$

From (13) we observe that

$$\frac{\partial \overline{U}_1^{dd}}{\partial r'}(r', r) = 2\mu[-\frac{F}{t} + \frac{r'}{t} + \frac{u}{t} - \frac{1}{n}] + 2(1 - \mu)[\frac{3F}{2t} - \frac{2r'}{t} - \frac{u}{t} + \frac{1}{n}]. \tag{14}$$

Next from (14) we find that $\overline{U}_i^{dd}$ is concave in r' if and only if $\mu < 2/3$.

Moreover, maximizing (13) with respect to r' and setting $r' = r$, we find that the solution $r^{**}(\mu)$ satisfies

$$r^{**}(\mu) = \frac{(2\mu - 1)(u - t/n) + (3 - 5\mu)F/2}{2 - 3\mu} = \frac{3F/2 - (u - t/n) - \mu(5F/2 - 2(u - t/n))}{2 - 3\mu}. \tag{15}$$

We shall later argue that under some parameter restrictions, there is a symmetric equilibrium where all MFIs charge $r^{**}(\mu)$.

4 Purely profit-oriented MFIs: $\mu = 0$

We now explore the special case of purely profit driven MFIs, i.e. MFIs for whom $\mu = 0$. We show that in this case any equilibrium will necessarily involve double dipping and default; in fact while a symmetric DDE exists, an SDE does not. We next introduce some notations.

Let $\tilde{n}$ be the largest integer such that

$$(u - c)^2 \geq \frac{2t}{n}[u + c - F - \frac{t}{2n}],\ \forall n < \tilde{n}, \tag{16}$$

and $\hat{n}$ be the largest integer such that

$$(u - c)^2 - (c - F/2)^2 \geq \frac{2t}{n}[u + c - F - \frac{t}{2n}],\ \forall n < \hat{n}. \tag{17}$$

We now briefly interpret inequalities (16) and (17). As shown formally in the proof of Proposition 1, we find (by setting $r' = r$ in equations (8)-(11)) that to break even in a DDE, MFIs must charge interest rates in an interval. Now (16) is the condition ensuring that this interval is well-defined. (17) ensures that the unconstrained optimal interest rate set by purely-profit maximizing MFIs in a DDE (denoted by $r^{**}(0)$) is in fact lower than the feasibility ceiling.

Note that at $n = \frac{t}{u+c-F}$, the RHS of (16) and (17) exceeds the LHS of (16),[19] and thus the LHS of (17). Consequently, (a) $\tilde{n}$ is well defined (given that for n large, the RHS of (16) exceeds the LHS), and (b) $\tilde{n} < \frac{t}{u+c-F}$. Furthermore, (a) $\hat{n}$ is well defined since from A2, the LHS of (17)

[19] At $n = \frac{t}{u+c-F}$, the RHS of (16) simplifies to $[u - (F - c)]^2$, which is greater than the LHS, $[u - c]^2$ given $F - c < F/2 < c$ from A1.

exceeds the RHS at $n = 2$ and (b) $\frac{t}{u+c-F} > \hat{n} > 2$ (also using A2). Next, comparing the LHS of (16) and (17) and noting that the RHS are the same, we have that $\hat{n} < \tilde{n}$.[20]

We restrict attention to n that is not too large, in particular to $n < \hat{n}$. This ensures that competition is not so severe that the MFIs fail to break-even in equilibrium. To see the intuition observe that the assumption that $n < \hat{n}$ in turn implies that $n < \frac{t}{u+c-F}$. In case this fails to hold all borrowers would double dip,[21] making it unviable for MFIs to operate.

The argument proceeds in two stages. We begin by solving for the equilibrium rate of interest in a symmetric DDE under the assumption that the MFIs make non-negative profits, and that there is double-dipping in equilibrium. This follows, as usual, from the utility maximizing conditions for the MFIs. The complete solution is then obtained by incorporating these two criteria into the analysis.

Proposition 1. *Let MFIs be purely profit-driven, i.e. $\mu = 0$. Then, for all $n < \hat{n}$*

(i) A DDE exists such that all MFIs earn strictly positive profits and charge an interest rate $r^{**}(0) = \frac{3F}{4} - \frac{(u-t/n)}{2}$. This equilibrium is unique in the class of symmetric DDE.

(ii) An SDE does not exist.

Proposition 1 (which is proved in the appendix) thus establishes that an equilibrium with double-dipping exists. In a series of remarks, we then discuss some interesting properties of this equilibrium.

Remark 1. Consider the utility level of the borrowers located in between M_1 and M_2. For borrowers who take a single loan, note that their utility decreases the farther they are from their lender, say M_1 (see (2)), whereas the utility of borrowers who double-dip is independent of location and constant at $u - t/n$. Thus, for a borrower located at a distance of x from M_1, the net difference in utility between single-dipping and double-dipping is decreasing in x. Thus borrowers closest to M_1 take a single loan, with their utility decreasing as x increases. For x large, double-dipping becomes relatively attractive as the total transactions costs of taking a single loan become too large, relatively speaking.

Remark 2. The interest rate $r^{**}(0)$ is increasing in F and t, whereas it is decreasing in u. Intuitively, the fact that it is increasing in F follows since, with single lending becoming more attractive, the MFIs can charge a slightly higher interest rate without leading to an increase in double-dipping and default. Whereas it is increasing in t, because this increase in cost is internalized by the MFIs, leading to an increase in the implicit costs for the MFI. Finally, it is decreasing in the consumption utility, u. Ceteris paribus, a higher consumption utility makes double-dipping more attractive, so that MFIs would need to reduce interest so that utility from single-dipping increases, making double-dipping relatively less attractive. We shall also discuss other interesting comparative statics results later in Section 7 when we discuss the case with $\mu \geq 0$, especially the effects of an increase in competition, i.e. n.

Remark 3. Next note that the equilibrium interest $r^{**}(0)$ does not depend on the MFI's cost of capital, i.e. c. This is because c enters an individual MFI's objective function only via its impact on

[20] This follows since the RHS of (16) and (17) are increasing at $n = \hat{n}$ and $n = \tilde{n}$. This in turn holds because $\tilde{n}, \hat{n} < \frac{t}{u+c-F}$, and the RHS of (16) and (17) are increasing in n till $\frac{t}{u+c-F}$, and decreasing thereafter.

[21] This follows that since even borrowers located at a zero distance from an MFI would prefer to double dip, rather than take a single loan from this MFI.

aggregate costs, which in turn depends on the aggregate number of borrowers who take loans from this MFI, which in turn only depends on the interest rate of the neighboring MFIs, but not on the MFI's own interest rate.[22] Interestingly, in the context of credit card markets Ausubel (1991) finds that the interest rates seemed insensitive to changes in the cost of capital, though the market was competitive. As we later argue in the concluding section, this result has some policy implications.

Remark 4. Note that borrowers only take loans from immediately neighboring MFIs. This is essentially an implication of our assumption that borrowers can have at most one productive and one consumption project. To see this, we next argue that borrowers between, say, M_1 and M_2 will never borrow from M_3, say. First note that no double-dipping borrower will do so since given that there is a single consumption project, she will merely increase her transaction costs if she approaches M_3 also. Next we examine if single dipping borrowers have an incentive to take loans from M_3. It is sufficient to consider the borrower located at M_2 itself, as she has the greatest incentive for doing so. However, for such a borrower, single-dipping dominates double-dipping from M_1 and M_2, and consequently single-dipping dominates double-dipping from M_1 and M_3 also.[23]

In what follows,we extend the analysis to allow for socially motivated MFIs. Our primary motivation for doing this is that, as highlighted in the introduction, this seems to be a realistic feature characterizing many NGOs including MFIs (UNICIRDAP, 1992). Interestingly, we find that allowing for socially motivated MFIs generates significantly richer results. For one, if the MFIs are sufficiently socially motivated, an SDE may exist while, correspondingly, a DDE may not always exist. The comparative static results are also significantly richer.

5 Equilibria with Single-dipping: $\mu \geq 0$

We now examine single-dipping equilibrium that provides a benchmark for the subsequent analysis. Further, this also allows us to examine, later on, the possibility of a regime switch from single-dipping to double-dipping equilibria. We find that such single-dipping equilibria exist whenever the projects are relatively productive, and the MFIs are not too profit-oriented. Further we derive some comparative statics properties of such equilibria.

The argument proceeds in two stages. We begin by solving for the equilibrium rate of interest in a symmetric SDE under the assumption that the MFIs make non-negative profits, and that there is no double-dipping in equilibrium. This follows, as usual, from the utility maximizing conditions for the MFIs. The complete solution is then obtained by incorporating these two criteria into the analysis.

From (6), recall that the unconstrained solution, ignoring feasibility and the possibility of double-dipping, is $r^*(\mu)$. In the Appendix we also check that $r^*(\mu)$ is immune to deviations such that some of the clients are double-dipping. For $r^*(\mu)$ to qualify as the equilibrium gross interest rate, recall however that it must be the case that (a) none of the borrowers have an incentive to double-dip, and (b) the MFIs break even. We need the following lemma for our argument.

Lemma 1. *$r^*(\mu)$ is decreasing in MFI motivation, μ.*

[22] As we shall later find this result goes through even if we allow for socially motivated MFIs (provided the motivation level is not too large), or imperfect appropriability of F (see sub-section 8.1), or loan seniority (see sub-section 8.2).

[23] Rather than double dip, the borrower may also borrow only from M_3. But if she does so, this must give her a utility of at least $u - t/n$, otherwise she would double dip. In that case, if this borrower prefers double dipping to borrowing solely from M_3, she would also prefer borrowing solely from M_2 to borrowing solely from M_3.

This lemma is proved in the appendix.

To rule out double dipping, the utility from doing so must be less than the utility of a borrower who takes a single loan from an MFI located at a distance x from her for any x, i.e. $F - r^* - tx$.

From (2), it is enough to consider a borrower located at a distance of $\frac{1}{2n}$ from both M_1 and M_2 since such a borrower has the greatest incentive for double-dipping. (Other borrowers would be closer to one MFI than to another, and hence would have a stronger incentive to borrow just from the closest one). Given that the utility of such a borrower in case she does not double-dip is $\frac{(1-\mu)(F-c)+(5\mu-3)t/2n}{1-2\mu}$, (using (6)) there is no double-dipping provided

$$\frac{(1-\mu)(F-c)+(5\mu-3)t/2n}{1-2\mu} \geq u - t/n, \tag{18}$$

which simplifies to

$$\mu \geq \hat{\mu} = \frac{u-(F-c-t/2n)}{2u-(F-c-t/2n)} < \frac{1}{2}. \tag{19}$$

From A1, both the numerator and the denominator of $\hat{\mu}$ are positive (from A1, $u > F/2$, $c > F/2$ so $u + c > F$ or $u > F - c > F - c - t/2n$). Intuitively, if the MFIs are very socially motivated, so that μ is large, then $r^*(\mu)$ would be small. This is because a higher interest rate reduces borrower welfare, which is unappealing to a socially motivated MFI. A low interest rate however makes double-dipping unattractive for the borrowers, hence the requirement that $\mu \geq \hat{\mu}$.

We next turn to the break-even constraint. We find that there is some $\mu' = \frac{t/n}{F-c+3t/2n}$, (we prove in the appendix that $0 < \mu' < 1/2$), such that whenever $\mu < \mu'$, the MFIs obtain a positive profit in case they all charge $r^*(\mu)$. The intuition again follows from the fact that, for μ small, $r^*(\mu)$ is large, so that MFIs make a positive profit charging $r^*(\mu)$. Otherwise, for $\mu \geq \mu'$, all the MFIs charge exactly c, and break even.

Moreover, we can show that an SDE exists if and only if the project is relatively productive, i.e. $F > u + c - t/2n$. This is because for F small, not only is the return from the project low, but moreover, $r^*(\mu)$ is large, so that taking a single loan is not very attractive to the borrowers.[24] Formally, an SDE exists if and only if $\mu' > \hat{\mu}$ (so that the range where MFIs earn positive profits is non-empty), which simplifies to $F > u + c - t/2n$.

Summarizing the preceding discussion we obtain Proposition 2 (the detailed proof can be found in the Appendix).

Proposition 2. *A symmetric equilibrium with single-dipping exists if and only if the project is productive enough, i.e. $F > c + u - t/2n$, and the MFIs are not too profit-oriented, i.e. $\mu \geq \hat{\mu} = \frac{u-(F-c-t/2n)}{2u-(F-c-t/2n)}$. Under these conditions we find that:*

(i) This equilibrium is unique in the class of symmetric SDE.

(ii) There exists $\mu' = \frac{t/n}{F-c+3t/2n} > \hat{\mu}$, such that whenever the MFIs are neither too socially motivated, nor too profit-oriented, i.e. $\hat{\mu} \leq \mu < \mu'$, then the equilibrium involves all the MFIs charging an gross interest rate of

$$r^*(\mu) = \frac{(1-\mu)c - \mu F - \frac{(3\mu-2)t}{2n}}{1-2\mu},$$

[24] This follows as

$$\frac{\partial^2 \overline{U_1}}{\partial r' \partial F} < 0.$$

So a decrease in F increases the marginal utility of the MFI with respect to its own interest rate, prompting an increase in r^*. Further note that this result is only true for socially motivated MFIs, and not if $\mu = 0$.

and earning positive profits. There is full market coverage in all cases.

Proof. Given Observations 1-5 (in the Appendix), it is sufficient to prove that the market is fully covered. From revealed preference, every one who borrows must be obtaining more than the utility of a double-dipper i.e. $u - t/n$. Further, $u - t/n > 0$. This follows since $u > F/2 = F - F/2 > F - c > t/n$, where the first and second inequalities follow directly from A1, and the last inequality from A1 and the fact that n is at least 2. Therefore, every one would obtain a strictly positive utility in the SDE, and would hence borrow. $\square$

Remark 5. If the MFIs are extremely socially motivated, i.e. $\mu \geq \mu'$, and $F > c+u-t/2n$, then a unique, symmetric SDE exists involving all MFIs charging c and just breaking even.[25] Further, by mimicking the earlier argument one can show that there is full market coverage (since the argument does not depend on the profits earned by MFIs).

Proposition 2 demonstrates that for an SDE to exist it is necessary that F be large, i.e. $F > u + c - t/2n$ and μ not be too small. The intuition follows from the utility function of a borrower who takes a single loan. Her net utility depends on the gross return from the productive project minus the interest rate and the total transportation cost. F large not only has a direct positive effect on her utility, but also an indirect one one via the interest rate, which is lower for higher values of F. This ensures that double-dipping, wherein her utility comes from consumption alone and is not affected by the interest rate, is not that attractive. Finally, a relatively large μ ensures that the interest rate is not too large, again making single-dipping relatively attractive for the borrowers.

5.1 Comparative Statics

We then examine the effects of changes in MFI competition level, as well as MFI motivation, on the interest rate and borrower welfare under an SDE.

Proposition 3. *Let $F > u + c - t/2n$ and $\mu' > \mu \geq \hat{\mu}$, so that the symmetric single-dipping equilibrium interest is $r^*(\mu)$.*

(i) Then an increase in MFI competition, i.e. in the number of MFIs n, leads to a decrease in the interest rate. Moreover, there is an increase in aggregate borrower utility.

(ii) An increase in MFI motivation, i.e. μ, leads to a decrease in interest rates and increases the utility of all borrowers.

The intuition for Proposition 3 is quite straightforward (the proof is in the appendix). With an increase in the number of MFIs, the business stealing effect gets stronger, forcing a lowering of interest. Further, aggregate borrower utility increases because (a) there is a reduction in interest, and (b) there is a reduction in aggregate transactions costs. Some borrowers however may be adversely affected because of the relocation of MFIs following an increase in their number. Consider a borrower who is located, say, at a distance of zero from some MFI. With entry, there would be some relocation of the MFIs, so that this borrower may find that her neighboring MFIs are at a positive distance from her, leading to increased total transactions costs. However, it may be argued that realistically, it is unlikely that competition will force existing MFIs to relocate (that it does

[25]We refer interested readers to Guha and Roy Chowdhury (2013) for a proof.

so here is an artifact of the Salop model); in which case these possible adverse effects on individual borrowers would also be absent.

As the MFIs become more socially motivated, charging a higher interest rate becomes less appealing to the MFIs, as this will lead to a lowering of borrower utility. Thus the equilibrium interest rate is lower, leading to greater utility for all the borrowers.

6 Equilibria with Double-dipping: $\mu \geq 0$

We next turn to analyzing equilibria with double-dipping. We show that an equilibrium with double-dipping exists in case either the projects are relatively unprofitable, or the projects are relatively profitable and moreover, the MFIs are not too socially motivated.

As earlier, we proceed by first solving for the equilibrium interest rate under the assumption that the MFIs make a non-negative profit, and that double-dipping does happen in equilibrium. We next examine what are the implications once these considerations are allowed for.

From (15), recall that the unconstrained solution, ignoring feasibility and the possibility of double-dipping, is $r^{**}(\mu)$. Of course, this only checks for deviations such that a nonzero mass of the deviating MFI's borrowers continues double-dipping. In the Appendix, we also check for deviations such that none of the clients of the deviating MFI are double-dipping. We show that the equilibrium is immune to such deviations whenever either the projects are not very profitable, or the projects are profitable, and the MFIs are profit oriented.

We now incorporate the non-negative profit-constraint into the analysis. Using (8), (9) and (10), we find that all MFIs charging $r^{**}(\mu)$ yields a non-negative profit if and only if $\mu \leq \underline{\mu}$, where $\underline{\mu}$ is implicitly defined by $r^{**}(\underline{\mu}) = \underline{r}$, where $\underline{r}$ is the "feasibility floor" mentioned in section 4.[26] Note that $\underline{\mu} < 1/2$ (see Observation 6 in the Appendix). As in the case of single-dipping equilibrium, the intuition is that as the MFIs become more socially motivated, charging a higher interest becomes less and less appealing, as this decreases borrower welfare.

We then examine if the equilibrium indeed involves double-dipping. We first focus on relatively profit-oriented MFIs. We find that whenever the MFIs are not very socially motivated, i.e. μ is small, there will be double-dipping with all MFIs charging $r^{**}(\mu)$. This is because if μ is small, then $r^{**}(\mu)$ is going to be high, making double-dipping more attractive. We find that this result obtains either when (a) the project is not very productive, i.e. $F < u + c - t/2n$, and $\mu \leq \underline{\mu}$, or (b) the project is relatively productive, i.e. $F > u+c-t/2n$, and $\mu \leq min[\hat{\mu}, \tilde{\mu}]$, where $\tilde{\mu} = \frac{u-F/2}{u-F/2+t/2n} < \underline{\mu}$, and $\hat{\mu}$ is given by (19).[27]

Consider case (a). Project productivity, i.e. F, being small, has a negative effect on the utility of a single-dipping borrower. While F being small also tends to make r^{**} smaller, thus mitigating the direct effect of F being small to some extent, it is the direct effect of a change in F that dominates. In case (b), F being large of course makes double-dipping less attractive, thus in this case the MFIs have to be more profit-oriented for a DDE to be sustainable (this is captured by the fact that $\tilde{\mu} < \underline{\mu}$).

On the other hand, if the MFIs are relatively socially motivated, i.e. $\mu > \underline{\mu}$, then we find that for F small, i.e. $F < u + c - t/2n$, the equilibrium involves all MFIs charging $\underline{r}$ such that they just break even.[28] These relatively socially motivated MFIs would prefer to charge low interest so that

[26]Formally, $\underline{r}$ is the minimal root that solves $r^2 - Yr + z = 0$ where $Y = 2F - c - u + t/n > 0$ and $Z = -(F - c)u + F(F - c + t/2n)$. See step 3 in the proof of Proposition 1 in the appendix for details.

[27]That $\tilde{\mu} < \underline{\mu}$ is proved in Observation 10, Step 2 in the appendix.

[28]The formal argument leading to this paragraph is provided in Observations 6-10 in the Appendix.

borrower welfare is high. Thus in equilibrium they charge the lowest possible interest rate that is consistent with feasibility.

Proposition 4. *Suppose that the number of MFIs is not too large, i.e. $n \leq \hat{n}$. A symmetric equilibrium with double-dipping exists unless the project is highly profitable, i.e. $F > u + c - t/2n$, and the MFIs are highly socially motivated, i.e. $\mu \geq min[\tilde{\mu}, \hat{\mu}]$ where $\tilde{\mu} = \frac{u-F/2}{u-F/2+t/2n} < 1/2$. Moreover:*

(i) This equilibrium is unique in the class of symmetric DDE.

(ii) Suppose the project is not too profitable, i.e. $F < u + c - t/2n$. In case the MFIs are relatively profit-oriented, i.e. $\mu < \underline{\mu}$, where $\underline{\mu}$ solves $\underline{r} = r^{**}(\mu)$ then all MFIs charge $r^{**}(\mu) = \frac{(2\mu-1)(u-t/n)+(3-5\mu)F/2}{2-3\mu}$, when they earn positive profits.[29] *Whereas if the MFIs are relatively more socially motivated, i.e. $\mu \geq \underline{\mu}$, then they charge $\underline{r}$, when they just break even.*

(iii) Suppose the project is highly profitable, i.e. $F > u + c - t/2n$. If the MFIs are highly profit-oriented, with $\mu \leq min[\hat{\mu}, \tilde{\mu}]$, then a DDE exists with all MFIs charging $r^{**}(\mu)$ and earning strictly positive profits.

Proof. Given Observations 6-10 (in the Appendix), for existence it is sufficient to show that there will be full market coverage. The argument mimics the corresponding one for Proposition 2, and holds irrespective of whether the MFIs are earning positive or zero profits.

Finally, the first order condition does not depend on the interest rate being charged by the other MFIs. Consequently, all firms face the same optimization problem. Thus the equilibrium is unique and symmetric. □

The intuition has to do with the fact that a borrower's utility from double-dipping depends on her consumption utility minus her total transportation costs. This is attractive as long as the utility from taking a single loan, which is positively related to F, is not too large. Thus for F small, double-dipping would tend to be relatively attractive. Further, double-dipping can still be relatively attractive for F large, if the MFIs are not too socially motivated since in this case the interest rate is going to be high, making the option of taking a single loan relatively unattractive.

Remark 6. Suppose all subsidies on MFI loans were removed, so that $c = c' > u$. Then it can be shown if projects are relatively unproductive, i.e. $F < u + c - t/2n$, then a DDE exists if and only if $\mu < \tilde{\mu}$. Thus while Proposition 4(ii) is modified to some extent, Proposition 4(iii) goes through.

Before going on to discuss the comparative statics properties of a DDE, we first note that the parameter zones for existence of an SDE (identified in Proposition 2) and for a DDE (identified in Proposition 4) are disjoint; therefore, for the same set of parameters, an SDE and a DDE cannot coexist.[30]

While the comparative statics properties of this equilibrium with respect to motivation and an increase in competition will be examined in greater details later, we examine some additional

[29] In case we had $\hat{n} < n < \tilde{n}$, very profit-oriented MFIs charge $\bar{r}$ in equilibrium, earning zero profits, where $\bar{r}$ is defined in the proof of Proposition 1. To reduce the number of cases we focus on the case where $n \leq \hat{n}$, that is, competition is not strong enough for this to happen.

[30] The exception is a knife-edge case at $\mu = \hat{\mu}$ involving the following parameter configuration (i) $F > u + c - t/2n$, (ii) $\hat{\mu} < \tilde{\mu}$. In this case, an SDE and a DDE coexist at $\mu = \hat{\mu}$, where the SDE and DDE parameter zones have a common boundary. The multiplicity in this knife-edge case vanishes if we assume a tie-breaking rule, e.g. if we allow borrowers indifferent between single-dipping and double-dipping to always double dip.

comparative statics properties at this point. In case the MFIs are very socially motivated, i.e. $\mu > \underline{\mu}$, the interest rate - which is set at the break-even interest rate $\underline{r}$ - may be decreasing in F at relatively high levels of $\underline{r}$ (and increasing at low levels).[31] Intuitively, an increase in project productivity makes single-dipping more attractive. On one hand, this implies that the mass of single-dippers can be kept constant through a corresponding rise in the interest rate. On the other hand, a higher mass of single-dippers means that the MFIs can break even by charging a lower interest rate than before. The second factor dominates at high levels of $\underline{r}$, since at high rates of interest the marginal utility gain from a further increase in interest is small.

6.1 Increase in Motivation

We now consider the effects of an increase in the motivation parameter, i.e. μ, on the number of defaulting borrowers in between any 2 MFIs, $b - a$. A priori the effect is unclear. On the one hand, more socially motivated MFIs will have an incentive to charge a lower interest rate, thus lowering default. On the other hand, however, it may be argued that they will be more tolerant of default, and thus increased motivation may lead to increased default. This argument would be in line with Roy and Roy Chowdhury (2009).

Our analysis suggests that an increase in the motivation parameter necessarily reduces default. More motivated MFIs find that by reducing interest rates, they can make it more attractive for some double-dipping borrowers to optimally choose to single-dip, thus improving these borrowers' welfare. Thus the MFIs, being socially motivated, in fact have an incentive to reduce double-dipping by lowering the interest rate.

Proposition 5. *Let there be a double-dipping equilibrium. If the MFIs are earning positive profits, then for a small increase in μ, i.e. the motivation of the MFIs, there is a decrease in the rate of interest, as well as the extent of default. Further, all borrowers become weakly better off.*

This is interesting given that some commentators have been concerned about mission-drift, i.e. the MFIs becoming more profit oriented, which can happen either because of the incumbent MFIs losing motivation, or due to the entry of more profit-oriented MFIs. In the Indian context the Malegam Committee Report (page 33) states "it has been suggested that the entry of private equity in the microfinance sector has resulted in a demand for higher profits by MFIs with consequent high interest rates and the emergence of some of the areas of concern which have been discussed earlier." Thus Proposition 5 does seem to suggest that, in case of mission drift, such an increase in interest rates, and consequently default, may indeed take place.

7 MFI competition: Default, interest rates and borrower welfare

We then turn to analyzing the effects of an increase in MFI competition. In the Indian context, this issue has become extremely important given that the micro-finance crisis and the increase in MFI competition were contemporaneous, with some commentators tracing the crisis to the increased competition itself. On the other hand, the Malegam committee report (2011, pp. 32) argues that it is of the utmost import "to reduce interest rates charged by MFIs....Ultimately, this can only be done through greater competition..." Our analysis suggests that, as is often the case, the truth lies somewhere in between.

[31] Note that, as mentioned earlier, $\underline{\mu} > \widetilde{\mu} \geq min[\widetilde{\mu}, \hat{\mu}]$ so that the MFIs referred to here are more highly motivated than those in the DDE of Proposition 4(iii).

Considering the effect of increased MFI competition on a double-dipping equilibrium, we find some interesting results. First, as discussed above, popular wisdom states that greater competition, by lowering interest rates, would lower default. In contrast we show that default, both aggregate as well as default per MFI, increases with competition. Further, given that default involves consumption, which is inefficient, an increase in MFI competition necessarily leads to an increase in inefficiency.

Second, we find that the effect on the interest rate can go either way. Somewhat paradoxically, we find that an increase in MFI competition leads to an increase in equilibrium interest rates if the MFIs are very socially motivated, and to a decrease in the interest rate otherwise.

Finally, the effect on borrower utility is also not straightforward, while double-dipping borrowers gain in the aggregate, the single-dipping borrowers may be worse off. These results are formalized in Proposition 6 below.

Proposition 6. *Let the hypotheses of Proposition 4 hold, so that an equilibrium with double dipping exists. Consider the effect of increased MFI competition on equilibria with double-dipping:*

(i) There is an increase in aggregate default, as well as the number of defaulters per MFI. Consequently, inefficiency increases.

(ii) Suppose that either (a) the project is not too profitable, i.e. $F < u+c-t/2n$ and the MFIs are not too socially motivated, i.e. $\mu \leq \underline{\mu}$, or (b) the project is profitable, i.e. $F > u + c - t/2n$, and the MFIs are not very socially motivated, i.e. $\mu \leq min[\hat{\mu}, \tilde{\mu}]$. Then an increase in the number of MFIs reduces interest rates and increases aggregate borrower utility.

(iii) In case the project is not too profitable, i.e. $F < u + c - t/2n$ and the MFIs are relatively socially motivated, i.e. $\mu > \underline{\mu}$, then an increase in the number of MFIs leads to an increase in interest rates. While the utility of borrowers who double-dip under both scenarios increases, that of single-dipping borrowers may either increase, or decrease.

Proposition 6(i) is intuitive. With an increase in competition, the total transaction cost for borrowing declines. While this makes both single-dipping and double-dipping more attractive, double-dipping becomes relatively more so as the total transaction cost under double-dipping decreases at a faster rate as multiple loans are involved. Ceteris paribus, this increases default. While in some cases there may a countervailing effect in the form of a decrease in interest, it is the direct effect which dominates.

Proposition 6(ii) follows from two effects generated by increased competition, (a) the business stealing effect, i.e. the fact that MFIs lose clients, and (b) an increase in default (from Proposition 6(i)). Thus the MFIs reduce their interest rates to address both these effects. The fact that the MFIs are profit-oriented means that they are earning positive profits to begin with, so that reducing interest rates is feasible. The reduction in interest rates, along with the fact that there is a decline in aggregate transaction costs, imply that there is an increase in aggregate borrower utility.

Proposition 6(iii) deals with relatively socially motivated MFIs, so that in this case the MFIs just break even. Since double dipping and default go up with an increase in n, a higher interest rate is required to break even. Turning to welfare effects, the utility of the double-dipping borrowers increases because of the reduction in their total transactions costs, while for the single-dippers, the increase in the interest rate and the reduction in their total transactions costs have opposite effects on utility.[32]

Note that as in Hoff and Stiglitz (1997), the present paper shows that an increase in lender competition may push up interest rates. Unlike Hoff and Stiglitz (1997) however, in this paper this effect is a function of MFI motivation; if the MFIs are profit-oriented, this result will not obtain and increased competition pushes interest rates down. Moreover, unlike in Van Tassel (2002), in the present model, (a) the interest rate does not necessarily go down with increased competition, and (b) if it does go down, it does not necessarily result in less default.

7.1 MFI competition and regime switch

We then examine if an increase in MFI competition can cause a regime switch. We show that a regime switch from an SDE to a DDE may happen if the project is neither too productive, nor too unproductive. Moreover, in that case interest rates can rise.

Proposition 7. *Let there be an increase in MFI competition, so that the number of MFIs increases from n to n'.*

(i) Suppose that the project is neither too productive, nor too unproductive, in the sense that $u + c - t/2n < F < u + c - t/2n'$, and suppose MFIs are not very profit-oriented, so that $\mu \geq \hat{\mu}$. Then an increase in MFI competition from n to n' causes a regime switch from an SDE to a DDE. In this case there can be an increase in interest rates.

(ii) Suppose the project is very productive in the sense that $F > u + c - t/2n'$. Then an increase in MFI competition from n to n' can never cause a regime switch either from an SDE to a DDE, or from a DDE to an SDE.

Proposition 7(i) follows since, as argued earlier, an increase in MFI competition makes double-dipping more attractive vis-a-vis taking a single loan. Why does this happen for intermediate values of F? This is because for F large, the equilibrium interest rate is going to be low under a candidate SDE, so that a SDE necessarily exists (from Proposition 2 and Remark 5). Interest rates may increase as a result of the regime switch. If so, then the increase in interest rate will have a negative impact on the utility of borrowers who continue to single-dip after the regime switch. The net effect is however ambiguous as the transaction costs effect is ambiguous (borrowers who end up closer to a MFI after the increase in the number of MFIs may benefit from a fall in total transaction costs, even if they continue to single dip). Borrowers who switch to double-dipping after the regime change may or may not be better off relative to their pre-regime switch SDE utility.

Example 1. Consider $F = 50$, $c = 25.5$, $u = 30$, $t = 48$ and $c' = 31$. We can check that A1 and A2 are both satisfied for these parameter values. For $n \leq 4$, we have $F > u + c - t/2n$. Consider $n = 4$ and $\mu = 0.28$. An SDE exists as $0.28 > \hat{\mu} = 0.277$; with MFIs charging an interest of 25.7272 (from (6)), and earning profits of 0.0818 each. If n increase from 4 to 5, there is a regime switch to a DDE, leading to a higher interest rate of 26.7448. Moreover, we can verify that (i) there is indeed double dipping (the mass of double-dippers between any two MFIs turns out to be 0.08103), and

[32] Admittedly, a limitation of our approach is that entry is exogenous. However, if we allow for *endogenous* entry, then socially motivated MFIs would still have an incentive to enter - raising n - even though they just break even. The reason is that socially motivated MFIs in our model obtain utility from (i) the welfare of their own clients, and (ii) profits. If an MFI enters, it will obtain some borrowers and these borrowers' utility will be positive, raising the MFI's own utility above its reservation utility of zero, even if it is just breaking even. We are indebted to an anonymous referee for encouraging us to examine this issue.

(ii) MFIs continue to earn positive profits (amounting to 0.0671 each). Note that $\underline{r}$ in this DDE is 25.746 (for $n = 5$), while $\underline{\mu} = 0.411$.

Interestingly, both Propositions 6 and 7(i) show that an increase in MFI competition can lead to an increase in equilibrium interest rates. However, while in Proposition 6 the result is driven by the fact that the MFIs are breaking even in equilibrium, in Proposition 7(i) it is driven by the possibility of a regime switch. Both these effects can, however, be traced to the fact that an increase in MFI competition makes double-dipping relatively attractive.

Proposition 7(ii) is straightforward; for very productive projects, a small increase in competition is not enough to propel the MFIs into the DDE zone. In spite of the fall in total transaction costs and the resultant greater attraction of double-dipping, single-dipping remains more attractive owing to high F.

8 Robustness and Policy Issues

Next we briefly discuss some robustness and policy issues. We argue that much of the analysis go through qualitatively in case either the MFIs can appropriate only a fraction of F, or if we allow for seniority in loan repayment. Turning to policy analysis, we analyze two issues that are motivated by the recent Indian experience, namely the provision of subsidized loans, as well as a cap on the interest rates. Both these policies are being mulled over by policy makers in response to the recent micro-finance crisis in Karnataka, India. One main insight is that the effect of such policy changes may be nuanced because of the indirect effect of any such change on the level of MFI competition. Provision of subsidized loans, for example, may lead to increased default and inefficiency, and even a higher interest rate in case it attracts entry by new MFIs.

8.1 Partial verifiability of the returns from the productive project

Under the present formulation, while the MFIs cannot observe whether multiple borrowing is taking place or not, they can fully appropriate the return from the productive project (up to the interest rate under single-dipping, and $F/2$ under double-dipping). We next allow for imperfect appropriation of project returns. In particular, let a fraction κ of the project return be appropriable by the MFIs, where $1/2 < \kappa \leq 1$. Further, we alter A1 to $\kappa F - t/2, u > c > F/2$, and also alter A2, replacing it by $u > 2c - \kappa F/2$, and $t > 4(u + c - \kappa F)$.

We now examine how the analysis is impacted by this assumption, focussing on the DDE which is the case of interest. Since a double-dipping borrower can retain a part $(1-\kappa)F$ of the project proceeds, her utility is given by $(1-\kappa)F + u - t/n$, whereas the utility from single-dipping is $F - r - tx_i$. One immediate implication of this formulation is that the utilities of both the single-dipping and the double-dipping borrowers are sensitive to F, making the framework more symmetric. As earlier, we consider a candidate DDE where all MFIs charge r, and consider a deviation to an interest rate of r' by, say, M_1. Then, the 'number' of double-dipping borrowers coming to M_1 is given by $2(b-a) = 2[\frac{2u-2\kappa F+r+r'}{t} - \frac{1}{n}]$, whereas the total number of single-dipping borrowers coming to M_1 is $2[\frac{\kappa F-u-r'}{t} + \frac{1}{n}]$. Using these expressions, we can derive the profit and utility functions for M_1. Finally, mimicking our earlier argument we obtain

$$r^{**}(\mu,\kappa) = \frac{(2\mu-1)(u-t/n) + (3-5\mu)\kappa F/2}{2-3\mu}, \tag{20}$$

so that a DDE where all MFIs charge this $r^{**}(\mu)$ can be sustained under the appropriate parameter restrictions.

We can check that the comparative static results with respect to this equilibrium are qualitatively unaffected, with increased competition leading to an increase in default. Moreover, the equilibrium interest rate is decreasing in n for relatively profit-oriented MFIs, whereas it is increasing in n for relatively socially motivated ones, which, as in the text, just break even. Further, an increase in competition can prompt a regime switch from an SDE to a DDE.

Finally, note that for MFIs that earn positive profits, $r^{**}(\mu)$ is increasing in κ,[33] (so that it is lower compared to the case with perfect appropriability, where $\kappa = 1$), and moreover, default (both individual and aggregate) increases compared to the case with perfect appropriability, since $b - a$ is decreasing in κ. Intuitively, in the partial verifiability case the attractiveness of double dipping goes up as borrowers can keep a part of their project returns after declaring default. This explains why MFIs would want to reduce interest rates in a bid to reduce default (provided they are not restricted by feasibility conditions).[34]

8.2 Loan seniority

Next we examine the role of loan seniority so that in case of double-dipping, the loans of some MFIs are repaid on a priority basis. First suppose that for every double-dipping borrower, which of the two concerned MFIs is the senior one is decided independently and randomly, so that both the concerned MFIs have an equal probability of becoming the senior lender for this borrower. It is straightforward to see that the earlier analysis goes through in this case.

We next consider a scenario with some 'strong' and some 'weak' MFIs, so that in case a borrower double-dips from one strong and one weak MFI, the loan of the strong MFI is repaid first, receiving its full interest charges, while the weak MFI obtains the "bankruptcy proceeds" of the project return net of the strong (senior) MFI's interest charges. For simplicity, we focus on the case where n is even, and strong and weak MFIs are located alternately on the circle. This does not affect the borrowers' payoffs in any way, so that (8)-(10) go through. Letting r_S and r_W denote the interest charged by the strong and the weak MFIs respectively, strong MFIs obtain r_S, while weak ones obtain $F - r_S$ from double-dipping borrowers (assuming that $r_S \leq F$ without loss of generality). We can then mimic our earlier argument to solve for the DDE in this case.

We find that if the MFIs are relatively profit-oriented, with $\mu < 1/2$, strong MFIs can compete weak ones out of business.[35] Hence if there is exit, then in the long run one will have a situation with symmetric MFIs, all strong, so that in the event of double-dipping from two neighboring strong MFIs, the project proceeds would be split equally between them, and our earlier analysis will apply. However, if the MFIs are relatively socially motivated, with $\mu > 1/2$, then there exists a DDE in which strong and weak MFIs coexist. We find that in this equilibrium, with an increase in competition (a) aggregate default, as well as default between any two MFIs, increase,[36] (b) the equilibrium r_S falls, whereas the equilibrium r_W increases, and (c) there can be a regime switch from a no-default equilibrium (SDE) to one where some borrowers double dip.[37]

[33]Positive profits in a DDE are earned only by relatively profit-oriented MFIs with μ strictly less than 1/2. We find that $r^{**}(\mu)$ is increasing in κ for all $\mu < 3/5$, which covers all MFIs earning positive profits.

[34]We may also check that a no-default equilibrium (SDE) now holds for a smaller parameter range as the necessary condition for an SDE changes to $\kappa F > u + c - t/2n$ which holds for a smaller range of parameter values.

[35]In this case $b - a$ is decreasing in r_W once r_S is written as a function of r_W (as r_S is decreasing in r_W). Now satisfying the constraint $b - a > 0$ requires weak MFIs to set their interest rates at less than c.

[36]$\frac{d(b-a)}{dn} = \frac{\mu}{(2\mu-1)n^2} > 0$ since $\mu > 1/2$.

[37]If $\mu = 1$, then this case completely parallels the similar case in the main model with no loan seniority.

8.3 Limited information sharing among the MFIs

We briefly examine a scenario with limited information sharing among the MFIs (Janvry et al., 2010, discuss a framework with credit bureaus). Thus in case a borrower takes two loans, there is an exogenous probability λ (< 1) that the concerned MFIs get to know about this double-dipping before the investment/consumption decisions are taken. In that event, a double-dipping borrower is forced to give 1 unit of the loan back (say 1/2 to each MFI she borrowed from), invest the remaining unit productively, and repay the two MFIs in proportion to the amount borrowed. Again, consider a deviant MFI, M_1, that charges r' when all other MFIs charge r. Now a double dipper's expected payoff is $(1-\lambda)(u-t/n)+\lambda(F-r'/2-r/2-t/n)$. Thus the payoff from both single-dipping and double-dipping depends on both r, as well as F. Preliminary investigation shows that the number of double-dipping borrowers going to any single MFI is given by $2(b-a) = 2(1-\lambda)\frac{2u-2F+r'+r}{t} - \frac{1}{n}$, so that it increases with competition, given interest rates. Given that this intuition was critical for many of the results in our baseline model, we conjecture that the analysis will remain qualitatively unchanged to a large extent in such a case. A complete analysis is beyond the scope of the present paper though.

While the three cases just described indicate that our results are qualitatively robust to several variations in assumptions, we may wonder which assumptions are, indeed, critical to deriving our results. Briefly, these are the parameter restrictions A1 and A2 in our framework, which, as we argued, capture the ground reality in developing countries quite well. If, for example, A1 were violated and projects were highly productive relative to the cost of capital, so that $F/2 > c$, then double dipping would not entail default, and our analysis would not apply.

8.4 Providing subsidized loans to MFIs

Policy-makers in India have argued in favor of a reduction in the MFIs' costs of lending, recommending the provision of subsidized loans to MFIs to this end (Malegam Committee Report, 2011). In our framework, such subsidized loans to MFIs translate into a reduction in c. Interestingly, in case the DDE involves a positive profit for the MFIs, such a fall in c does not affect the interest rate, and hence default and borrower welfare. The only effect is an increase in MFI profits. It is interesting that, even with socially motivated MFIs, the benefits arising out of the provision of subsidized credit need not be passed on to the borrowers. Of course, in case the MFIs are very highly socially motivated, and the DDE involves the MFIs just breaking even, then the provision of subsidized credit (leading to a fall in c) does lead to a fall in the equilibrium interest rate, which improves borrower welfare.

However, in case such a decrease in c attracts entry by more MFIs, then the implications, as we have already argued, may be complex. Consider a double-dipping equilibrium. With an increase in competition, there is an increase in aggregate default, as well as the number of defaulters per MFI. Consequently, inefficiency increases. The interest rate however can either increase, or decrease. In case the project is not too profitable, i.e. $F < u + c - t/2n$ and the MFIs are relatively socially motivated, i.e. $\mu > \underline{\mu}$, an increase in the number of MFIs in fact leads to an increase in interest rates. Otherwise, there is a decrease in the interest rates.

8.5 A cap on interest charged by the MFIs

In response to increasing borrower defaults (notably in some Indian states like the Andhra Pradesh), some Indian policy-makers are advocating a cap on the interest rates that MFIs are allowed to charge (Malegam Committee Report, 2011).[38] Their rationale for advocating such a cap is that the poor may be unable to repay unless the interest rate is kept low. On the other hand, many commentators disagree with this measure, fearing that such a cap may be too low to enable MFIs to break even.[39] What would a cap on interest rates mean in the context of our model?

We focus on DDE. Suppose that the interest cap, say $\hat{r}$, is lower than the existing interest rate. In case the MFIs break even if they all charge $\hat{r}$, then it is easy to check that all MFIs charging $\hat{r}$ constitutes a DDE. In this case an interest cap unambiguously reduces the interest rate as well as default, and consequently increases borrower welfare.[40]

Things however are different in case the MFIs make losses at the interest cap. If we expand the model by allowing for exit, then it is natural to conjecture that in equilibrium there will be exit, and moreover, the equilibrium interest rate will involve all remaining firms charging $\hat{r}$. The implications for borrower welfare are now unclear, because while a lower interest rate would tend to increase welfare, welfare would tend to fall as there is an increase in transaction costs.[41]

9 Conclusion

In conclusion, we develop a tractable model of competition between socially motivated MFIs where some borrowers may double dip and default in equilibrium. We then use this framework to analyze the effect of competition on interest rates, default and borrower utility, obtaining several interesting results along the way. We find that an increase in competition increases the incentive to double dip, and hence increases default. Moreover, this result holds even in scenarios where an increase in competition leads to a decrease in interest rates. Further, such an increase in MFI competition can not only lead to an increase in the interest rate, and strikingly, such an increase happens when the MFIs are very socially motivated. For projects of intermediate productivity, competition may induce a regime switch from a no-default equilibrium to one with double dipping, possibly with an accompanying rise in interest rates. Turning to policy implications we find, among other results, that the provision of subsidized credit to the MFIs could lead to an increase in default, and even interest rates, in case it attracts entry by new MFIs.

Acknowledgements. We are grateful to the editor, Maitreesh Ghatak, and two reviewers for extremely useful and perceptive comments. The second author is grateful for the PPRU grant 870-G, as well as visitorships to the Singapore Management University and the National University of Singapore that made this collaboration possible. We would also like to thank seminar participants at the Indian Statistical Institute, Singapore Management University and Sydney University for their comments.

[38] The Committee advocates an interest cap of 24% on individual loans.

[39] See, for example, http://www.indianexpress.com/news/help-microfinance-dont-kill-it/716105/0

[40] Note that all borrowers continue to be served at the interest rate cap, as full market coverage merely relies on a double dipper's payoff being positive, which follows directly from A1 as shown earlier.

[41] What if an interest cap $\hat{r}$, where $\hat{r} \geq c$, is imposed in an SDE? If the MFIs are relatively profit-oriented, charging $r^* > \hat{r} \geq c$, then the interest rate simply falls to $\hat{r}$ and the outcome involves an SDE with lower interest, and consequently higher borrower welfare. Thus we note that an interest cap can never lead to a regime switch from an SDE to a DDE.

10 Appendix

Proof of Proposition 1. (i) First note that, as established earlier, $n < \frac{t}{u+c-F}$ as $n \le \hat{n} < \frac{t}{u+c-F}$. Therefore the utility a double-dipper gets, $u - t/n$, does not exceed the maximum utility of a single-dipping borrower located at a distance of zero from M_1 $(F-c)$. Thus, it is not the case that every one double dips. We next proceed via several steps.

Step 1. From (14) note that that $r^{**}(0) = \frac{3F}{4} - \frac{(u-t/n)}{2}$. We shall argue that an outcome where all MFIs charge $r^{**}(0)$ can be sustained.

Step 2. To verify this claim, we first argue that a nonzero mass of borrowers is double dipping, i.e. $b - a > 0$. Using (10), we find that at $r = r'^{**}(0)$, $b - a = (u - F/2)/t > 0$ (given $u > c > F/2$ from A1).

Step 3. We next demonstrate that the break-even constraint is satisfied. Observe that the non-negative profit constraint when all MFIs charge r, simplifies to

$$r^2 - Yr + Z \le 0, \tag{21}$$

where $Y = 2F - c - u + t/n > 0$ and $Z = -(F-c)u + F(F - c + t/2n)$.[42] Note that (21) is derived by setting the expression in (11) greater than or equal to zero, after substituting in for a, b and $b-a$ from (8)-(10), and setting $r' = r$. Let $\underline{r}$ and $\overline{r}$ be the minimal and maximal root respectively that satisfy (21) with equality. Note that $r^2 - Yr + Z$ is convex in r, being negatively sloped at $r = 0$. Thus $r^2 - Yr + Z$ is negative over the interval $[\underline{r}, \overline{r}]$.if and only if $Y^2 - 4Z \ge 0$, which turns out to be identical to (16) and holds given $n < \hat{n} < \tilde{n}$.

We next argue that $r^{**}(0) < \overline{r}$. This condition turns out to be identical to (17) which holds given that $n < \hat{n}$. Moreover, $r^{**}(0) > \underline{r}$. This follows as $r^{**}(0) - \underline{r} = \frac{\sqrt{Y^2-4Z}+(c-F/2)}{2} > 0$, since $c > F/2$ from A2. Since $\underline{r} < r^{**}(0) < \overline{r}$, MFIs are earning positive profits at this interest rate.

Step 4. We then argue that this outcome is immune to deviations such that none of the deviant's borrowers double-dip. For such deviations it is necessary for the deviant M_1 to charge an interest rate r' such that $F - r' - tb > u - t/n$, i.e. borrowers up to a distance b from M_1 strictly prefer to borrow from M_1, rather than to double dip. However, for feasibility, $r' > c$; moreover, $b = \frac{u-F/2}{2t} + 1/2n > 1/2n$ (given $u > F/2$ from A1). Thus $F - r' - tb < F - c - t/2n$. There are two cases to consider.

4(a). First suppose the projects are not very productive, so that $F < u + c - t/2n$. Then, $F - r' - tb < F - c - t/2n < u - t/n$. Thus it is infeasible for the deviant to charge an interest rate such that there is no double-dipping.

4(b). Next let $F > u + c - t/2n$. Let $r^{SD}(0)$ denote the highest interest rate at which all of the deviant's clients only borrow from it. Equating the payoff of a double dipper, $u - t/n$, to $F - r^{SD}(0) - tb$, which is the payoff of a borrower at a distance b from the deviant if she borrows only from the deviant, and using (9), we have

$$r^{SD}(0) = 2F - 2u - r^{**}(0) + t/n.$$

From (5), the partial of the deviant's utility with respect to respect to its own interest rate r' has the same sign as

$$-4r'^{**}(0) + 2c + 2t/n.$$

[42] Note that $Y = F + [F - c - (u - t/n)]$. The term in square brackets is positive given the restrictions on n, and hence $Y > 0$. Further, from A1 and A2, Z is positive.

Evaluating (10) at $r'^{SD}(0)$, we find that the partial of the deviant MFI's utility with respect to r' is $-8F + 8u + 6r^{**}(0) + 2c - 2t/n = 5(u - F/2) + 2(c - F/2) + t/n > 0$ (using step 1 and A1). Moreover, since $\mu = 0 < 4/7$, due to concavity the partial is positive $\forall\, r'^{SD}(0)$, as well. Therefore, the deviant's utility decreases when it reduces its interest rate; hence it will never undertake such a deviation. Now steps 1-4 prove part (i) of Proposition 1, with uniqueness following as $r^{**}(0)$ is uniquely defined.

(ii) Observe that $r^*(0) = c + t/n$. For an outcome where all MFIs charge r^* to be an SDE, it is necessary that no borrowers are double-dipping, including the borrower who is equidistant from 2 neighboring MFIs. This requires that $u - t/n < F - r^*(0) - t/2n$. Simplifying, we have $u < F - c - t/2n$, which is a contradiction since from A1, $u > F/2 > F - c > F - c - t/2n$. Note that the second inequality follows since $F - F/2 > F - c$ (because $c > F/2$, from A1). Therefore, an SDE does not exist. ■

Proof of Lemma 1. Differentiating $r^*(\mu, n)$ with respect to μ,

$$\frac{dr^*(\mu,n)}{d\mu} = \frac{-(F - c - t/2n)}{(1-2\mu)^2} < 0, \tag{22}$$

as $F > c + t/2n$ from A1. □

Proof of Proposition 2. The proof follows from a series of observations. We begin by showing that for an SDE to exist it is necessary that the project is not too unproductive, i.e. $F \geq u + c - t/2n$.

Observation 1. *A necessary condition for an SDE to exist is that* $F \geq u + c - t/2n$.

Proof. Suppose not, i.e. $F < u + c - t/2n$. Rearranging, $u - t/n > F - c - t/2n$. Next, a borrower located at a distance of $1/2n$ from both her neighboring MFIs double-dips for an interest rate of c, since her utility from double-dipping, i.e. $u - t/n$, exceeds that from taking a single loan, i.e. $F - c - t/2n$. Thus, this borrower, and therefore a non-zero mass of borrowers, would double-dip for any interest rate greater than c also. □

We then examine the incentive for double-dipping.

Observation 2. *There exists $\hat{\mu}$, where $0 < \hat{\mu} < 1/2$, such that if $\mu \geq \hat{\mu}$ and all MFIs charge r^*, then the borrowers have no incentive to double-dip. Further, in this case there is full market coverage.*

Proof. From (19), the no double-dipping condition is that $\mu \geq \hat{\mu}$, where

$$\hat{\mu} = \frac{u - (F - c - t/2n)}{2u - (F - c - t/2n)}. \tag{23}$$

Note that $u > F/2 = F - F/2 > F - c > F - c - t/2n$, where the first inequality follows from A1, and the second also from A1, using $c > F/2$. Thus $\hat{\mu} > 0$. Moreover, from A1, $F - c - t/2 > 0$, and for all $n \geq 2$, we have $F - c - t/2n > F - c - t/2$. Therefore $F - c - t/2n > 0$, so that $\hat{\mu} < \frac{1}{2}$.

Finally if the no double-dipping condition holds, then the utility levels of all borrowers are at least equal to their utility from double-dipping, i.e. $u - t/n$. Given that $u - t/n > 0$ (since from A1, $u > F - F/2 > F - c > t/2$), there is full market coverage. □

We then check if r^* exceeds c, which is necessary for the MFIs to break even in case the symmetric SDE interest equals r^*.

Observation 3. *There exists $\mu' > 0$, such that $r^* \geq c$ if and only if $\mu \leq \mu'$. Further, (i) $\hat{\mu} < \mu'$ whenever $F \geq u + c - t/2n$, and (ii) for $\mu < \mu'$, $\overline{U}_i(r, r')$ is concave in r'.*

Proof. Using (6), there exists a threshold μ', such that $r^* \geq c$ if and only if $\mu \leq \mu'$, where

$$\mu' = \frac{t/n}{F - c + 3t/2n}. \tag{24}$$

(i) Now given $F - c + t/2n > u$, we can cross multiply by $F - c - t/2n$ (which is positive from A1), and then manipulate to obtain $\frac{t}{n}[2u - (F - c - t/2n)] > [u - (F - c - t/2n)][F - c + 3t/2n]$. This yields $\mu' > \hat{\mu} > 0$.

(ii) Finally, from A1, $F - c > t/n$ for $n \geq 2$, so $F - c + 3t/2n \geq 5t/2n$, or $\mu' \leq 2/5 < 4/7$, ensuring that $\overline{U}_i(r, r')$ is concave in r', $\forall \mu < \mu'$. □

Recall that in case all MFIs are charging r^*, then, by the definition of r^*, no MFI can deviate and gain in utility, *as long as there is single-dipping.* We next argue that such an utility enhancing deviation does not exist even if one allows for double-dipping.

Observation 4. *Let $\mu \leq \mu'$. If all MFIs are charging r^*, then M_1 cannot gain even if it charges an r' large enough such that there is double-dipping.*

Proof. Suppose not, and consider a deviation by M_1 to r' that entails double-dipping. From (13), for such an r' and $\mu \leq \mu'$, $\overline{U}_i^{dd}$ is concave in r'. From (10), the critical r' at which double-dipping just starts, call it $r'(DD)$, is given by $r'^* + t/n$. Substituting for r^* we have that

$$t\frac{\partial \overline{U}_i^{dd}}{\partial r'}|_{r'=r'^*} = (6\mu - 4)\frac{(2 - 3\mu)F - (\mu)t/2n - 2(1 - 2\mu)u}{1 - 2\mu} + (3 - 5\mu)F - 2(1 - 2\mu)(u - t/n). \tag{25}$$

Since $F - c > t/n$ (from A1), we have that $\mu' \leq 2/5 < 1/2$, so that $1 - 2\mu > 0$. Multiplying the RHS of the preceding equation by $1 - 2\mu$, we can check that the resulting expression is either uniformly increasing in μ, or initially decreasing and then increasing in μ.[43]

(i) Suppose it is uniformly increasing in μ. We can check that it is negative at $\mu = 2/5$,[44] so that given that $\mu' \leq 2/5$, it is negative throughout the relevant range.

(ii) Next suppose the expression is, however, first decreasing and then increasing in μ. Given that it is negative at $\mu = 2/5$, it remains to show that it is also negative at $\hat{\mu}$, which is indeed the case.[45] Given that $\overline{U}_i^{dd}$ is concave, the MFI cannot gain by deviating to an r' such that there is double-dipping. □

Combining Observations 1-4, we then examine the existence of equilibria for all $\mu \leq \mu'$.

[43] Its derivative with respect to μ is $-(24u - 13F) + \mu[40u - 16F - 2t/n]$, which is positive since from A1, $u > F/2 > F - c > t/n$, so that $40u - 16F - 2t/n > 0$. The sign of $24u - 13F$ is ambiguous though. First, suppose it is positive; then $t\frac{\partial \overline{U}_i^{dd}}{\partial r'}|_{r'=r'^*}$ is decreasing in μ for $\mu < \frac{24u - 13F}{40u - 16F - 2t/n}$ and increasing beyond this. Whereas, if $24u < 13F$, then $t\frac{\partial \overline{U}_i^{dd}}{\partial r'}|_{r'=r'^*}$ is uniformly increasing in μ.

[44] At $\mu = 2/5$ the expression is $-27F + 10t/n + 14u$, which, using $u < F - c + t/2n$, and manipulating, is less than $-13F - 14c + 17t/n < 0$ given $F > t/n$ (from A1) and $c > F - c > t/n$ (again, from A1).

[45] Consider $\hat{\mu} = \frac{u - (F - c - t/2n)}{2u - (F - c - t/2n)}$. Given that we are considering $24u > 13F$, we obtain $24u > 26(F - c - t/2n)$, which on manipulation yields $\hat{\mu} > 1/14$. Therefore if the derivative is negative at $\mu = 1/14$, it is negative throughout the range. Evaluating the derivative at $\mu = 1/14$ we obtain $\frac{-403F + 169t/2n + 456u}{98} < \frac{53F - 456c + 625t/2n}{98}$ (using $u < F - c + t/2n$), which on rearrangement equals $\frac{53(F - 2c) - 625/2(c - t/n) - 37.5c}{98} < 0$, given $F < 2c$ from A1, and $c > F - c > t/n$, where the first inequality follows from $c > F/2$, and the second from A1.

Observation 5. *(i) Let $F > u + c - t/2n$. For any μ in $[\hat{\mu}, \mu']$, all MFIs charging an interest of r^* constitutes an SDE.*

(ii) No SDE exists for $\mu < \hat{\mu}$.

Proof. (i) This follows since (a) from Observation 1, none of the borrowers want to double dip as $\mu \geq \hat{\mu}$, (b) from Observation 2, all the MFIs break even as $\mu \leq \mu'$, (c) given that $\overline{U}_i(r, r')$ is concave in r' (Observation 2(ii)), r^* constitutes the global optimum for an MFI given that all other MFIs are charging r^*, and (d) from Observation 4, M_1 cannot gain by deviating to an r' such that there is double-dipping. Finally from Observations 1 and 2, the interval $[\ \hat{\mu}, \mu']$ is non-empty and moreover, there is full market coverage.

(ii) Follows from Observation 1. □

Proof of Proposition 3. Consider $F - c + t/2n \geq u$ and $\mu \in [\widehat{\mu}, \mu']$ so that there is an SDE with all MFIs charging $r^*(\mu, n)$, where $r^*(\mu, n)$ is given by (6). Differentiating $r^*(\mu, n)$ with respect to n,

$$\frac{dr^*(\mu, n)}{dn} = \frac{t(3\mu - 2)}{2n^2(1 - 2\mu)} < 0, \tag{26}$$

as $\mu < \mu' < \frac{2}{5} < \frac{2}{3}$ (where the second inequality is proved in Observation 3 step 2).

From Lemma 1, it follows that $r^*(\mu)$ is decreasing in μ.

Since under this SDE the utility of a borrower located at a distance $x \leq \frac{1}{2n}$ from her lender is given by $F - r^* - tx$, the fall in r^* following a small rise in motivation therefore improves borrower welfare. Similarly, the fall in r^* following a small rise in competition also improves borrower welfare in the aggregate. □

Proof of Proposition 4. The proof follows from a series of observations.

Observation 6. *Let $\mu \leq \underline{\mu}$ and let $n < \hat{n}$. Then in the symmetric outcome where all MFIs charge r^{**}, all MFIs have non-negative profits.*

Proof. The argument is in several steps.

Step 1. The zero-profit constraint for this case yields

$$Q(r) = r^2 - Yr + Z < 0,$$

where $Y = 2F - c - u + t/n > 0$ and $Z = -\{F - c\}u + F(F - c + t/2n)$. Observe that $Y > 0$ (see the proof of Proposition 1), so that $Q(r)$ is decreasing at $r = 0$ and convex. Consequently, $Q(r) < 0$ for $r \in [\underline{r}, \overline{r}]$.

Step 2. Next observe that $\frac{dr^{**}(\mu)}{d\mu} = \frac{u - t/n - F/2}{(2-3\mu)^2}$. The denominator is positive, and the numerator is negative given $u - t/n < F - c < F/2$, where the first inequality follows as $n < \frac{t}{u+c-F}$, and the last inequality since $c > F/2$.

Step 3. There exists $\underline{\mu}$ such that $r^{**}(\underline{\mu}) = \underline{r}$. Moreover, $\underline{\mu} < 1/2$. To see this, first, $\underline{r} > c$. This follows since the MFIs have to recoup the losses made on the double-dipping borrowers from the non-defaulting borrowers. Next $r^{**}(1/2) = F/2 < c$ so that there are losses. Given $\frac{dr^{**}}{d\mu} < 0$, there exists $\underline{\mu} < 1/2$ such that $r^{**}(\underline{\mu}) = \underline{r}$. Moreover, $\underline{\mu}$ is strictly positive as $r^{**}(0) > \underline{r}$. Hence the interval $[0, \underline{\mu}]$ is non-empty.

Step 4. From steps 2 and 3, MFIs with $\mu < \underline{\mu}$ have $r^{**} > \underline{r}$. Finally A2, combined with $n < \hat{n}$, is sufficient to show that $r^{**}(0) < \overline{r}$. From Step 2, $r^{**} \leq r^{**}(0)$ for all μ, so $r^{**} < \overline{r}$. Therefore, for $\mu < \underline{\mu}$ the MFIs earn a positive profit. □

We then examine if the equilibrium indeed involves double-dipping.

Observation 7. *Let $\mu \leq \underline{\mu}$ and $u + c - t/2n > F$. In case all MFIs charge $r^{**}(\mu)$, then some borrowers double-dip.*

Proof. From Obs. 6, for $\mu \leq \underline{\mu}$, we have $r^{**} \geq \underline{r}$. From (10), $b - a$ is increasing in r. Hence if it is positive at $r = r' = \underline{r}$, it is also positive for $r^{**} > \underline{r}$. From (10), the mass of defaulters at $\underline{r}$ is $b - a = \frac{u-c-\sqrt{Y^2-4Z}}{t}$. Thus the condition for $b - a > 0$ simplifies to

$$u > c + \sqrt{Y^2 - 4Z}$$

Substituting for Y and Z, and simplifying, this is equivalent to $F - c + t/2n < u$. Note that the condition does not depend on μ. $\square$

Observations 6 and 7 show that whenever the MFIs are not too socially motivated, i.e. $\mu \leq \underline{\mu}$ and the project is not too profitable, i.e. $F < u+c-t/2n$, then if all other MFIs charge r^{**}, then no MFI has an incentive to deviate to an interest rate such that a positive mass of its own borrowers are still double-dipping. In Observation 8 below, we show that it will also not deviate to a much lower interest rate such that all its own borrowers single-dip. Moreover, as long as $F < u+c-t/2n$, the result is independent of μ.

Observation 8. *Let $F < u + c + t/2n$. In case all MFIs charge $r^{**}(\mu)$, no single MFI will deviate to an interest rate low enough such that all its own borrowers single-dip.*

Proof. Consider a candidate DDE where all MFIs charge $r^{**}(\mu)$. We show that $b > 1/2n$. Rearranging $F < u + c - t/2n$, we get $u - F + c > t/2n$. Now $r^{**} > c$ from Obs. 6, therefore $u - F + r^{**} > t/2n$, or $b > 1/2n$ (from (9)). Next rearranging $F < u + c - t/2n$, we have $F - c - t/2n < u - t/n$. Next, consider whether M_1 can deviate to r' so that none of its clients double-dip. For this, borrowers up to at least a distance b away from M_1 must strictly prefer to borrow from M_1, rather than double dip, i.e. $F - r' - tb > u - t/n$. However, for feasibility, we must have $r' > c$. Given that $b > 1/2n$, $F - r' - tb < F - c - t/2n < u - t/n$. Hence the deviant cannot feasibly charge an interest rate such that double-dipping is eliminated. $\square$

Combining Observations 6, 7 and 8, it is easy to see that provided competition is not too strong, a double-dipping equilibrium exists whenever the MFIs are not too socially motivated, i.e. $\mu \leq \underline{\mu}$ and the project is not too profitable, i.e. $F < u + c - t/2n$.

Next let the MFIs be very socially motivated, i.e. $\mu > \underline{\mu}$, and $F < u + c - t/2n$. Recall that for $\mu = \underline{\mu}$, the MFIs just break-even at $\underline{r}$. Consider any higher μ, and suppose that all MFIs apart from M_i are charging $\underline{r}$. In that case one can show that while M_i would like to charge a lower interest rate, doing so leads to a negative profit, violating the break-even constraint. Moreover, deviations such that all of the deviant's borrowers start single-dipping are also infeasible. We summarize this discussion in

Observation 9. *Let $F < u + c - t/2n$, $\mu > \underline{\mu}$, $n < \tilde{n}$ and suppose that all MFIs apart from M_i are charging $\underline{r}$. Then, for all $r \geq \underline{r}$, the utility of M_i is decreasing in r. Moreover, as long as all other MFIs charge $\underline{r}$, no single MFI will deviate to an interest rate low enough such that all its own borrowers single-dip.*

Proof. The proof is in three steps.

Step 1. Consider $2/3 > \mu > \underline{\mu}$. Let all other competing MFIs set their interest rate at $\underline{r}$. Consider an individual MFI's incentive to deviate such that a positive mass of its borrowers still continue to double dip. Note that

$$t\frac{\partial U_i^{dd}}{\partial r'} = [2\mu - 1](u - t/n) + (3 - 5\mu)F/2 - (2 - 3\mu)r'.$$

Given $\mu < 2/3$, we have $\frac{\partial U_i^{dd}}{\partial r'} > 0$ for $r' < r^{**}$, and $\frac{\partial U_i}{\partial r'} < 0$ for $r' > r^{**}$. Now $r^{**} < \underline{r}$ for μ in this range as $\underline{r} = r^{**}(\underline{\mu})$ and $\frac{dr^{**}}{d\mu} < 0$. Thus MFI utility is decreasing in r' for $r' \geq \underline{r}$.

Next observe that at $r' = r = \underline{r}$, $t\frac{\partial U_i}{\partial r'} < 0$, so that an individual MFI will not charge an interest rate beyond $\underline{r}$. Whereas a decrease in its rate of interest, would violate the profit constraint (provided some of its borrowers continue to double dip). Hence, by concavity, starting from $r = r' = \underline{r}$, we can rule out deviations to a lower r'. Next let $r' = r > \underline{r}$, so that the MFIs are earning positive profits. At any interest rate greater than $\underline{r}$, utility is decreasing in r'. Moreover, such a deviation will not violate the profit constraint as $r > \underline{r}$. Hence, there is no symmetric DDE in this range where the MFIs earn positive profits, though there is one at which they just break even.

Step 2. Consider $\mu > 2/3$. Again, consider an MFI's incentive to deviate such that a positive mass of its borrowers double dip, given that other MFIs are charging $\underline{r}$. Using (10), $\mu > 2/3$, so that $\frac{\partial U_i}{\partial r'}$ is increasing in r'. Now the highest feasible r' is necessarily less than $F - u + t/n$ recalling that for non-negative a, we must have $r' \leq F - u + t/n$. Even at this r', we have $\frac{\partial U_i}{\partial r'} = -(1 - \mu)F/2 - (u - t/n) < 0$ where the last inequality follows as $F/2 > F - c$ as $c > F/2$ from A1, and $F - c > u - t/n$ given our restrictions on n. Therefore the partial is necessarily negative for lower r'. The rest of the argument mimics the earlier case.

Step 3. Let all other MFIs charge $\underline{r}$. It is not feasible for an MFI to deviate to a sufficiently low interest rate to induce all its borrowers to single dip. The proof mimics that of Observation 8, replacing r^{**} by $\underline{r}$. □

We finally show that if the project is relatively profitable, in the sense that $u < F - c + t/2n$, then a DDE exists whenever the MFIs are not too socially motivated.

Observation 10. *Suppose $F > u + c - \frac{t}{2n}$ and $n < \hat{n}$. Then an equilibrium where some borrowers double dip exists if MFIs are relatively profit-oriented, i.e. for $\mu \in [0, \min\{\hat{\mu}, \widetilde{\mu}\}]$, where $\widetilde{\mu} = \frac{u-F/2}{u-F/2+t/2n} < \underline{\mu}$.*

Proof. The proof proceeds in several steps.

Step 1. We begin by showing that no DDE exists for $\mu > \underline{\mu}$.

Recall that $r^{**}(\underline{\mu}) = \underline{r}$. Thus for any $\mu > \underline{\mu}$, $r^{**}(\mu) < \underline{r}$ (since from Observation 6, step 2, $\frac{dr^{**}}{d\mu} < 0$). Next consider a candidate symmetric equilibrium where all MFIs charge r. (i) If $r < \underline{r}$, this cannot be sustained as the MFIs make losses. (ii) $r = \underline{r}$ cannot be sustained since, given that $F > c + u - t/2n$, no borrower will double dip at $\underline{r}$ (since from Observation 7, $b - a \leq 0$ at $\underline{r}$ for this case). (iii) $r > \underline{r}$ cannot be sustained as the borrowers have an incentive to charge a lower interest rate (as $r > r^{**}(\mu)$).

Step 2. We then show that no DDE exists for $\mu > \tilde{\mu} = \frac{u-F/2}{u-F/2+t/2n}$.

Let $\tilde{r} = F - u + t/2n$ be such that the borrower located at an equal distance from both M_1 and M_2, is indifferent between single and double-dipping. Note that $\tilde{\mu}$ solves $r^{**}(\mu) = \tilde{r} = F - u + t/2n$. Then, for $\mu > \tilde{\mu}$, $r^{**}(\mu) < F - u + t/2n$. We then consider a candidate DDE where all MFIs charge r. (i) If $r \leq F - u + t/2n$, then no one double dips. (ii) If $r > F - u + t/2n$ then, given that $r^{**}(\mu) < F - u + t/2n < r$, the MFIs have an incentive to charge a lower interest rate.

Note that $\widetilde{\mu} < 1/2$. Since $F - c + t/2n > u$, we have $t/2n > u - (F - c) > u - F/2$, where the last inequality follows from $F/2 = F - F/2 > F - c$, given $c > F/2$ from A1. Now $t/2n > u - F/2$ is equivalent to $\frac{u-F/2}{u-F/2+t/2n} < 1/2$. Moreover given $u > F/2$, $\widetilde{\mu} > 0$. Next from Step 1, $F - \underline{r} - \frac{t}{2n} > u - \frac{t}{n}$ (as there is no double-dipping at $r = \underline{r}$). Since, by definition, we have $F - \tilde{r} - \frac{t}{2n} = u - \frac{t}{n}$, we get $\tilde{r} > \underline{r}$. Using $\frac{dr^{**}}{d(\mu)} < 0$, we therefore have $\tilde{\mu} < \underline{\mu}$.

Step 3. For $\mu \leq \tilde{\mu}$, in the outcome where all MFIs charge $r^{**}(\mu)$, we argue that (i) there is double dipping, (ii) none of the MFIs want to deviate to a interest rate where there is double dipping, and (iii) profits are positive.

(i) Since $\mu < \tilde{\mu}$, $r^{**} > \tilde{r}$ inducing double-dipping by a positive mass of borrowers. (ii) This follows as r^{**} is optimal whenever there is double-dipping. (iii) Follows as $\mu < \underline{\mu}$, so that $r^{**} > \underline{r}$. (Further, given our restrictions on n, and using $\frac{dr^{**}}{d\mu} < 0$, we have $r^{**} \leq r^{**}(0) < \overline{r}$).

Step 4. We finally check whether an MFI will have an incentive to deviate to an interest rate such that all its borrowers single dip. Now let r^{SD} denote the highest interest rate at which all of the deviant's borrowers single dip, only borrowing from the deviant. Given that its neighbors are charging r^{**}, this critical interest rate

$$r^{SD} = 2F - 2u - r^{**} + t/n,$$

equates the payoff of a double dipper, $u - t/n$, to $F - r^{SD} - tb$, which is the payoff of a borrower at a distance b from the deviant if she borrows only from the deviant, and b is given by (9) substituting in $r = r^{**}$. Now from (5), the partial of the deviant's utility with respect to her own interest rate r' has the same sign as

$$(7\mu - 4)r' - 2(\mu)F + (2 - 3\mu)r{*}{*} + 2(1 - \mu)c + (2 - 3\mu)t/n.$$

Evaluating (10) at r'^{SD}, we next show that the expression is positive as long as $\mu \leq \hat{\mu}$. The expression becomes $(12\mu - 8)F + (8 - 14\mu)u + (6 - 10\mu)r^{**} + 2(1 - \mu)c - 2(1 - 2\mu)t/n \geq (12\mu - 8)F + (8 - 14\mu)u + (6 - 10\mu)(F - u + t/2n) + 2(1 - \mu)c - 2(1 - 2\mu)t/n$, given $\mu < \widetilde{\mu} < 1/2$, and $r^{**} > F - u + t/2n$ from step 3. The above expression simplifies to $2(1 - \mu)(u - (F - c - t/2n)) - 2(\mu)u$, which is positive for all $\mu \leq \hat{\mu}$. Moreover, given concavity, the partial is positive for all r'^{SD} for $\mu < 4/7$. Therefore, the deviant's utility is increasing in its interest and it will never undertake such a deviation. $\square$

Proof of Proposition 5. (i) From (15) recall that MFIs set their interest rate according to r^{**} for $\mu < \underline{\mu}$. Now differentiation yields

$$\frac{dr^{**}}{d\mu} = \frac{u - t/n - F/2}{(2 - 3\mu)^2} < 0.$$

The negative sign follows since $F/2 = F - F/2 > F - c > u - t/n$, given $F/2 < c$ and $n < \frac{t}{u+c-F}$. Note that this proof - and the proof of the subsequent parts of this proposition - applies equally to MFIs in a DDE in the zone where $F > u + c - t/2n$. In this case MFIs have $\mu < \min[\widetilde{\mu}, \hat{\mu}] < 1/2$ and always charge r^{**} earning positive profits. (We have $\hat{\mu} < 1/2$ from Observation 2 and $\widetilde{\mu} < 1/2$ from Observation 10 step 2).

(ii) From (10), the range of default, $b - a$, is increasing in interest rates.

(iii) Let $\mu < \underline{\mu}$, so that the MFIs set $r = r^{**}$. Consider borrowers located in between M_1 and M_2. As μ increases, there is a fall in r^{**}, so that the utility of all single-dipping borrowers, including those who have switched from double-dipping to single-dipping, increases. The utility of those who double-dip in both cases remains unaffected. A similar proof applies in the DDE zone when $F > u + c - t/2n$. $\square$

Proof of Proposition 6(i). Effect on default. Consider $F < u + c - t/2n$ and $\mu < \underline{\mu}$, so that the equilibrium interest rate is r^{**}. From (15), we can substitute for r^{**} into (10), and differentiate the resultant expression with respect to n. Thus

$$\frac{d(b-a)}{dn} = \frac{\mu}{(2-3\mu)n^2} > 0, \tag{27}$$

as $\mu < \underline{\mu} < \frac{1}{2} < \frac{2}{3}$.

Therefore, the range of double dippers in between any two MFIs increases, and consequently so does aggregate default. Note that this proof applies equally to relatively profit-oriented MFIs (with $\mu < \min[\widetilde{\mu}, \hat{\mu}] < 1/2$) in a DDE when $F > u + c - t/2n$. Now consider $F < u + c - t/2n$ and $\mu > \underline{\mu}$. Thus the interest rate is $\underline{r}$, so that the expression for $b - a$ is

$$b - a = \frac{u - c - \sqrt{c^2 - 2uc + 2(F-c)t/n + (u - t/n)^2}}{t} \tag{28}$$

(substituting for Y and Z). Differentiation and simplification yields

$$\frac{d(b-a)}{dn} = \frac{F - c - (u - t/n)}{n^2\sqrt{Y^2 - 4Z}} > 0.$$

The positive sign follows from the sign of the numerator, whose positive sign follows directly from $n < \frac{t}{u+c-F}$. Finally, aggregate default also increases.

6(ii). Effect on the interest rate and borrower utility for profit-oriented MFIs. Consider $F < u + c - t/2n$. Both r^{**} and $\underline{r}$, and consequently $\underline{\mu}$ is a function of n. However, it can be shown that it will still be less than 1/2. First let μ be less than the (new) critical threshold, so that the equilibrium interest rate is r^{**}. Differentiation yields

$$\frac{dr^{**}}{dn} = \frac{t(2\mu - 1)}{n^2(2-3\mu)} < 0, \tag{29}$$

as $\mu < \underline{\mu} < \frac{1}{2} < \frac{2}{3}$. This proof applies equally to MFIs in a DDE if $F > u + c - t/2n$. In this case $\mu < min[\widetilde{\mu}, \hat{\mu}] < \underline{\mu} < 1/2$ and MFIs charge r^{**}. Now consider relatively profit-oriented MFIs, who charge r^{**}. With a rise in competition to $n' > n$, the utility of double-dipping borrowers increases to $u - t/n'$ as the total cost of double dipping, t/n', is now smaller. As for the single-dipping borrowers, while their utility increases because of a fall in both interest rates and total transactions costs, some borrowers may be worse off as the MFIs may move away to a further location.

6(iii). Effect on interest rate and borrower welfare for relatively socially motivated MFIs. Consider $\mu \geq \underline{\mu}$ and $F < u + c - t/2n$, so that a DDE exists. Next calculations show that $d\underline{r}/dn$ has the same sign as $2\underline{r} - F$. However, we know that $F/2 < c < \underline{r}$ (see Step 3, Observation 6). Hence, $d\underline{r}/dn > 0$. In this case, an increase in competition to $n' > n$ still increases the welfare of those borrowers who were previously double dipping. However, borrowers who continue to single dip may be worse off than before, as their utility falls due to a rise in the interest rate. They may however gain from the MFIs coming closer to them. Borrowers who switch from single-dipping to double-dipping may or may not be better off than before. $\square$

Proof of Proposition 7. (i) From Proposition 2 and Remark 5, we know that an SDE exists when $\mu \geq \hat{\mu}$ and $F > u + c - t/2n$. When projects are at an intermediate level of productivity, so that $u + c - t/2n' > F > u + c - t/2n$, an increase in competition from n to n' will cause a regime switch from an SDE to a DDE (which exists in this range, from Proposition 4). (See Figure 6).

(ii) If $F > u + c - t/2n'$, i.e. projects are very productive, we do not transit to the zone where only DDE is possible. $\square$

11 References

Aldashev, G., Verdier, T., 2010. Goodwill bazaar and giving to development. Journal of Development Economics 91, 48-63.

Ausubel, L., 1991. The failure of competition in the credit card market. American Economic Review 81, 50-81.

Basu, K., 2012. Commitment savings in informal banking markets. Working paper.

Besley, T., Ghatak, M., 2005. Competition and incentives with socially motivated agents. American Economic Review 95, 616 - 636.

Besley, T., Ghatak, M. 2006. Sorting with socially motivated agents: implications for school competition and teacher incentives. Journal of the European Economic Association 4, 404-414.

Brito, D., Hartley, P., 1995. Consumer rationality and credit cards. Journal of Political Economy 103, 400-433.

Dam, K., Roy Chowdhury, P., 2012. Competition and incentives in micro-finance. Presented at the ThReD-CIDE Conference on Development Theory at CIDE, Mexico City, 2012.

Fernando, N.A, 2006. Understanding and dealing with high interest rates on microcredit: a note to policy makers in Asia and the Pacific Region. Asian Development Bank, East Asia Department, May 2006.

Fischer, G., Ghatak, M. 2010. Repayment frequency in microfinance contracts with present-biased borrowers. Working paper, London School of Economics.

Ghatak, M., Mueller, H. 2011. Thanks for nothing?: not-for-profits and socially motivated agents. Journal of Public Economics 95, 94-105.

Guha, B., Roy Chowdhury, P. 2011. Borrower targeting under microfinance competition with motivated MFIs. Working paper, Singapore Management University. Available at http://www.economics.smu.e

Guha, B., Roy Chowdhury, P. 2013. Micro-finance Competition: Motivated Micro-lenders, Double-dipping and Default. Working paper, Singapore Management University. Available at https://mercury.smu.edu.sg/rsrchpubupload/20026/01-2013.pdf

Heidhues, P., Koszegi, B., 2010. Exploiting naivete about self-control in the credit market. American Economic Review 100, 2279-2303.

Hermes, N., Lensink, R., 2007. The empirics of microfinance: what do we know? Economic Journal 117: F1-F10.

Hoff, K., Stiglitz, J.E, 1997. Money-lenders and bankers: price-increasing subsidies in a monopolistically competitive market. Journal of Development Economics 52, 429-462.

Janvry, A. de, McIntosh, C., Sadoulet, E., 2010. The supply and demand side impacts of credit market information. Journal of Development Economics 93:173-188.

Kahn, C.,. Mookherjee, D., 1995. Market failure with moral hazard and side trading. Journal of Public Economics 58, 159-184.

Kahn, C., Mookherjee, D., 1998. Competition and incentive with non-exclusive contracts. The Rand Journal of Economics 29, 443-465.

Meier, S., Sprenger, C., 2010. Present-biased preferences and credit card borrowing. American Economic Journal Applied Economics 2, 193-210.

Kranton, R., Swamy, A., 1999. The hazards of piecemeal reform: British civil courts and the credit market in colonial India. Journal of Development Economics 58, 1-24..

Malegam, Y.H., 2011. Report of the sub-committee of the central board of directors of Reserve Bank of India to study issues and concerns in the MFI sector. Reserve Bank of India, January 2011.

Marconi, R., Mosley, P., 2005. Bolivia during the global crisis 1998-2004: towards a macroeconomics of microfinance. Sheffield Economic Research Paper Series 2005007.

McIntosh, C., Wydick, B., 2005. Competition and microfinance. Journal of Development Economics 78, 271-298.

McIntosh, C., de Janvry, A., Sadoulet, E., 2005. How rising competition among microfinance lenders affects incumbent Village Banks. Economic Journal 115, 987-1004.

Navajas, S., Conning, J., Gonzalez-Vega, C., 2003. Lending technologies, competition and consolidation in the market for microfinance in Bolivia. Journal of International Development 15, 747-770.

Parameshwar, D., Aggarwal N., Zanchi, R., Shankar, S.S., 2009. Inverting the pyramid: Indian microfinance coming of age. 3rd edition. Intellecap.

Porteous, D., 2006. Competition and microcredit interest rates. CGAP Focus Note No 33, February 2006.

Quidt. J. de, Fetzer, T., Ghatak, M., 2012. Microfinance, social capital and for-profit lending. Mimeo, London School of Economics.

Roy, J., Roy Chowdhury, P., 2009. Public-private partnerships in microfinance: should NGO involvement be restricted? Journal of Development Economics 90, 200-208.

Srinivasan, N., 2009. Microfinance India, state of the sector report 2009. Sage India.

United Nations Interagency Committee on Integrated Rural Development for Asia and the Pacific. Partners in rural poverty alleviation: NGO cooperation. United Nations, New York; 1992.

Van Tassel, E., 2002. Signal jamming in new credit markets. Journal of Money, Credit and Banking 34, 469-490.

Vogelgesang, U., 2003. Microfinance in times of crisis: the effects of competition, rising indebtedness and economic crisis on repayment behavior. World Development 31, 2085-2114.