Incentives and competition in microfinance☆

Kaniṣka Dam

Centro de Investigación y Docencia Económicas
Carretera México-Toluca 3655, Mexico City, Mexico.

Prabal Roy Chowdhury*

Indian Statistical Institute, Delhi Center
7 Sahid Jit Singh Sansanwal Marg, New Delhi, India.

Abstract

We develop a model of competition among socially motivated microfinance institutions (MFIs), where the MFIs offer repayment-based incentive contracts to credit agents. The agents gather information regarding a borrower, and may, or may not collude with the borrower, taking bribes in return for not acting upon their information in case of collusion. We show that competition may either increase, or decrease incentives, with incentives becoming less high powered if the MFIs are not too motivated. Further, whenever either the moral hazard problem is relatively severe and/or the MFIs are not too motivated, competition increases default, thus providing a possible explanation for the recent episodes of crisis in the MFI sector. Interestingly, the effects of competition are linked to mission drift, i.e., whether the MFIs in the concerned countries are more, or less motivated. Further, default problems may worsen in case competition is accompanied by greater access to donor funds.

JEL classification: C72, D40, D82, G21
Keywords: Microfinance; competition; socially motivated MFIs; collusion; staff incentive schemes; monitoring.

☆We thank Christian Ahlin, Jean-Marie Baland, Gautam Bose, Indraneel Dasgupta, Bhaskar Dutta, Maitreesh Ghatak, Parikshit Ghosh, Carlos Lever, Ashok S. Rai, Patrick Rey, Santanu Roy and the seminar participants at the CIDE-ThReD Conference on Development Theory, the 22nd Annual Conference on Contemporary Issues in Development Economics (Jadavpur University), Banco de México, Indian Statistical Institute (Delhi and Kolkata centers) and Southern Methodist University for useful comments.

*Corresponding author.

Email addresses: kaniska.dam@cide.edu (Kaniṣka Dam), prabalrc@isid.ac.in (Prabal Roy Chowdhury)

1. Introduction

There have been several recent episodes of crisis in the microfinance sector. While the crisis that engulfed the sector in Andhra Pradesh, South India, around 2008-09, is quite well known, microfinance sectors in countries like Bosnia, Nicaragua, Morocco, Pakistan, etc. also ran into problems around the same period (see Roodman, 2012). Interestingly in Andhra Pradesh, as in many of the other cases, default and MFI competition increased contemporaneously.[1] This has naturally led to the idea that increased competition among microfinance institutions (MFIs) has, somehow, worsened lending discipline, thus leading to the crises. In turn, such a perception has led to demand for regulation of this sector in India, with the state government of Andhra Pradesh having already passed a legislation to this end (Andhra Pradesh Microfinance Institutions Act, 2011).[2]

Regarding the issue of increased MFI competition, data from MIX indicates that between 2000 and 2011, the number of MFIs reporting data increased from 11 to 144 for india, from 7 to 73 for Bangladesh, and from 2 to 60 for Indonesia. This trend is common across most countries, with the estimated number of MFIs worldwide growing from 618 in 1997, to 3133 in 2005 (Hermes and Lensink, 2007).[3] Moreover, such increased competition has been linked to borrowers taking loans from several MFIs,[4] and consequently an increase in borrower default.

It is the possible link between increased MFI competition and worsening performance regarding repayment that forms the central motivation of our paper. Further, in a departure from the existing literature on MFI competition (reviewed later), we examine a relatively less explored channel through which such competition may affect MFI performance, namely through its effect on the organizational structure, in particular *staff incentive schemes* (henceforth, SIS). We argue that this issue is of significance given that incentive schemes are (a) key to MFI performance, and (b) of wide spread use in MFIs.

Given that the loans in the microfinance markets are typically unsecured, the MFIs have to monitor their borrowers. Direct monitoring is however difficult since the micro-lenders are often located far away from their borrowers. Irrespective of any other mechanisms that may be used to allay this problem (e.g. group-lending), the MFIs employ credit agents in order to monitor the borrowers.[5] Such monitoring however generates two possible incentive issues that are at the heart of this paper. First, monitoring efforts are privately costly for the agents and cannot be verified by their employers, which induces the typical moral hazard problem in (monitoring) effort choice. Second, the credit agents may have incentives to collude with the agents, and misreport the information they have gathered to the MFIs. This induces an additional moral hazard problem. In order to mitigate both types of incentive problems, the MFIs must

[1] Microfinance critics have in fact traced farmer suicides in Andhra Pradesh to such increased MFI competition (see Banerjee et al., 2010; de Quidt et al., 2012).

[2] At the central government level, India is mulling on the Microfinance Institutions (Development and Regulation) Bill aimed at regulating this sector.

[3] In India, the average year-on-year increase in the portfolio of the microfinance sector over the period 2004-2009 was 107% (Parameshwar et al., 2009). McIntosh and Wydick (2005) provide evidence of increased MFI competition in Uganda and Kenya in Africa, and Guatemala, El Salvador and Nicaragua in America. McIntosh, de Janvry, and Sadoulet (2005) find evidence for double-dipping for Uganda.

[4] 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."

[5] MFIs are typically very labour intensive, with salary consisting of 60-70% of administrative expenses in general. These include workers other than credit officers of course. Further, many MFIs are very decentralized with far flung branches (see Holtmann, 2002).

offer incentive contracts to their agents. The structure of incentives therefore plays an important role in the performance of the MFIs.

As far as the use of such incentive contracts in MFIs is concerned, McKim and Hughart (2005), among others, suggest that the use of such contracts is extremely common, and has been increasing in recent years. In fact, the percentage of MFIs using a staff incentive scheme has increased by more than ten-fold, from 6% to 63%, between 1990 and 2003, with the percentage doubling from 30 to 60 during the period 1999-2002. Further, such incentive schemes are considered to be of importance by the MFIs themselves since they are perceived to improve repayment performance. In Subsection 2.1 to follow, we provide some more discussion of such schemes.

Unfortunately, however, there is very little research on the issue of incentives in MFIs, either theoretical or empirical, even though its importance is well recognized.[6] To quote Holtmann (2002):

> "... staff incentive schemes are something of a blindspot in microfinance. Most of the available data are anecdotal and limited to specific MFIs, and so far no systematic research has been conducted on this issue."

At a theoretical plane, the central challenge is to construct a tractable model of MFI competition that allows for endogenously derived incentive structures. This is a non-trivial task, given that there is not too much literature on competition in a principal-agent framework (see Subsection 2.2 for a brief discussion). Further, we are interested in developing a framework that allows for several important aspects of reality, e.g. the fact that the MFIs may be socially motivated, as well as the possibility of collusion between credit agents and borrowers.

To this end, we consider a model with two MFIs, each lending to a single common borrower who may divert fund to projects with non-verifiable private benefits. The MFIs hire a credit agent each by offering repayment-based incentive schemes. Further, the MFIs are socially motivated in that they not only care about their own income, but also that of the borrower. That many NGOs (including MFIs) are motivated is well known in the literature.[7] As we shall find later, the magnitude of such motivation plays an important role in the analysis.

The agents exert non-verifiable monitoring efforts in a bid to prevent the misuse of funds by the borrower. Once monitoring is successful however, the agents may collude with the borrower an receive bribes. In return, the credit agents do not act upon their information even if they are successful in monitoring.[8] Thus, contracts must fulfill the twin objectives of mitigating incentive problems in effort choice, as well as of collusion.

At this point it may be worth noting that in this paper we focus on some particular aspects of MFI

---

[6] In a similar vein Armendáriz and Morduch (2010, chapter 11, pp. 347) write "A great deal of what distinguishes failed microfinance from successful microfinance ultimately has to do with management, particularly with how staff members are motivated and equipped to do their jobs. In this, microfinance is no different from businesses that sell soft drinks or haircuts."

[7] In 1992, The United Nations Interagency Committee on Integrated Rural Development for Asia and the Pacific (UNICIRDAP) defined 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. See Besley and Ghatak (2005, 2006); Ghatak and Mueller (2011) for studies on incentive provision in mission-oriented firms.

[8] Armendáriz and Morduch (2010) argue that as incentives to perform increases, so does the incentive to cheat. In the context of a consumer credit company in Bolivia, Bazoberry (2001) argues that loan officers can engage in several deceptive activities, e.g. frequent re-scheduling of loans, creation of ghost accounts to hide default, etc.

"competition" critical to the issue at hand, abstracting from some other aspects. In particular, in the case with two MFIs, they do not really compete for the borrower's custom, with both MFIs being able to lend the full amount that they want to. Rather the focus is on studying the interactions between two MFI-agent hierarchies that lend to a single borrower. Note that the fact that we have two MFI-credit agent hierarchies, and not two monolithic principals, differentiates the present paper from the literature on common agency (e.g. Bernheim and Whinston, 1986; Dixit, Grossman, and Helpman, 1997). Further, we also abstract from issues like product substitutability, entry costs, as well as allowing for an arbitrary number of MFIs, which are often considered as measures of the intensity of competition in a given market.[9]

We find that under competition the outcomes depend on how motivated the MFIs are. When the MFIs are not very motivated, collusive threats are small, i.e., the agents have little incentives to collude with the borrower, whereas collusive threats are large otherwise. This is intuitive since the borrowers stand to gain from choosing a 'bad' project, and the MFIs are more sympathetic to this objective in case they themselves are very motivated. Thus, greater the motivation levels, lower are the repayment-based incentives and greater are the incentives to collude. This has interesting comparative statics implications, in that the incentives, as well as the monitoring levels of the credit agents, are non-monotone in the lending rate. We find that while both are *increasing* in the rate of interest when the MFIs are very motivated, they are *decreasing* in the rate of interest when the motivation level is low.

Turning to the effects of MFI competition on incentives, we find that competition exacerbates the incentives to collude compared with the situation under a single MFI. The effect of competition on incentives to monitor is however ambiguous. For high level of motivation of the MFIs, competition implies more high-powered incentives, whereas incentives are less high-powered under competition if motivation is low enough. There are two countervailing effects. On the one hand, there is a free-riding problem in monitoring since the probability of success jointly depends on the individual monitoring efforts, and hence in equilibrium each agent exerts low effort. This lowers each MFI's marginal benefit from providing high-powered incentives, thus leading to lower incentives. On the other, under competition the agents have a greater incentive to collude. Mitigating this issue requires stronger incentives. We have already argued, collusive threats increase with an increase in motivation. Thus, when motivation levels are high, the second effect dominates, so that incentives are weaker under competition.

Another interesting finding is that competition leads to an increase in default corresponding to a wide range of parameter values. This happens whenever either the moral hazard problem is relatively severe, and/or the MFIs are not too motivated. The result is quite intuitive. When the MFIs are not very motivated, competition leads to low-powered incentives implying lower levels of individual monitoring. This is enough to outweigh the fact that two agents are monitoring the borrower under competition, rather than a single one.

[9]Many of these assumptions however are for tractability and focus alone. For example, preliminary investigations suggest that the analysis may go through qualitatively with $n \geq 2$ MFIs. Furtther, our analysis of MFI *competition*, have some formal similarities with the literature on competition among vertical chains (e.g. Bonanno and Vickers, 1988; Rey and Stiglitz, 1988; Gal-Or, 1991), where a vertical chain consists of a producer of a good (upstream firm) and a retailer (downstream firm), who in turn sells to the consumers. Note that the upstream firms face the problem of incentivizing the downstream firms so as to maintain a high price. While typically informational issues are not considered in this literature, there are some similarities with our problem in that the MFIs also face the problem of incentivizing their credit agents, and cannot ensure a high monitoring level just by fiat.

Note that this result provides a possible explanation of the recent crises in the MFI sector. Further, we find that this theory is rich enough to accommodate the fact that in some countries, e.g. Bangladesh, there is little evidence that MFI competition led to any such crisis, namely that the MFIs in those countries were relatively more motivated. Interestingly, this result links the effects of competition to mission drift, i.e., whether the MFIs in these countries are more, or less motivated.

We then extend the analysis in several directions. In case MFI competition is also accompanied by increased access to donor funds, which some commentators have argued actually happened in some cases (Roodman, 2012), we find that the MFIs provide stronger incentives to the agents. Further in this case, the agents have a greater incentive to collude with the borrowers. This *suggests* one possible reason why MFI competition may have worsened lending discipline, namely through increased collusion (of course in the present framework collusion does not happen in equilibrium).

Finally, we generalize the analysis by allowing for monitoring technologies where the monitoring levels of the credit agents can be either substitutes or (strong) complements. We find that the results are qualitatively robust whenever the monitoring technology exhibits submodularity, i.e., monitoring efforts are substitutes. Interestingly though, some of the analysis may change in the event of log-supermodularity. Consider the effect of an increase in the motivation level of one of the MFIs, say MFI 1. While, under some reasonable conditions, the incentives offered by MFI 1 decreases irrespective of whether the technology is submodular, or log-supermodular, the incentives offered by MFI 2 increase in case submodularity, and decrease in case of log-supermodularity. This is of course intuitive since the incentive structure is designed so as to elicit monitoring effort, and under log-supermodularity, monitoring becomes more effective in some sense so that the second MFI does not require to increase incentives. The fact that the other MFI increases its own incentives, leading to increased monitoring, is enough.

The rest of the paper is organized as follows. In Section 2 we report some stylized facts about commonly used incentive schemes in microfinance, and review the related literature. In Section 3 we analyze a single MFI framework, whereas Section 4 considers the case of MFI competition. In Section 5 we examine the effects of competition. Some robustness issues are analyzed in Section 6. Finally, we conclude in Section 7. While the proofs are relegated in Appendix A, in Appendix B we analyze a model with a more general monitoring technology.

2. Incentives and competition in microfinance

2.1. Incentive structure in the MFIs

We briefly report a few stylized facts that seem to emerge from the existing empirical works on MFI incentives. McKim and Hughart (2005) suggest that about 72% of all credit officers actually received an incentive scheme, with bonus pay as a percentage of base salaries varying from 0 to 101 per cent (MicroRate). The perception among the MFIs appear to be that such incentive schemes have a positive effect on financial performance, portfolio at risk and staff motivation. This last claim is corroborated by Woller and Schreiner (2003) who, using MicroBanking Bulletin data between 1997 and 1999, find "staff salaries to be significant determinants of financial self-sufficiency."[10]

[10]Godel (2003) also finds that ASA (Bangladesh), BSFL (India), Fundacion Diacomia FRIF (Bolivia), CAME (Mexico), PSHM (Albania), ESA Foundation (Albania), BTTF (Kyrgyzstan), all of who had repayment based bonus schemes (among other incentives), also had good operational and financial self-sufficiency ratio.

McKim and Hughart (2005) claim that such incentive schemes are mostly used in East Europe and Central Asia (91%), followed by Latin America and Carribeans (82%), and Africa (70%).[11] They show that there are several types of incentive schemes which include individual monetary schemes, team or branch based monetary schemes, gain- or profit-sharing schemes and non-monetary schemes. Further, while MFIs in East Europe and Central Asia are most likely to adopt individual monetary schemes, those in South Asia and Africa are more likely to use monetary branch- or team-based schemes. For example, BRI, Indonesia, uses several different incentive schemes including providing the staff a percentage of the relevant unit, and allowing them to keep 2% of total loans that have been written off, but are recovered (see Holtmann, 2002).

A case study of the Azerbaijan-based MFI *CredAgro* in (see McKim and Hughart, 2005, Box 2, pp. 20) shows that the bonus paid to the credit agents is based on four indicators: 40% on portfolio-at-risk (PAR), 25% on average portfolio, 25% on number of loans approved, and the remaining 10% on financial self-sustainability of the branch. In 1997, the SIS in the *Centenary Rural Development Bank* (CERUDEB) of Uganda was made comprehensive by introducing four variables: PAR (60%), processing speed (10%), number of outstanding loans (10%), and number of approved loans (20%). It also had a cap of 45% of base salary (see Okecho and Holtman in Holtmann, 2002).

While these two studies show the SIS having a positive impact, Corposol, Bogota (Steege, 1998) on the other hand provides a salutary example of mishandling of incentives. Started in 1986, it had a portfolio of of nearly 50,000 clients and a loan portfolio of $38 million at its peak in 1995. In a bid to expand, however, Corposol put in place an incentive scheme that provided bonuses based on the volume, rather than the quality of loans. Delinquencies, which were at a around 2.5% initially, increased to 35.7% by 1996, and finally it went bankrupt in 1996.

2.2. Related Literature

We begin by relating our paper to the growing literature on MFI competition that includes, among others, Hoff and Stiglitz (1998); Kranton and Swamy (1999); Van Tassel (2002); Navajas, Conning, and Gonzalez-Vega (2003); McIntosh and Wydick (2005); de Quidt, Fetzer, and Ghatak (2012); Guha and Roy Chowdhury (2013). Both Navajas et al. (2003), and McIntosh and Wydick (2005) analyze the interaction between a client-maximizing incumbent MFI and a profit-oriented entrant. With increased competition, while McIntosh and Wydick (2005) show that poorer borrowers may be screened out, Navajas et al. (2003) find that the profit-oriented MFI may siphon off the more productive borrowers, with negative implications for the less productive borrowers being serviced by the socially motivated MFI. Guha and Roy Chowdhury (2013) examine the effect of competition among motivated MFIs on borrower default in a Salop circular-city framework. de Quidt et al. (2012) show that the welfare effects of the entry of new lenders into the credit market, so that competition increases, is similar to that of the lenders becoming more socially motivated. Finally, Hoff and Stiglitz (1998), 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. All these papers however abstract from organizational issues in microfinance.

The present paper therefore adds to this literature by analyzing the effect of competition on the organizational structures of the MFIs. To the best of our knowledge, the only related papers are Aubert,

[11] The use of such schemes is much less common in Asia (44%) however. In Bangladesh, for example, leading MFIs rely on job security, promotions, and developing a culture that makes them feel part of the MFIs (see McKim and Hughart, 2005).

de Janvry, and Sadoulet (2009), and Bond and Rai (2002) . Aubert et al. (2009) consider a model with a single MFI that uses incentives to motivate a credit agent whose principal task is to gather information on the wealth level and the productivity of the borrowers. They show that a repayment-based incentive scheme, along with random monitoring by the MFI on the group selected by the agent, is optimum. Bond and Rai (2002) analyze a model where the credit agent is able to impose social sanctions on the borrower. They analyze the equilibrium incentive schemes that deter the agent from colluding with the borrower. We extend this nascent literature by developing a framework that allows for MFI competition, in the presence of collusion possibilities and endogenous incentives. Finally, the empirical literature on incentive structures in MFIs is still at the anecdotal stage. Lack of data on incentive schemes for the credit officers appear to be the primary reason behind this.

The issue of multiple lending is related to a broader literature on non-exclusive contracts, (e.g. Kahn and Mookherjee, 1995, 1998), with the central theme that such contracts impose an externality on the other agents. Externality across contractual relationships also arises in the present paper since any changes in the incentives being offered to one agent affects repayment performance, thus impacting the payoffs of the other MFI, and also the other credit agent. The present paper however extends the literature on non-exclusive contracts in several dimensions. First, it allows for a three layered hierarchy, rather than a two layered one. Second, it allows for motivated principals. And finally, it analyzes lending without collaterals.

Finally, there is a recent literature that seeks to analyze over-borrowing from a behavioral perspective (e.g. Fischer and Ghatak, 2010; Basu, 2012). However, while Fischer and Ghatak (2010) analyzes frequent repayment, Basu (2012) focuses on commitment savings. Our focus, however, is on incentive issues in MFIs, and neither on commitment savings, nor on repayments frequency. Further, we consider fully rational agents with incentive problems, so that behavioral aspects are abstracted from.

3. The Baseline Model: A Single MFI

There are three classes of agents in the economy: two microfinance institutions (MFIs) indexed by $i \in \{1, 2\}$, $n \geq 3$ credit agents (or simply agents), and one borrower. All individuals are risk neutral. Further, there is no discounting. To begin with we develop a baseline model with a single active MFI.

The borrower has access to $K+1$ projects indexed by $k \in \{0, 1, \dots, K\}$, with $K \geq 1$, with the identity of the projects being private information of the borrower. Each project requires an initial outlay of \$1 which the indigent borrower requires to borrow from the MFI. Project 0 is a 'good' project with verifiable income $H > 1$, and no non-verifiable income. The remaining projects are all 'bad', with no verifiable income and non-verifiable private benefits of $L \geq 0$ apiece, where $L < H$.[12,13] The borrower can undertake at most one project.

[12]It will soon be clear that for the baseline models in Sections 3 and 4 existence of only one bad project is enough for our purpose.

[13]This is a standard way of modeling the borrower's moral hazard as in Hölmstrom and Tirole (1997). We can think of each project k having verifiable returns $H_k \geq 0$, and non-verifiable private benefits $L_k \geq 0$. Since money is fungible, the borrower can divert the fund invested to private uses. Assume that $H_0 > H_k$ and $L_0 < L_k$ for $k = 1, \dots, K$. Thus from the lenders' point of view P^0 is the best project with the highest verifiable incomes and the lowest non-verifiable private benefits. For simplicity, and without loss of generality we normalize $H_0 = H > 0$, $L_0 = 0$, and $H_k = 0$ and $L_k = L > 0$ for all $k = 1, \dots, K$.

The MFIs are liquidity constrained. There is a donor who has \$1 which can be made available to the MFI, who has no use for this money except for lending to the borrower. With a single active MFI, the \$1 is given to this MFI as aid.[14] The MFI lends this amount to the borrower at a gross interest rate of $r \geq 1$, where r is exogenously given.[15] This is realistic in many contexts, as the MFI sector is mostly regulated. Further, it allows us to focus on the interactions in incentive contracts, abstracting away from the issue of competition over borrowers.

Note that since the borrower does not have any pledgable collateral, all loans are unsecured. In order to focus on the case of interest, we assume that $L > H - r$. This implies that the borrower has an incentive to divert the loan to a bad project. Given that the identity of the project is private information to the borrower, it is therefore imperative to gather information regarding the identity of the project by monitoring the borrower.

The MFI thus hires a credit agent who can, by putting in a monitoring effort of $m \in [0,1]$, uncover the identity of the projects with probability m. In the process the agent incurs a cost of $m^2/2$. Monitoring level, as well as any evidence gathered from monitoring are however both non-verifiable, so that the MFI cannot write a contract contingent on the monitoring level. Given that monitoring is costly, this leads to the second moral hazard problem in our framework, i.e., the agent may shirk. Thus the MFI can only try to incentivize the agent by offering him a share s of the payoff received by it.[16] Further let $r < 2(H - L)$, so that the repayment obligation r is not too large. Otherwise, the borrower will always choose a bad project.

We consider an economy that lasts for three dates: $t = 0, 1, 2$, with the following timeline:

Date $t = 0$:

(a) The MFI offers the agent a repayment-based incentive scheme s, where s is a share of the interest repaid r. Thus the agent receives a gross income of sr in case the loan is repaid, and 0 otherwise.[17]

(b) In case the agent accepts, the MFI offers \$1 to the borrower as a loan, who is supposed to repay a gross amount r if she can (or if the MFI can make her pay). The game then moves to stage 2. In case the agent rejects, the game ends with both the agent and the borrower obtaining their reservation payoffs, normalized to zero each.

Date $t = 1$: The agent exerts an effort of m in monitoring, which can either succeed, or fail.

Date $t = 2$:

(a) If monitoring fails then the borrower invests a bad projects.

[14] Alternatively, this amount can be interpreted as a loan, with the MFI passing on any positive income, net of payments to the agent, to the donor.

[15] In what follows we will analyze the equilibrium organizational structure of the MFIs, i.e., how do they incentivize their credit agents. Therefore, the interest rate has been taken exogenously given for the agency relationship between each MFI and its employee. One can also think of a situation that the MFIs have negotiated r with the borrower prior to hiring the agents. Or, the lending rate r is simply regulated by the government.

[16] To quote, "individual monetary schemes are the most popular type of staff inventive schemes" (McKim and Hughart, 2005).

[17] A more general form of contract may be a linear contract $w + sr$ where w is a fixed salary. Given the limited liability constraint $w \geq 0$ of agent i, it is easy to show that at the optimum $w = 0$.

(b) If monitoring is successful then the agent has two options:
(i) Ensure that the good project is implemented.
(ii) The agent can collude with the borrower. In that case the borrower implements one of the 'bad' projects, and the agent receives a bribe b from the borrower.

Then the project return is realized, and all individuals are paid off.[18]

We then specify the utility function of the individuals. As discussed in the introduction, the MFIs are taken to be "socially motivated" in that they care about the expected income of the borrower. Thus the single active MFI maximizes the wiighted sum of its own payoff, and that of the borrower, with the borrower's utility having a weight of $\theta \in [0,1]$. When $\theta = 0$, the MFI is not motivated at all, and its objective function is indistinguishable from that of a standard profit-maximizing lender. Whereas for $\theta = 0.5$, the MFI cares as much about the borrower's payoff, as it does for its own.

First consider the case where there is no collusion. In that case the borrower invests in the good project and repays r in case monitoring is successful, obtaining a payoff of $H - r$. Thus the agent has a payoff of sr, gross of monitoring costs. In case monitoring fails, the borrower invests in the bad project and obtains L. Neither the MFI, nor the agent obtain any income.

Recalling that all individuals are risk neutral, there is no discounting and that the MFI is "socially motivated", the expected incomes in the event of no collusion of the borrower, the MFI and the agent are respectively given by:

$$\begin{aligned} B(s, m) &:= m(H-r) + (1-m)L = L - m(L-H+r), \\ M(s, m) &:= (1-\theta)[m(1-s)r] + \theta[L - m(L-H+r)], \\ A(s, m) &:= msr - \frac{1}{2}m^2. \end{aligned}$$

Let (IR), (ICM) and (ICH) denote the individual rationality, effort incentive and no-collusion constraint of the credit agent (we shall shortly flesh out these terms). We then define an optimization program, denoted $\mathscr{P}$, for the MFI:

$$\begin{aligned} &\max_{\{s,m\}} \ M(s,m), \\ &\text{subject to} \ \text{(IR), (ICM) and (ICH).} \end{aligned}$$

We are finally in a position to define our notion of equilibrium.

Definition 1 *The pair (s^*, m^*) is said to be a collusion-proof contract if it solves $\mathscr{P}$, i.e., it maximizes the MFI's utility, subject to the constraints that (i) the agent has the option of refusing the contract, (ii) the agent will choose his monitoring level so as to maximize his own income, and (iii) the agent implements the good project in case of successful monitoring.*

[18] Why does the MFI offer the loan amount 1 in the first stage itself? While such a formulation is standard (see Hölmstrom and Tirole, 1997), for completeness we describe a possible scenario where such a formulation makes sense. Suppose the agent needs some seed money for the good project, with the rest of the investment being made later on. The amount required as seed money is however private information of the agent, and can vary from zero to 1. Consequently, not loaning the full amount at date 0 is inefficient.

As is standard, we shall solve for the equilibrium contract using backwards induction. We thus begin with the date 2 subgame.

Date 2:

(a) Clearly, in case monitoring fails, the borrower will invest in a bad project, obtaining L. Neither the MFI, nor the agent obtains any payoff.

(b) Next consider the case where monitoring is successful and the agent colludes with the borrower. We assume that the bribe, call it b^*, solves a generalized Nash bargaining problem between the borrower and the agent (see Roth, 1979). Let β represent the bargaining power of the agent, and (r_0, b_0) denote the threat point, with r_0 and β_0 being the payoffs of the borrower and the agent respectively in case of disagreement. Following Besley and McLaren (1993), we assume that in the event of disagreement the agent reports truthfully to the MFI, and the borrower invests in the good project, so that $(r_0, b_0) = (H - r, sr)$. Thus, the equilibrium bribe

$$b^* = \text{argmax}_b \left\{ (L - b - r_0)^{1-\beta} (b - b_0)^{\beta} \right\} = \beta(L - H + r) + (1 - \beta)sr,$$

and the borrower's expected income in case there is collusion is given by:

$$L - b^* = L - \beta(L - H + r) - (1 - \beta)sr.$$

Date 1: Assuming there is no collusion, the agent selects m so as to maximize $A(s, m)$, so that $m = sr$.

Date 0: The MFI offers a contract that solves the following maximization problem:

$$\max_{\{s,m\}} \quad (1 - \theta)[m(1 - s)r] + \theta[L - m(L - H + r)], \tag{M}$$

$$\text{subject to} \quad msr - \frac{1}{2}m^2 \geq 0, \tag{IR}$$

$$m = \text{argmax}_{\hat{m}} \left\{ \hat{m}sr - \frac{1}{2}\hat{m}^2 \right\} = sr, \tag{ICM}$$

$$sr - \frac{1}{2}m^2 \geq b^* - \frac{1}{2}m^2 = \beta(L - H + r) + (1 - \beta)sr - \frac{1}{2}m^2. \tag{ICH}$$

The first constraint (IR), is the agent's *individual rationality* constraint which ensures that the agent's expected utility from accepting the contract is at least as large as her exogenously given reservation payoff, which is normalized to 0. The second constraint (ICM), captures the moral hazard problem in effort selection that arises because the level of m cannot be contracted upon. The final constraint (ICH) is a no-collusion constraint that ensures that the net income of the agent from implementing the good project is greater than that from collusion.

Notice that the no-collusion constraint simplifies to:

$$sr \geq L - H + r. \tag{ICH}$$

Further it is straightforward to check that (ICM) implies that (IR) never binds. Thus the agent's utility is strictly higher than his reservation payoff. In other words, the agent earns an *efficiency wage* since it is optimal to pay him a strictly positive payoff in order to induce him to exert high monitoring effort.

Finally, substituting $sr = m$ into (M) and (ICH), the maximization problem of the MFI simplifies to:

$$\max_{m} \quad mR_1(\theta, r) - (1-\theta)m^2 + \theta L, \tag{M$'$}$$

$$\text{subject to} \quad m \geq L - H + r, \tag{ICH$'$}$$

where $R_1(\theta, r) := (1-\theta)r - \theta(L-H+r)$. One can interpret $R_1(\theta, r)$ as the effective rate of interest facing the MFI, where $R_1(\theta, r)$ is less than r because the MFI, being socially motivated, internalizes the fact that interest payments reduce borrower utility. In fact for $\theta = 0$, note that $R_1(\theta, r) = r$. Let $R(\theta, r) := R_1(\theta, r)/(1-\theta)$.

Notice that the above objective function is strictly concave in m, and the constraint function is linear in m, and hence a unique solution in m exists. Moreover, (ICM) implies a unique relation between s and m, and therefore, the equilibrium s is unique. Denote by (s^*, m^*) the unique equilibrium values of share and monitoring effort.

Definition 2 We shall say that *collusive threats are large* if, at the equilibrium contract, the constraint (ICH$'$) binds, i.e., $m^* = L - H + r$. Otherwise we say that *collusive threats are small*.

The following proposition characterizes the equilibrium contract.

Proposition 1 *There exists a unique threshold value of motivation $\tilde{\theta}_1 \in (0, 1)$ such that collusive threats are large if and only if $\theta \geq \tilde{\theta}_1$.*

(a) *In case collusive threats are small, i.e., $\theta < \tilde{\theta}_1$, the equilibrium monitoring effort and incentives are given by:*

$$m^* = m^*(\theta, r) := \frac{1}{2}R(\theta, r) \quad \textit{and} \quad s^* = s^*(\theta, r) := \frac{1}{2r}R(\theta, r).$$

(b) *For $\theta \geq \tilde{\theta}_1$ so that collusive threats are large, the equilibrium monitoring effort and incentives are given by:*

$$m^* = m^*(r) := L - H + r \quad \textit{and} \quad s^* = s^*(r) := 1 - \frac{H-L}{r}.$$

Observe that when θ is large, the MFI cares relatively less about repayment, so that incentives are not very high-powered. This makes collusion relatively more attractive for the agent, and (ICH) binds. The equilibrium monitoring effort and share are determined either by the first order condition of the unconstrained maximization problem of the MFI for $\theta < \tilde{\theta}_1$ (the interior solution), or by $m^*(r) = s^*(r)r = L - H + r$ for $\theta \geq \tilde{\theta}_1$ (the corner solution). The cut-off value $\tilde{\theta}_1$ is given by:

$$s^*(\tilde{\theta}_1, r) = s^*(r) \iff \frac{1}{2}R(\tilde{\theta}_1, r) = L - H + r.$$

Note that the cut-off value $\tilde{\theta}_1$ decreases with r, i.e., the likelihood of collusion is increasing in r. The following proposition summarizes the comparative statics results for this case.

Proposition 2

(a) *In case $\theta < \tilde{\theta}_1$, so that collusive threats are small, both the equilibrium monitoring effort of the agent, as well as the equilibrium incentives, are decreasing in the motivation level θ. When collusive threats are large, i.e., $\theta \geq \tilde{\theta}_1$, both the equilibrium monitoring effort and incentives remain unaffected by any changes in θ.*

(b) *The equilibrium incentives are non-monotone in r. In particular, incentives are strictly decreasing in r if collusive threats are small, i.e., $\theta < \tilde{\theta}_1$. Incentives are increasing in r otherwise.*

(c) *The equilibrium monitoring effort is non-monotone in r. If $\theta \leq 1/2$, then the equilibrium monitoring effort is strictly increasing in r. For $\theta > 1/2$, on the other hand, the equilibrium monitoring effort is strictly decreasing (increasing) in r if $\theta < (\geq)\, \tilde{\theta}_1$.*

In Proposition 2(a), note that an increase in the level of motivation θ means that the MFI cares relatively less about repayment, and hence provides less high powered incentives. As a consequence, the equilibrium monitoring effort decreases.

Proposition 2(b), while less obvious, is also intuitive. For $\theta < \tilde{\theta}_1$, the agent has little incentive to collude (Proposition 1). Thus the only issue is to induce higher monitoring. Since the agent is interested in his payoff in case of success, i.e., sr, an increase in r implies that s can be reduced. Whereas for $\theta \geq \tilde{\theta}_1$, the central issue is to prevent collusion. With an increase in r, the net surplus from collusion $L - H + r$ increases. This necessitates an increase in s, so as to make collusion less attractive.

Finally consider Proposition 2(c). When the level of motivation of the MFI is low ($\theta < 1/2$), the MFI cares relatively more about repayment. Thus the MFI incentivizes the agent by offering a large s. Thus collusion is not attractive, and the agent only cares about income from non-collusion, i.e., sr. Thus monitoring level of the agent is increasing in r. If, on the other hand, the level of motivation is high, i.e., $\theta \geq \max\{1/2, \tilde{\theta}_1\}$, the MFI cares less about repayment, and s is low. Thus the collusive threats are large, and hence it is beneficial for the agent to exert greater monitoring effort with an increase in r. This is because an increase in monitoring efforts increases the probability of success, consequently increasing the agent's expected revenue from collusion, and in equilibrium there is no collusion.

Note that Proposition 2(c) has some interesting policy implications. Given that the rate of interest that the MFIs can charge is sometimes regulated,[19] it may be of interest to ask what happens if such interests are lowered. Interestingly, Proposition 2(c) suggests that the answer depends on whether the MFIs are motivated or not. Thus, for example, if there are reasons to believe that significant mission drift has taken place, so that θ is small, a lowering of r will have adverse consequences for monitoring, and hence for repayment.

4. Competition among the MFIs

In this section we analyze the case with two active MFIs, $i \in \{1, 2\}$, both having identical levels of motivation θ. Without loss of generality let MFI i be matched with agent i, $i = 1, 2$.

In order to focus on the effects of competition alone, we abstract from situations in which increase in the number of MFIs, in many cases, may be accompanied by an increase in the aggregate availability of credit in the economy.[20] Hence, we assume that each MFI receives \$0.50 from a single donor, lends

[19] In India, for example, the Malegam Committee Report (Malegam, 2011) stipulated a 26% limit on the interest rate MFIs can charge from the borrowers. The draft Indian Microfinance Institutions (Development and Regulation) Bill 2011 retains the Malegam committee recommendation regarding having the interest rate caps.

[20] Roodman (2012) in fact argues that it is such an increase in the availability of credit which was the root cause of the crisis in the microfinance sector in 2008-09, rather than just competition alone. For the sake of completeness, we however briefly consider the case where both MFIs can access \$1 each, later in the paper.

this amount to the borrower, and receives $r/2$ in case the borrower repays.

Turning to the monitoring technology under competition, let $\pi(m_1, m_2)$ denote the probability that at least one agent is successful in detecting the project identity. We assume that if at least one agent succeeds, then this agent can ensure that the good project is implemented (if he wants to). Hence, we call $\pi(m_1, m_2)$ the probability of success.

Further, given that both the monitoring level, as well as any evidence gathered from monitoring is unobservable, the payoff of an agent can only be conditioned on whether repayment occurs or not. In this sense, our approach has some elements of the *moral hazard in teams* issue analyzed in Hölmstrom (1982) where the owner of a firm observes only the production of a joint output that depends on the vector of individual efforts. As a consequence, salaries cannot be made contingent on individual performances.

In our benchmark model we analyze the case where the monitoring efforts m_1 and m_2 are perfect substitutes in determining the probability of success so that $\pi_{12} = -1$. For simplicity, we consider the following probability of success function:[21]

$$\pi(m_1, m_2) = 1 - (1 - m_1)(1 - m_2) = m_1 + m_2 - m_1 m_2. \tag{1}$$

We then describe the time-line of this game with two active MFIs:

Date $t = 0$:

(a) The two MFIs simultaneously offer contracts to their own agents, with MFI i offering a repayment based incentive of s_i to agent i. In case agent i accepts, the i-th MFI extends a loan of 0.5 to the borrower, who is expected to repay $r/2$ if she can.

(b) In case both agents accept, the borrower obtains a loan of \$1 in the aggregate, and the game goes to the next period. Otherwise, the game ends immediately, with the borrower refusing any loan offer from MFI i, in case the other MFI does not offer a loan either.[22]

Date $t = 1$: The agents simultaneously decide on their monitoring levels, m_1 and m_2.

Date $t = 2$: There are three possible outcomes:

(a) Neither MFI succeeds: Then the borrower implements one of the bad projects.

(b) Only one agent succeeds: Then this agent, say agent i, can either implement the good project, or collude with the borrower. In case of collusion the borrower implements one of the bad projects, obtaining L and the agent i receives a bribe b_i from the borrower.

(c) Both succeed: (i) In case either one, or both the agents behave honestly, the good project is implemented. (ii) In case both the agents collude, the borrower implements one of the bad projects, and agent i obtains a bribe of b_i for $i = 1, 2$.

The project return is realized, and all agents are paid.

[21] In Subsection 6.3 later, we will analyze a more general form of the monitoring technology.

[22] This can be formalized by assuming that in the event the borrower does take the loan, the agent will get to know with probability one, and will compel the borrower to return the amount in any case. For simplicity we refrain from modeling this formally.

We further require some additional notations. Let the expected payoffs of MFI i and agent i, $M_i(s_i, m_i, m_j)$ and $A_i(s_i, m_i, m_j)$ respectively, in the event of no collusion be:

$$\begin{aligned}
M_i(s_i, m_i, m_j) &:= (1-\theta)\left[\frac{1}{2}\pi(m_i, m_j)(1-s_i)r\right] + \theta[L - \pi(m_i, m_j)(L-H+r)] \\
&= \pi(m_i, m_j)\left[R_2(\theta, r) - (1-\theta)\frac{1}{2}s_i r\right] + \theta L, \\
A_i(s_i, m_i, m_j) &:= \frac{1}{2}\pi(m_i, m_j)s_i r - \frac{1}{2}m_i^2, \;\; i, j = 1, 2, \;\; i \neq j,
\end{aligned}$$

where

$$R_2(\theta, r) = \frac{1}{2}(1-\theta)r - \theta(L-H+r),$$

is the effective rate of interest facing MFI i, allowing for the MFIs being motivated. Note that when $\theta = 0$, an MFI's gross income from repayment is $R_2(0, r) = r/2$.

4.1. Equilibrium under competition

As before, we analyze the collusion-free contracts where neither agent colludes even if they are successful in their monitoring. Let (IR$_i$), (ICM$_i$) and (ICH$_i$) denote the individual rationality, effort incentive and no-collusion constraint of agent i under the assumption that agent j does not collude with the borrower even when agent j is successful (we shall shortly put content into these terms). We then define an maximization program, denoted $\mathscr{P}_i$, for MFI i:

$$\begin{aligned}
&\max_{\{s_i, m_i\}} \;\; M_i(s_i, m_i, m_j), \\
&\text{subject to} \;\; (\text{ICH}_i), (\text{ICM}_i) \text{ and } (\text{IR}_i).
\end{aligned}$$

We are finally in a position to define our notion of equilibrium.

Definition 3 A vector $(s_1^{**}, m_1^{**}, s_2^{**}, m_2^{**})$ of incentives and monitoring efforts constitutes a *collusion-free equilibrium in contracts* if and only if (s_i^{**}, m_i^{**}) solves $\mathscr{P}_i$ subject to MFI j choosing (s_j^{**}, m_j^{**}), $i, j = 1, 2$, $i \neq j$.

Notice that the no collusion constraint adopted here, i.e., (ICH$_i$) takes it that agent j will also not collude in case he is successful in monitoring. Thus the notion of equilibrium states that given the monitoring level by the other agent, and the fact that he will not collude even if successful, the choice of s_i maximizes the i-th MFI's expected utility taking into account the effort incentive, the individual rationality and the no collusion constraint.

We then turn to the task of fleshing out the constraints (IR$_i$), (ICM$_i$) and (ICH$_i$). We again resort to backwards induction, starting by analyzing the last date.

Date 2: Consider the case where agent i has been successful in monitoring. In order to derive the constraint under which agent i will not collude, we first solve for the equilibrium bribe to agent i in the event of collusion:

2(b) *Agent j has failed:* Consider the equilibrium level of bribe, call it b_i^*, in case the agent decides to collude with the borrower. As before, let b_i^* be the solution of a generalized Nash bargaining problem between the borrower and the agent, where β represents the bargaining power of the agent, and (r_0, b_0) denote the threat points of the borrower and the agent respectively. Following the earlier logic, we assume that in the event of disagreement the agent reports truthfully to the MFI, and the borrower invests in the good project, so that $(r_0, b_0) = (H - r, s_i r/2)$. Thus, the equilibrium bribe is given by:

$$b_i^* = \text{argmax}_{b_i} \left\{ (L - b_i - r_0)^{1-\beta} (b_i - b_0)^{\beta} \right\} = \beta(L - H + r) + (1-\beta)\frac{1}{2} s_i r.$$

2(c)(i) *Agent j has succeeded and decided not to collude:* In this case agent j will report truthfully in any case, when the good project will be implemented. Thus there will be no collusion between agent i and the borrower as well.

2(c)(ii) *Agent j has succeeded and decided to collude:* In that case we assume that the bargaining power of the borrower is $1-\beta$, and that of each agent is $\beta/2$ each. Clearly, the threat point is $(H - r, s_1 r/2, s_2 r/2)$. Thus the tripartite Nash bargaining solution involves

$$\max_{b_1, b_2} \left\{ (L - H + r - b_1 - b_2)^{1-\beta} \left(b_1 - \frac{s_1 r}{2} \right)^{\beta/2} \left(b_2 - \frac{s_2 r}{2} \right)^{\beta/2} \right\}.$$

Thus the equilibrium bribe is given by:

$$b_i^* = \frac{1}{2} \left(\beta(L - H + r) + (2-\beta)\frac{s_i r}{2} - \beta \frac{s_j r}{2} \right) \quad \text{for } i, j = 1, 2 \text{ and } i \neq j.$$

Date 1: We next consider the effort incentive constraint of agent i, i.e., (ICM$_i$), in the event the stage 2 game does not involve any collusion. The equilibrium monitoring level involves:

$$m_i = \text{argmax}_{\hat{m}_i} \left\{ \frac{1}{2} \pi(\hat{m}_i, m_j) s_i r - \frac{1}{2} \hat{m}_i^2 \right\} = \frac{1}{2}(1 - m_j) s_i r. \tag{ICM$_i$}$$

Date 0: We then write down the individual rationally, and the no-collusion constraints that MFI i must respect. The individual rationality constraint of agent i is given by:

$$\frac{1}{2} \pi(m_i, m_j) s_i r - \frac{1}{2} m_i^2 \geq 0. \tag{IR$_i$}$$

In a situation where agent j does not collude, agent i has no incentive to collude himself if and only if

$$\frac{1}{2} s_i r - \frac{1}{2} m_i^2 \geq (1 - m_j) \left[\beta(L - H + r) + (1-\beta)\frac{1}{2} s_i r \right] + m_j \frac{1}{2} s_i r - \frac{1}{2} m_i^2,$$

which simplifies to

$$\frac{1}{2} s_i r \geq L - H + r. \tag{ICH$_i$}$$

The following proposition characterizes the collusion free equilibrium in contracts. We need some more notations. Define $\rho(\theta, r)$ such that $(1-\theta)\rho(\theta, r) = R_2(\theta, r)$. Further define

$$m^{**}(\theta, r) := \frac{3 + 2\rho(\theta, r) - \sqrt{9 + 4\rho(\theta, r)}}{2[2 + \rho(\theta, r)]},$$
$$\frac{1}{2} s^{**}(\theta, r) r := \frac{m^{**}(\theta, r)}{1 - m^{**}(\theta, r)}.$$

Finally, denote the symmetric equilibrium monitoring efforts by m^{**} and the incentives by s^{**}.

Proposition 3

(a) *A unique symmetric collusion-free equilibrium in contracts exists.*

(b) *There exists a unique threshold value of motivation* $\tilde{\theta}_2 \in [0, 1)$ *such that collusive threats are large, i.e.,* (ICH_i) *binds, if and only if* $\theta \geq \tilde{\theta}_2$.

(c) *For* $\theta < \tilde{\theta}_2$*, the equilibrium monitoring effort and incentives are given by:*

$$m^{**} = m^{**}(\theta, r) \quad \textit{and} \quad s^{**} = s^{**}(\theta, r).$$

(d) *Whereas for* $\theta \geq \tilde{\theta}_2$*, we have*

$$m^{**} = m^{**}(r) := \frac{L-H+r}{1+(L-H+r)} \quad \textit{and} \quad s^{**} = s^{**}(r) := 2\left(1 - \frac{H-L}{r}\right).$$

Given that the MFIs and the agents are identical, the no-collusion constraints will either both be binding, or both be non-binding. Let $\tilde{\theta}_2$ be the value of θ at which (ICH$_i$) for each agent $i = 1, 2$ binds at the the optimum, which is given by:

$$s^{**}(\tilde{\theta}_2, r) = s^{**}(r).$$

When the level of motivation of the MFIs is very low, i.e., $\theta < \tilde{\theta}_2$, the MFIs provide very strong incentives so as to ensure that the agents exert high monitoring efforts. Given that the agents' income from not colluding is large, the agents will have no incentive to collude. Therefore we obtain an interior equilibrium given by the first order condition of the maximization problem $\mathscr{P}_i$. Under the interior optimum, an increase in θ of the MFIs means that they care relatively less about the repayment, and hence provide less powerful incentives. Consequently, the equilibrium monitoring effort decreases. Whereas when $\theta \geq \tilde{\theta}_2$, the no-collusion constraint binds at the optimum. Therefore, the equilibrium effort and incentives do not depend on θ.

Remark In the spirit of dominant strategy equilibria, one can consider a notion of equilibrium where both the agents report truthfully irrespective of whether the other agent colludes or not. We argue that the equilibrium described in Proposition 3 above satisfies this stricter criterion as well. Recall that the payoff of agent i from colluding, when agent j does not collude, is given by $s_i r/2$, whereas agent i's payoff when the other agent also colludes, is given by:

$$\frac{1}{2}\left(\beta(L-H+r) + (2-\beta)\frac{s_i r}{2} - \beta\frac{s_j r}{2}\right).$$

Note that

$$\frac{s_i r}{2} \geq \frac{1}{2}\left(\beta(L-H+r) + (2-\beta)\frac{s_i r}{2} - \beta\frac{s_j r}{2}\right) \iff \frac{s_i r}{2} + \frac{s_j r}{2} \geq L-H+r,$$

which is satisfied given (ICH$_i$) and (ICH$_j$). Thus, agent i's payoff from colluding is higher in case the other agent does not collude. Consequently, if agent i prefers not to collude when agent j is not colluding, he will prefer not to collude even if the other agent is colluding.

4.2. Comparative statics

We first analyze the effects of changes in θ, i.e., the common level of motivation of both the MFIs. The motivation for this exercise comes from the fact that it has sometimes been argued that increased MFI competition had led to/been accompanied by mission drift (e.g. de Quidt et al., 2012), that is the MFIs becoming more profit-oriented.[23] Clearly, in our framework, such mission drift can be formalized

[23]Mohammad Yunus in particular has been severely critical of this perceived mission drift (e.g. Roodman, 2012).

as a reduction in the motivation level of either one, or both the MFIs.

The following proposition shows that results analogous to Proposition 2 also go through in this case. The intuition is also similar. Define $\tilde{r}_2$, with $H-L < \tilde{r}_2 < 2(H-L)$, as solving $s^{**}(\theta, \tilde{r}_2) = s^{**}(\tilde{r}_2)$. It is easy to show that $\tilde{r}_2$ is well defined, and that collusive threats are small (large), i.e., $\theta < (\geq)\, \tilde{\theta}_2$ if and only if $r < (\geq)\, \tilde{r}_2$.

Proposition 4

(a) *If $\theta < \tilde{\theta}_2$, then with an increase θ (both MFIs becoming more motivated), the equilibrium monitoring effort of the agent decreases, and the incentives get less high powered. On the other hand, for $\theta \geq \tilde{\theta}_2$ both the monitoring effort and incentives remain unaffected by any changes in θ.*

(b) *The equilibrium incentives are non-monotone in r. In particular, incentives are strictly decreasing in r if and only if collusive threats are small, i.e., $\theta < \tilde{\theta}_2$ (equivalently $r < \tilde{r}_2$).*

(c) *The equilibrium monitoring effort is non-monotone in r. If $\theta \leq 1/3$, then the equilibrium monitoring effort is strictly increasing in r. For $\theta > 1/3$, on the other hand, the equilibrium effort is strictly decreasing in r if and only if collusive threats are small, i.e., $\theta < \tilde{\theta}_2$ (equivalently $r < \tilde{r}_2$).*

Next, we analyze the effects of asymmetric changes in the level of motivation, say in θ_1. As we argue later, this is of interest for analyzing the market outcome when a moneylender competes with a motivated MFI.

Proposition 5 *Suppose that $\theta_1 = \theta_2 = \theta$ initially, and the parameter values are such that $\rho(\theta, r) < \rho^* \approx 0.6$. Then following an increase in θ_1, the level of motivation of MFI 1:*

(a) *For MFI 1, the monitoring effort m_1^{**} decreases and the incentive s_1^{**} increases relative to their symmetric equilibrium values.*

(b) *For MFI 2, the monitoring effort m_2^{**} increases and the incentive s_2^{**} decreases relative to their symmetric equilibrium values.*

(c) *In equilibrium MFI 1 offers stronger incentives, but induces lower monitoring compared to MFI 2, i.e., $s_1^{**} > s_2^{**}$, but $m_1^{**} < m_2^{**}$.*

The intuition follows from the fact that given s_1 and s_2, the monitoring efforts of agents are strategic substitutes.[24] The first order effect of an increase in θ_1 is that MFI 1 would prefer to induce a decline in m_1. Since efforts are strategic substitutes, this would lead agent 2 to increase his effort. As m_1 decreases in the new equilibrium, MFI 1 must provide stronger incentives to her agent, so that s_1 increases. On the other hand, MFI 2 does not require to provide very strong incentives, and hence s_2 decreases.[25]

What implications can we draw regarding the effects of mission drift from the analysis? Leaving aside the question of whether competition actually causes mission drift or not (being beyond the scope of

[24]In Appendix B we analyze in details under what conditions the best reply functions are downward/upward sloping, and discuss their implications for such comparative static results.

[25]Notice that the slope of the best reply function in effort of agent 1 at the symmetric equilibrium $m_1^{**} = m_2^{**} = m^{**} = m^{**}(\theta, r)$, is given by:

$$-\frac{2(1-m^{**})^2}{1+\rho(1-m^{**})^2}.$$

Stability of the Nash equilibrium in effort choice requires that the above expression is less than -1 which is equivalent to $\rho(\theta, r) < \rho^* \approx 0.6$. If $\rho(\theta, r) > \rho^*$, the equilibrium is unstable, i.e., the best reply function of agent 2 intersects that of agent 1 from above. In this case, following an increase in θ_1, the equilibrium m_1 and s_2 increase, and m_2 and s_1 decrease.

this paper), let us just examine the effect of mission drift, if any. In the present framework, such mission drift can be formalized as a decrease in the motivation level. First, suppose that mission drift occurs across the board, so that both MFIs become less motivated. Proposition 4(a) suggests that if, the MFIs are not too motivated to begin with, then mission drift would in fact improve monitoring, and hence repayment performance. In case however there is a decline in the motivation level of one of the MFI alone, then Proposition 5 suggests that while the monitoring level of that MFI increases, that of the other MFI in fact decreases. In that case the impact on repayment rates is ambiguous.

Finally, Propositions 4 and 5 have interesting implications vis-à-vis one canonical case often studied in the literature, namely competition between an MFI and a profit-maximizing moneylender. Let MFI 2 be a traditional moneylender with $\theta_2 = 0$, whereas suppose MFI 1 is a motivated lender, with $\theta_1 > 0$. Proposition 5(c) then implies that the credit market equilibrium will be characterized by the moneylender inducing higher monitoring effort, and offering weaker incentives.

5. Effects of competition

We now compare the market equilibrium under a single active MFI with that under competition, i.e., with two active MFIs. In particular, we analyze the following three questions. First, whether competition leads to an increase in the likelihood of collusion among the agents and the borrower. The second is whether competition induces more high powered incentives. Third, whether default is more likely under competition.

5.1. Effects of competition on incentives

We show that the incentive to collude increases under competition. However, whether incentives become more or less high powered with competition is ambiguous, with incentives becoming more high powered if the MFIs are very motivated.

Proposition 6 *Suppose the number of active MFI(s) increases from one to two. Then,*

(a) *competition exacerbates the incentives of the agents to collude with the borrower, i.e., $\tilde{\theta}_2 < \tilde{\theta}_1$.*
(b) *There exists a unique $\theta^* \in (\tilde{\theta}_2, \tilde{\theta}_1)$ such that incentives under competition are more high-powered if $\theta > \theta^*$.*

Proposition 6(a) follows since the payoff from no-collusion under a single MFI, i.e., *sr*, is higher compared to that with two MFIs, i.e., $sr/2$. Thus, an agent has a smaller incentive to collude under a single MFI. Next consider Proposition 6(b). This arises because of an interplay between two factors. On the one hand, the free-riding problem in monitoring implies that the marginal benefit to any MFI from providing incentives to its own agent is relatively smaller under competition, thus tending to reduce incentives for the agents. With competition, on the other hand, the agents have a greater incentive to collude, since the utility of the borrower becomes relatively more important in the agent's objective function. Mitigating this issue requires offering stronger incentives. As we know, collusive threats increase with an increase in motivation. Thus, when motivation levels are high, the second effect dominates, so that incentives are weaker under competition. For low levels of motivation, the first effect dominates, and incentives become more high powered under competition.

The above results are depicted in Figure 1. In the figure, we have $\tilde{\theta}_2 < \tilde{\theta}_1$, i.e., competition exacerbates the incentives for each agent to collude with the borrower.

[Insert Figure 1 about here]

The interior solution of incentive under the single MFI is given by the downward sloping line $rs^*(\theta, r)$, whereas under competition this is given by the downward sloping curve $rs^{**}(\theta, r)$. On the other hand, the corner solution of s under single MFI is given by $rs^*(r) = L - H + r$, whereas the corner solution of s under competition is given by $rs^{**}(r) = 2(L - H + r)$. Since $rs^{**}(r) > rs^*(r)$, the cut-off θ^* is unique.

5.2. Effects of competition on monitoring and default

We show that competition among the MFIs increases the probability of default whenever either the moral hazard problem is severe, and/or the MFIs are not too motivated to begin with. Recall that under competition, the probability of default is given by $1 - \pi^{**}$, where

$$\pi^{**} := \pi(m^{**}, m^{**}).$$

Whereas the probability of default with a single active MFI is given by $1 - m^*$.

Proposition 7

(a) *The individual monitoring effort under competition is lower than that under a single MFI.*

(b) *There exists $\bar{y} > 0$ and a unique $\theta^{**} \in (\tilde{\theta}_2, \tilde{\theta}_1)$, such that the probability of default is higher under competition whenever either the moral hazard problem is severe, i.e., $L - H + r > \bar{y}$, or when the moral hazard problem is not very severe, but the MFIs are not too motivated, i.e., $L - H + r < \bar{y}$ and $\theta < \theta^{**}$. Otherwise, competition lowers the probability of default.*

Part (a) of the preceding proposition follows from the free-riding problem intrinsic to monitoring since the probability of success jointly depends on the individual monitoring efforts. This in turn leads to the next part of the proposition, showing that for a large class of parameter values, this effect is enough to outweigh the fact that under competition there are more agents exerting monitoring effort.

To begin with, consider the case where the moral hazard problem is severe, i.e., $L - H + r \geq \bar{y}$. Since, in the event of collusion, the equilibrium level of bribe of an agent is an increasing function of the net surplus from collusion, i.e., $L - H + r$, the fact that $L - H + r$ is large implies that the no-collusion constraint is binding in both cases. Hence, in case of success, an agent obtains the same gross payoff under both scenarios, i.e., $L - H + r$. Given that the gross incentives are the same under both cases, with an increase in $L - H + r$, the monitoring level increases at a slower rate under MFI competition because of the free-riding in monitoring. Thus for $L - H + r$ large, individual monitoring levels are significantly lower under competition. Whereas, if the MFIs are not too motivated, then as discussed earlier, credit agents are provided significantly lower incentives under competition (see the discussion following Proposition 6). In both cases, the lower level of individual monitoring therefore outweighs the fact that now two agents are monitoring, rather than a single one.

However, the result is reversed whenever the moral hazard problem is not too large, and the MFIs are quite motivated. Given that the moral hazard problem is not too serious, agents have less of an incentive to under-monitor in any case. This, along with the fact that the MFIs are motivated, makes collusion the central problem in this case. Hence, the free-riding problem, though present, is not critical. Thus the fact that there are two agents who are monitoring, is sufficient to outweigh the negative effect on monitoring because of free-riding.

Interestingly, this result shows that whenever the moral hazard problem is relatively severe and/or the MFIs are not too motivated, default increases with competition, thus providing a possible explanation for the recent episodes of crisis in the MFI sector, e.g. in Andhra Pradesh, India. Further, it also identifies scenarios under which increased competition need not affect repayment performance. This suggests a possible reason as to why some countries with high degrees of MFI competition, most notably Bangladesh, seem to have largely avoided such crisis. Finally, Proposition 7 suggests competition is likely to have negative implications for repayment performance if the MFIs are not very motivated. This observation allows us to link this result to the debate on mission-drift, suggesting that competition is more likely to lead to increased defaults in case mission-drift has already occurred.

Remark A similar result holds for the expected incomes of the borrower, which, under the single MFI and under competition are respectively given by:

$$B^* = L - m^*(H - L + r),$$
$$B^{**} = L - \pi^{**}(H - L + r).$$

Therefore, we have

Corollary 1 *There exists $\bar{y} > 0$ such that the welfare of the borrower is higher under competition whenever the moral hazard problem is severe, i.e., $L - H + r > \bar{y}$. When, on the other hand, the moral hazard problem is not severe, i.e., $L - H + r \leq \bar{y}$, then there is a unique $\theta^{**} \in (\tilde{\theta}_2, \tilde{\theta}_1)$ such that the welfare of the borrower is higher (lower) under competition if $\theta < (\geq)\, \theta^{**}$.*

Notice that higher probability of default, higher is the expected income for the borrower. Therefore, the above result follows directly from Proposition 7(b).

6. Discussions

At this juncture, we briefly comment on some modeling issues adopted in the present paper.

6.1. MFI competition being accompanied by increased loan funding

We now allow for the possibility that competition may be contemporaneous with the MFIs having greater access to credit, with a consequent worsening of lending discipline. Roodman (2012) in fact argues that it is such increased access to funds, rather than increased competition *per se*, that may have triggered some of the recent episodes of microfinance crisis worldwide.

Suppose that the increase in MFI competition is accompanied by increased donor funds, so that each MFI can lend \$1 instead of \$0.50. In this case the borrower will be able to undertake 2 projects. Since only one good project is available, out of the two projects chosen, one will surely be a bad project. The role of monitoring is then to ensure that the other project chosen is the good one. If the good project is implemented, then the borrower will have a net income of $H+L-2r$, assuming $H > 2r$.[26] Otherwise the borrower will undertake two bad projects, obtaining $2L$.

Consider the case where agent i is successful in monitoring and colluding, while agent j will not collude even if successful. Then, from Nash bargaining, the equilibrium bribe received by agent i in this case is given by:

$$b_i^* = \beta(L-H+2r)+\beta s_i r, \quad \text{for} \quad i = 1, 2.$$

Using this expression, and mimicking our earlier argument, the no-collusion constraint of agent i in this case is $s_i r \geq L-H+2r$.

Interestingly, comparing the (ICH$_i$) constraints across the two cases, we find an increase in aggregate donor funding makes collusion even more attractive since the gross surplus from collusion is now higher at $2L$, compared to L earlier. While, under the present framework, collusion can never happen in equilibrium, this suggests a possible channel as to how an increase in loan funds can weaken borrowing discipline, namely through increased collusion among the agents and the borrowers. This corroborates the argument in Roodman (2012).

6.2. *The bargaining protocol*

Consider the bargaining protocol in case there is collusion between the borrower and an agent. We have taken the threat point to be $(r_0, b_0) = (H-r, sr)$ which can be interpreted as the payoffs the two agents obtain in case bargaining fails, but they continue to remain engaged with the production process. In this we follow the approach taken in Besley and McLaren (1993).

In applications of Nash bargaining, the threat point is sometimes identified with the 'outside option' instead, which is the payoff of the players in case they walk out of the production process altogether.[27] Assuming that in that case the agent and the borrower just receive their reservation payoffs, the threat point becomes $(0, 0)$. The Nash bargaining problem for the single MFI case is therefore given by:

$$\max_b \left\{ (L-b)^{1-\beta} b^{\beta} \right\},$$

which yields $b^* = \beta L$. In case of two MFIs, the equilibrium bribe to agent i (in case the other agent does not collude even if successful), is given by $b_i^* = \beta L$. While this specification of the bargaining protocol quantitatively modifies the no-collusion constraints, all the results remain qualitatively unchanged.[28]

6.3. *Incentive schemes when monitoring efforts are not perfect substitutes*

Next turning to the probability success function $\pi(m_1, m_2)$, the analysis so far focuses on the case where the individual monitoring efforts m_1 and m_2 are perfect substitutes, i.e., $\pi_{12}(m_1, m_2) = -1$. Let us generalize by assuming a probability of success function that satisfies $\pi_{12}(m_1, m_2) \neq 0$ apart from some natural properties (discussed in Appendix B).

[26] Our analysis does not change qualitatively if one assumes $H < 2r$. In this case, each MFI receives $H/2$ in the case when the good project is implemented, and the borrower obtains L.

[27] See Binmore, Rubinstein, and Wolinsky (1986) for an elaborative discussion on this issue. Formally of course our framework does not allow either the agents or the borrower to walk out once they accept the contracts.

[28] The proofs are available on request.

Our analysis suggests that most of the results, in particular Propositions 1 and 3 go through qualitatively under some additional technical conditions, suggesting that the analysis is robust to the specific functional form adopted for the probability success function.

Interestingly however, some new properties emerge depending on whether the probability of success function $\pi(m_1, m_2)$ is submodular, i.e., $\pi_{12} < 0$, or log-supermodular, i.e., $\pi\pi_{12} - \pi_1\pi_2 > 0$ in the individual monitoring efforts (m_1, m_2). Whenever $\pi(m_1, m_2)$ is submodular, i.e., m_1 and m_2 are substitutes in determining the probability of success, the equilibrium monitoring efforts of the two agents and the incentives offered by the MFIs turn out to be strategic substitutes. This is to say, when one agent increases his effort, the other finds it beneficial to reduce it. Moreover, if one MFI provides stronger incentives to its agent, the other weaken the incentives. With log-supermodularity, however, the equilibrium monitoring efforts and incentives are strategic complements.

There is a negative level effect due to the free-riding problem in monitoring. On the other hand, there is a marginal effect which can be positive or negative depending on the sign of π_{12}. The free-riding problem in effort choice arises because $\pi(m_1, m_2)$ defined to be the probability of success of detecting the project identity, and hence if one agent is successful this undermines the incentives for the other agent to exert higher effort. If the probability of success is submodular in (m_1, m_2), then the marginal effect of an increase in the monitoring effort exerted by one agent is dampened if the other agent increases his monitoring. In other words, the marginal effect is also negative. Consequently, the best reply functions of monitoring efforts are downward-sloping, i.e., monitoring efforts are strategic substitutes.

Note that the probability of success function in Section 4 is a special case of a submodular probability of success function. On the other hand, if the probability of success is supermodular in (m_1, m_2), i.e., $\pi_{12} \geq 0$, the marginal effect is positive since if one agent increases his monitoring effort it has a favorable impact on the marginal effect of an additional unit of effort exerted by the other agent on the probability of success. Thus, depending on the extents of these two countervailing effects the equilibrium monitoring effort of one agent may increase or decrease with that of the other. It turns out that simple complementarity, i.e., $\pi_{12} \geq 0$ alone is not sufficient to offset the negative effect generated by the free-riding problem in order to induce strategic complementarity between m_1 and m_2, and hence we require that the complementarity must be strong enough. Log-supermodularity of $\pi(m_1, m_2)$, which in turn implies supermodularity, guarantees that the best reply functions are upward sloping, i.e., monitoring efforts are strategic complements. The incentive compatibility constraints imply that the equilibrium incentives, i.e., the shares of the agents, change in the same direction as the monitoring efforts as a consequence of competition. Therefore, s_1 and s_2 are strategic substitutes (complements) whenever the monitoring efforts are strategic substitutes (complements).

Strategic complementarity between the equilibrium efforts has interesting implications for Proposition 5, i.e., the effect of an increase in the level of motivation of MFI 1. In contrast to Proposition 5, in this case both the equilibrium monitoring by agent 2 may decrease, whereas the incentives offered by MFI 2 may increase. The intuition follows from the fact that the best reply functions in efforts are now positively sloped. With an increase in θ_1, MFI 1 cares more about the welfare of the borrower, and hence reduces incentives, which in turn lowers monitoring effort of agent 1. Since under log-supermodularity the monitoring efforts are strategic complements, agent 2 also decreases his effort level. Thus, MFI 2 may have to offer stronger incentives to its agent.

7. Conclusion

This paper has been motivated by several recent episodes of crises in the microfinance sector all over the world. We argue that the contemporaneous increase in MFI competition can provide a natural explanation for such problems, with the incentive implications of such increased competition providing the channel through which competition affects repayment performance.

To this end we develop a three tiered principal agent framework of competition among motivated MFIs. We then use this framework to analyze how MFI competition affects incentive structure, and consequently repayment rates, demonstrating that under a large class of parameter values default increases with competition. We find that it is likely whenever either the moral hazard problem is severe, and/or the MFIs are not too motivated. Interestingly, MFI competition is more likely to have deleterious effects on repayment if the MFI sector was already suffering from mission drift.

Further, our analysis has interesting implications for several issues that are being debated in the literature. In line with Roodman (2012) we find, for example, that repayment problems may worsen in case competition implies greater access to donor funds. This result has interesting policy implications in the Indian context, given that some commentators have suggested providing subsidized funds to the MFIs (e.g. Malegam, 2011). Also, the analysis allows us to throw some light on the effect of mission drift under competition (e.g. de Quidt et al., 2012).

Appendix A: Proofs

Proof of Proposition 1

The MFI solves the following maximization problem:

$$\max_{\{s,m\}} \quad M(s,m) := m(1-s)r + \theta[L - m(L-H+r)], \tag{M}$$

$$\text{subject to} \quad A(s,m) := msr - \frac{1}{2}m^2 \geq 0, \tag{IR}$$

$$m = \text{argmax}_{\hat{m}} \left\{ \hat{m}sr - \frac{1}{2}\hat{m}^2 \right\} = sr, \tag{ICM}$$

$$sr \geq L - H + r. \tag{ICH}$$

Substituting $sr = m$ into the expected profits of the MFI and agent we get

$$M(m) = mR(\theta, r) - m^2 + \theta L,$$
$$A(m) = \frac{1}{2}m^2.$$

Given that $m \geq 0$, $A(m) \geq 0$, i.e., the individual rationality constraint (IR) of the agent is always satisfied, and hence can be ignored. Therefore, the above maximization problem reduces to:

$$\max_{m} \quad mR(\theta, r) - m^2 + \theta L, \tag{M}$$

$$\text{subject to} \quad m \geq L - H + r, \tag{ICH}$$

where $R(\theta, r) := r - \theta(L - H + r)$ is the effective revenue of the MFI. Notice that R is less than r because the MFI is willing to forego a part of the repayment because $\theta > 0$. When $\theta = 0$, we have $R = r$, and the MFI behaves like a standard profit maximizing money lender.

Consider first the case when the constraint (ICH) does not bind at the optimum. The first order condition implies that

$$m = sr = \frac{1}{2}R(\theta, r) = \frac{1}{2}[r - \theta(L - H + r)].$$

The first equality holds because $m = sr$ from the effort incentive constraint. For $m \geq 0$, we require $R(\theta, r) \geq 0$ for all θ and r, i.e.,

$$\theta \leq \frac{r}{L - H + r} \equiv \theta_1^{max}.$$

When (ICH) binds, the equilibrium effort and share are given by:

$$m = sr = L - H + r.$$

Define $\tilde{\theta}_1$ such that

$$\frac{1}{2}R(\tilde{\theta}_1; r) = L - H + r. \tag{2}$$

We now show that $\tilde{\theta}_1$ exists and is unique. Notice that

$$\frac{1}{2}R(0; r) - (L - H + r) = \frac{r}{2} - (L - H + r) > 0$$

because $r < 2(H - L)$. On the other hand,

$$\frac{1}{2}R(\theta_1^{max}; r) - (L - H + r) = 0 - (L - H + r) < 0.$$

Since $R_\theta(\theta, r) = -(L - H + r) < 0$, the function $R(\theta, r)$ is a strictly decreasing in θ on $[0, \theta_1^{max}]$. Then by the Intermediate Value Theorem there exists a unique $\tilde{\theta}_1 \in (0, \theta_1^{max})$ that solves (2). This completes the proof of the proposition. ■

Proof of Proposition 2

To prove part (a) of the proposition, first consider the case when $\theta < \tilde{\theta}_1$. In this case, the equilibrium monitoring effort is given by:

$$m^*(\theta, r) = \frac{1}{2}R(\theta, r). \tag{3}$$

Differentiating the above expression with respect to θ we get

$$\frac{\partial m^*}{\partial \theta}(\theta, r) = -\frac{L - H + r}{2(1 - \theta)^2} < 0,$$

and hence the equilibrium effort is strictly decreasing in θ. The equilibrium incentives in this case are given by:

$$s^*(\theta, r) = \frac{m^*(\theta, r)}{r} \quad \Longrightarrow \quad \frac{\partial s^*}{\partial \theta}(\theta, r) = \frac{1}{r}\frac{\partial m^*}{\partial \theta}(\theta, r) < 0. \tag{4}$$

Therefore, the equilibrium incentives are also decreasing in θ. Next, consider the case when $\theta \geq \tilde{\theta}_1$. In this case, the equilibrium monitoring effort and incentives are given by:

$$m^*(r) = L - H + r,$$
$$s^*(r) = 1 - \frac{H-L}{r}.$$

The above two expressions are independent of θ, and hence remain unaffected by any changes in θ. This completes the proof of Proposition 2(a).

When $\theta < \tilde{\theta}_1$, the equilibrium incentives are given by $s^{**}(\theta, r)$, and hence

$$\frac{\partial s^*}{\partial r}(\theta, r) = -\frac{\theta(H-L)}{2r^2(1-\theta)} < 0.$$

On the other hand, the equilibrium incentives are given by $s^*(r)$ for $\theta \geq \tilde{\theta}_1$, which implies

$$\frac{ds^*}{dr}(r) = \frac{H-L}{r^2} > 0.$$

The above proves part (b) of the proposition.

Finally, to prove part (c), consider first the case when $\theta < \tilde{\theta}_1$. In this case the equilibrium monitoring effort is given by $m^*(\theta, r)$. Therefore,

$$\frac{\partial m^*}{\partial r}(\theta, r) = \frac{1-2\theta}{2(1-\theta)} \gtrless 0 \quad \text{as} \quad \theta \lessgtr \frac{1}{2}.$$

On the other hand, the equilibrium effort is given by the corner solution $m^*(r)$ for $r \geq \tilde{r}_1$, which implies

$$\frac{dm^*}{dr}(r) = 1 > 0.$$

This completes the proof of the proposition. ■

Proof of Proposition 3

The effort incentive constraint of agent i defines $s_i(m_i, m_j)$, which can be substituted into the expression $A_i(s_i, m_i)$, the expected payoff of agent i, to yield

$$A_i(m_i, m_j) := A_i(s_i(m_i, m_j), m_i) = \frac{m_i m_j}{1-m_j} + \frac{1}{2}m_i^2.$$

The above expression is always positive since $m_i, m_j \in [0, 1]$. Therefore, the individual rationality constraint of agent i can be ignored. Substituting $s_i(m_i, m_j)$ into the objective function of the MFI we get

$$M_i(m_i, m_j) := M_i(s_i(m_i, m_j), m_i) = \pi(m_i, m_j)\left[R_2(\theta, r) - (1-\theta)\frac{m_i}{1-m_j}\right] + \theta L.$$

Therefore, the above maximization problem reduces to:

$$\max_{m_i} \ \pi(m_i, m_j)\left[R_2(\theta, r) - (1-\theta)\frac{m_i}{1-m_j}\right] + \theta L, \tag{M_i'}$$
$$\text{subject to} \quad \frac{m_i}{1-m_j} \geq L - H + r. \tag{ICH_i}$$

We first analyze the equilibrium contracts, and then prove the existence of the unique cut-off value $\tilde{\theta}_2$ of θ. Notice that the constraints (ICH$_1$) and (ICH$_2$) will either bind simultaneously or will not since the MFIs and the agents are identical. First consider the case when these constraints bind. Then each MFI i will solve the unconstrained maximization problem, whose first order conditions are given by:

$$\begin{aligned} & R_2(\theta, r)(1-m_j) - \left(\frac{1-\theta}{1-m_j}\right)[m_i(1-m_j)+\pi(m_i, m_j)] = 0 \\ \iff & \rho(\theta, r)(1-m_j)^2 = 2m_i - 2m_im_j + m_j. \end{aligned} \tag{BR$_i$}$$

Recall that $(1-\theta)\rho(\theta, r) := R_2(\theta, r)$. The symmetric equilibrium effort levels $m_1^{**} = m_2^{**} = m^{**}$ is thus determined from the above first order condition, which is given by:

$$\begin{aligned} & \rho(\theta, r)(1-m^{**})^2 = m^{**}(3-2m^{**}) \\ \implies & m^{**} = m^{**}(\theta, r) := G(\rho(\theta, r)) = \frac{3+2\rho(\theta, r)-\sqrt{9+4\rho(\theta, r)}}{2[2+\rho(\theta, r)]}. \end{aligned} \tag{E}$$

The above confirms the existence of a symmetric solution in monitoring efforts. To show the uniqueness, notice that (BR$_i$) defines the best-reply functions in effort $b_i(m_j)$ of agent i. Further,

$$\left.\frac{dm_j}{dm_i}\right|_{b_i(m_j)} = -\frac{2(1-m_j)^2}{1+\rho(\theta, r)(1-m_j)^2} < 0 \quad \text{for } i, j = 1, 2 \quad \text{and} \quad i \neq j.$$

Since the best-reply functions are strictly downward sloping for $m_1, m_2 \in [0, 1]$, the symmetric solution is the unique solution. The interior solutions of the equilibrium incentives, which are also symmetric, are determined from the effort incentive constraints, which are given by:

$$\frac{1}{2}s^{**}(\theta, r)r = \frac{m^{**}(\theta, r)}{1-m^{**}(\theta, r)} := f(\theta, r) = F(\rho(\theta, r)) = \frac{3+2\rho(\theta, r)-\sqrt{9+4\rho(\theta, r)}}{1+\sqrt{9+4\rho(\theta, r)}}.$$

Next, consider the corner solutions of the equilibrium monitoring effort and incentives when the constraints (ICH$_1$) and (ICH$_2$) bind at the optimum, which are given by:

$$\begin{aligned} \frac{1}{2}s^{**}(r)r &= L-H+r, \\ m^{**}(r) &= \frac{L-H+r}{1+(L-H+r)}. \end{aligned}$$

The cut-off $\tilde{\theta}_2$ for collusion is defined by:

$$\frac{1}{2}s^{**}(\tilde{\theta}_2, r)r = f(\tilde{\theta}_2, r) = L-H+r.$$

For the existence and uniqueness of the above cut-off we require to show that the function $f(\theta, r)$ intersects the line $L-H+r$ only once. It is easy to show that $f(\theta, r)$ is strictly decreasing in θ on $[0, 1]$. Obviously, the strict monotonicity of $f(\theta, r)$ with respect to θ does not guarantee an intersection with the line $L-H+r$. Notice that for the interior solution $m^{**}(\theta, r)$ of equilibrium monitoring effort to be positive, we require that $\rho(\theta, r) \geq 0$ which is equivalent to

$$\theta \leq \frac{r}{3r-2(H-L)} \equiv \theta_2^{max}.$$

Clearly, $\theta_2^{max} \le 1$ given that $r \ge H - L$. Also, $\rho(\theta_2^{max}, r) = 0$ which implies that $F(\rho(\theta_2^{max}, r)) = 0$. Therefore,

$$f(\theta_2^{max}, r) - (L - H + r) = F(\rho(\theta_2^{max}, r)) - (L - H + r) = 0 - (L - H + r) < 0.$$

On the other hand, $\rho(0, r) = r/2$, and hence

$$f(0, r) = F(\rho(0, r)) = F(r/2) = \frac{3 + r - \sqrt{9 + 2r}}{1 + \sqrt{9 + 2r}}.$$

The above may or may not be greater than $L - H + r$. If $f(0, r) - (L - H + r) > 0$, then it follows from the Intermediate Value Theorem that the cut-off $\tilde{\theta}_2$ is unique since $f_\theta(\theta, r) < 0$, and lies strictly between 0 and 1. If $f(0, r) - (L - H + r) \le 0$, then the graph of $f(\theta, r)$ lies below the line $L - H + r$ for all values of θ, i.e., an agent never has incentives to report truthfully, and hence the cut-off is given by $\tilde{\theta}_2 = 0$. This completes the proof of the proposition. ■

Proof of Proposition 4

We only provide a sketch of the proof since it is very similar to that of Proposition 2. The interior solutions $m^{**}(\theta, r)$ and $s^{**}(\theta, r)$ can easily shown to be strictly decreasing in θ. The corner solutions $m^{**}(r)$ and $s^{**}(r)$ do not depend on θ, and hence are unaffected by any changes in θ. For part (b), notice that the equilibrium incentives are given by:

$$s^{**} = \begin{cases} s^{**}(\theta, r) & \text{if } r < \tilde{r}_2, \\ s^{**}(r) & \text{if } r \ge \tilde{r}_2. \end{cases}$$

It is easy to show that $s^{**}(\theta, r)$ is strictly decreasing in r, whereas the corner solution $s^{**}(r)$ is strictly increasing in r. This proves part (b). Finally, when $\theta < (\ge)\, 1/3$, $m^{**}(\theta, r)$ is strictly increasing (decreasing) in r, while the corner solution $m^{**}(r)$ is always strictly increasing in r. This completes the proof of part (c). ■

Proof of Proposition 5

We prove parts (a) and (b) together. First we show that m_1 decreases and m_2 increases in the new equilibrium resulting from an increase in θ_1. The resulting equilibrium in effort choice will clearly be asymmetric since only the best reply function in monitoring effort of agent 1 shifts. Let $\rho_i := \rho(\theta_i, r)$ for $i = 1, 2$. Then the first order conditions for the interior optima in m_1 and m_2, providing the best reply functions of agents 1 and 2 respectively, are given by:

$$\rho_1(1 - m_2)^2 - m_1(1 - m_2) = m_1 + m_2 - m_1 m_2,$$
$$\rho_2(1 - m_1)^2 - m_2(1 - m_1) = m_1 + m_2 - m_1 m_2.$$

Further, let $b_i(m_j)$ denote the best reply function in effort of agent i with

$$b_i'(m_j) = -\frac{1 + \rho_i(1 - m_j)^2}{2(1 - m_j)^2}.$$

Local stability of the equilibrium requires that $\Delta_m := 1 - b_1'(m_2)b_1'(m_1) > 0$ around the symmetric equilibrium $m_1^{**} = m_2^{**} = m^{**}(\theta, r)$ with $\rho_1 = \rho_2 = \rho(\theta, r)$. Thus, a sufficient condition for stability is

$$\begin{aligned} & 1 - \frac{1 + \rho(\theta, r)[1 - m^{**}(\theta, r)]^2}{2[1 - m^{**}(\theta, r)]^2} > 0 \\ \iff & 4[m^{**}(\theta, r)]^2 - 7m^{**}(\theta, r) + 1 > 0 \\ \iff & m^{**}(\theta, r) < \bar{m} \approx 0.16 \iff \rho(\theta, r) < \rho^* \approx 0.6. \end{aligned}$$

Now, differentiating the above two first order conditions with respect to ρ_1 we get

$$\frac{dm_1}{d\rho_1} = \frac{1 - m_2}{2\Delta_m}, \quad \frac{dm_2}{d\rho_1} = \frac{(1 - m_2)b_2'(m_1)}{2\Delta_m}.$$

Since

$$\frac{d\rho_i}{d\theta_i} = -\frac{L - H + r}{(1 - \theta_i)^2} < 0,$$

from the above it follows that

$$\begin{aligned} \frac{dm_1}{d\theta_1} &= -\frac{1 - m_2}{2\Delta_m} \cdot \frac{L - H + r}{(1 - \theta_1)^2} < 0, \\ \frac{dm_2}{d\theta_1} &= -\frac{(1 - m_2)b_2'(m_1)}{2\Delta_m} \cdot \frac{L - H + r}{(1 - \theta_1)^2} = b_2'(m_1) \cdot \frac{dm_1}{d\theta_1} > 0, \end{aligned}$$

since $b_2'(m_1) < 0$. Hence the result follows.

Next, we show that s_1 increases and s_2 decreases following an increase in θ_1. Recall the effort incentive constraint of agent $i = 1, 2$ which is given by:

$$\frac{1}{2}s_i r = \frac{m_i}{1 - m_j}.$$

The above equations define implicitly $m_i = m_i(s_i, s_j)$ with

$$\frac{\partial m_i}{\partial s_i} = \frac{r(1 - m_j)}{2}, \quad \text{and} \quad \frac{\partial m_j}{\partial s_i} = \frac{1 - m_j}{s_i} \quad \text{for } i, j = 1, 2 \quad \text{and} \quad i \neq j.$$

Therefore,

$$dm_i = \frac{r(1 - m_j)}{2} \cdot ds_i + \frac{1 - m_i}{s_j} \cdot ds_j \quad \text{for } i, j = 1, 2.$$

Now, using the expressions of $dm_1/d\theta_1$ and $dm_2/d\theta_1$ we get

$$\frac{ds_1}{d\theta_1} = \frac{\Delta_1}{\Delta_s}, \quad \text{and} \quad \frac{ds_2}{d\theta_1} = \frac{\Delta_2}{\Delta_s},$$

where

$$\begin{aligned} \Delta_1 &:= (1 - m_1)\left[\frac{r}{2} - \frac{b_2'(m_2)}{s_2}\right]\frac{dm_1}{d\theta_1}, \\ \Delta_2 &:= (1 - m_2)\left[\frac{rb_2'(m_1)}{2} - \frac{1}{s_1}\right]\frac{dm_1}{d\theta_1}, \\ \Delta_s &:= -\frac{r^2(1 - m_1)(1 - m_2)(1 - m_1 - m_2)}{4m_1 m_2}. \end{aligned}$$

Since $dm_1/d\theta_1 < 0$ and $b_2'(m_1)$<0, we have $\Delta_1 < 0$ and $\Delta_2 > 0$. Further, it is easy to show that $m^{**}(\theta, r) < 0.25$, and hence in a neighborhood of $m^{**}(\theta, r)$ we have $1 - m_1 - m_2$, and thus $\Delta_s < 0$. The above relations then imply $ds_1/d\theta_1 > 0$ and $ds_2/d\theta_1 < 0$. The proof of part (c) trivially follows from (a) and (b). ■

Proof of Proposition 6

Recall the definitions of $\tilde{\theta}_1$ and $\tilde{\theta}_2$:

$$\frac{1}{2}R(\tilde{\theta}_1, r) = L - H + r,$$
$$f(\tilde{\theta}_2, r) = L - H + r.$$

We first show that $(1/2)R(\theta, r) > 2f(\theta, r)$ for all θ and r. Notice that

$$\frac{1}{2}R(\theta, r) = \rho(\theta, r) + \frac{\theta}{2(1-\theta)}(L - H + r) > \rho(\theta, r).$$

Also,

$$\begin{aligned}
&\rho(\theta, r) - 2f(\theta, r) \\
&= \rho(\theta, r) - \frac{2[3 + 2\rho(\theta, r) - \sqrt{9 + 4\rho(\theta, r)}]}{1 + \sqrt{9 + 4\rho(\theta, r)}} \\
&= \frac{(2 + \rho(\theta, r))[\sqrt{9 + 4\rho(\theta, r)} - 3]}{1 + \sqrt{9 + 4\rho(\theta, r)}} \geq 0, \quad \text{since } \sqrt{9 + 4\rho(\theta, r)} \geq 3.
\end{aligned}$$

Therefore,

$$\frac{1}{2}R(\theta, r) > \rho(\theta, r) \geq 2f(\theta, r) > f(\theta, r). \tag{5}$$

Now suppose on the contrary that $\tilde{\theta}_1 \leq \tilde{\theta}_2$. Since $f(\theta, r)$ is strictly decreasing in θ, we must have

$$f(\tilde{\theta}_1, r) > f(\tilde{\theta}_2, r) = L - H + r = \frac{1}{2}R(\tilde{\theta}_1, r).$$

The above contradicts the fact that $(1/2)R(\theta, r) > f(\theta, r)$ for all θ. This completes the proof of part (a) of the proposition.

To prove part (b), define $\Delta s(\theta, r) := s^*r - s^{**}r$. Recall that

$$s^*r = \max\left\{\frac{1}{2}R(\theta, r), L - H + r\right\},$$
$$s^{**}r = \max\{2f(\theta, r), 2(L - H + r)\}.$$

Notice that

$$s^*r = \frac{1}{2}R(\theta, r) > 2f(\theta, r) = s^{**}r \quad \text{for } \theta < \tilde{\theta}_2,$$
$$s^*r = L - H + r < 2(L - H + r) = s^{**}r \quad \text{for } \theta \geq \tilde{\theta}_1,$$

Now consider the values of θ in $[\tilde{\theta}_2, \tilde{\theta}_1]$. Since in this interval we have $s^*r = (1/2)R(\theta, r)$ and $s^{**}r = 2(L-H+r)$, $\Delta s(\theta, r)$ is strictly decreasing and continuous on $[\tilde{\theta}_2, \tilde{\theta}_1]$. Moreover,

$$\Delta s(\tilde{\theta}_2, r) = \frac{1}{2}R(\tilde{\theta}_2, r) - 2(L-H+r) = \frac{1}{2}R(\tilde{\theta}_2, r) - 2f(\tilde{\theta}_2, r) > 0,$$
$$\Delta s(\tilde{\theta}_1, r) = \frac{1}{2}R(\tilde{\theta}_1, r) - 2(L-H+r) = (L-H+r) - 2(L-H+r) < 0.$$

Therefore, the Intermediate Value Theorem and monotonicity of $\Delta s(\theta, r)$ together imply that there exists a unique $\theta^* \in (\tilde{\theta}_2, \tilde{\theta}_1)$ such that $\Delta s(\theta^*; r) = 0$, i.e., $s^* = s^*$ at $\theta = \theta^*$. This completes the proof of the proposition. ■

Proof of Proposition 7

To prove part (a), recall that $m^*(\theta, r) > \rho(\theta, r)$ by (5). Since

$$\rho(\theta, r) - m^{**}(\theta, r) = \frac{2\rho(\theta, r)(2+\rho(\theta, r)) + \left(\sqrt{9+4\rho(\theta, r)} - 3\right)}{2(2+\rho(\theta, r))} \geq 0,$$

we have $m^*(\theta, r) > m^{**}(\theta, r)$. On the other hand, we have

$$m^*(r) = L-H+r > \frac{L-H+r}{1+(L-H+r)} = m^{**}(r).$$

Therefore,

$$m^* = \max\{m^*(\theta, r), m^*(r)\} > \max\{m^{**}(\theta, r), m^{**}(r)\} = m^{**}.$$

Now we prove part (b) of the proposition. The probability of success under competition is given by:

$$\pi^{**} := \pi(m^{**}, m^{**}) = m^{**}(2 - m^{**}),$$

whereas, that under the single MFI is given by m^*.

Consider first the interior solution of π^{**} which is given by:

$$\pi^{**}(\theta, r) = m^{**}(\theta, r)[2 - m^{**}(\theta, r)],$$

which is strictly decreasing in θ since $d\pi^{**}/dm^{**} = 2(1-m^{**}) > 0$ and $dm^{**}/d\theta < 0$.

Next, we show that $\rho(\theta, r) \geq \pi^{**}(\theta, r)$ because

$$\rho(\theta, r) \geq \left[\frac{3+2\rho(\theta, r) - \sqrt{9+4\rho(\theta, r)}}{2[2+\rho(\theta, r)]}\right]\left[2 - \frac{3+2\rho(\theta, r) - \sqrt{9+4\rho(\theta, r)}}{2[2+\rho(\theta, r)]}\right]$$
$$\iff 4\rho(\theta, r)[1+3\rho(\theta, r)+\rho^2(\theta, r)] + 2\sqrt{9+\rho(\theta, r)} \geq 6.$$

The above holds because $2\sqrt{9+\rho(\theta, r)} \geq 6$ for all $\rho(\theta, r) \geq 0$. Therefore,

$$m^*(\theta, r) > \rho(\theta, r) \geq \pi^{**}(\theta, r) \quad \text{for all} \quad \theta.$$

Next, consider the corner solutions for the probabilities of success under the single MFI and competition, which are respectively given by:

$$m^*(r) = L - H + r,$$
$$\pi^{**}(r) = \frac{(L-H+r)[2+(L-H+r)]}{[1+(L-H+r)]^2}.$$

If $L - H + r > \bar{y} \approx 0.6$, then clearly $m^*(r) > \pi^{**}(r)$. Therefore, $m^* > \pi^{**}$ for all θ. In other words, the probability of default is always higher under competition. If $L - H + r < \bar{y}$, then $m^*(r) < \pi^{**}(r)$. On the other hand, $m^*(\theta, r) > \pi^{**}(\theta, r)$. Thus, following the same logic as Proposition 6(c), we show that there exists a unique $\theta^{**} \in (\tilde{\theta}_2, \tilde{\theta}_1)$ such that if $\theta \lesseqgtr \theta^{**}$ implies $m^* \gtreqless \pi^{**}$. This completes the proof of the proposition. ■

Appendix B: Incentive schemes when monitoring efforts are not perfect substitutes

We have so far analyzed the equilibrium incentives for the credit agents assuming that the monitoring efforts are perfect substitutes in determining the probability of success. In this section we generalize the model presented in the previous section by assume an arbitrary probability of success function $\pi(m_1, m_2)$. We assume that (i) $\pi(m_1, 0) \geq 0$ and $\pi(0, m_2) \geq 0$; (ii) $\pi_i(m_i, m_j) > 0$ for $i, j = 1, 2$ and $i \neq j$; and (iii) $\pi_{ii}(m_i, m_j) = 0$ and $\pi_{ij}(m_i, m_j) \neq 0$ for $i, j = 1, 2$ and $i \neq j$. Noitice that assumption (iii) implies for a given value of m_j that the probability of success $\pi(m_i, m_j)$ is linear in m_i, which is without loss of generality. Further, π_i depends only on m_j. We further assume that the probability of success function and all its partial derivatives are symmetric in (m_i, m_j) so that no agent ex ante has greater ability than the other. Our objective in this section is to add the minimum set of assumptions on the probability of success function used in the previous section in order to generate interesting predictions regarding the strategic effects of incentives under competition.

Under these modifications, the effort incentive constraint of agent i becomes

$$\frac{1}{2} s_i r = \frac{m_i}{\pi_i(m_i, m_j)}. \tag{ICM$'_i$}$$

On the other hand, the constraint for no-collusion reduces to:

$$\frac{1}{2} s_i r = \frac{m_i}{\pi_i(m_i, m_j)} \geq L - H + r. \tag{ICH$''_i$}$$

As in the previous section, it is easy to show that under binding limited liability, the individual rationality constraint of each agent i will bind. Therefore using the effort incentive constraint, the maximization problem of MFI i reduces to:

$$\max_{m_i} \quad \pi(m_i, m_j) R_2(\theta, r) - (1-\theta)\frac{m_i \pi(m_i, m_j)}{\pi_i(m_i, m_j)} + \theta L, \tag{M$'_i$}$$

$$\text{subject to} \quad \frac{m_i}{\pi_i(m_i, m_j)} \geq L - H + r, \tag{ICH$''_i$}$$

The equilibrium incentives s_i and s_j are solved from the respective effort incentive constraints.

7.1. Strategic effects of contracts

We analyze the strategic effects of the incentive contracts offered to the credit agents by the the MFIs. In particular, we analyze whether monitoring efforts and incentives are strategic substitutes or complements. As in Proposition 3, it is easy to argue that there is a unique symmetric equilibrium monitoring efforts and incentives. Moreover, there exists a unique θ^{π} such that (ICH$_i''$) binds (does not bind) at the optimum for agent $i = 1, 2$ if $\theta < (\geq)\, \theta^{\pi}$. The first order conditions of the above maximization problem are given by:

$$\rho \pi_i^2(m_i, m_j) = m_i \pi_i(m_i, m_j) + \pi(m_i, m_j) \quad \text{if} \quad \theta < \theta^{\pi}, \tag{6}$$

$$m_i = \pi_i(m_i, m_j)(L - H + r) \quad \text{if} \quad \theta \geq \theta^{\pi}, \tag{7}$$

for $i, j = 1, 2$ and $i \neq j$, and $\rho := \rho(\theta, r)$. Now consider $\theta < \theta^{\pi}$, i.e., (ICH$_i''$) does not bind for both agents. Then differentiating the first order condition (6) we get

$$b_i'(m_j) := \frac{dm_i}{dm_j} = \frac{1}{2}\left[\rho \pi_{ij} + \frac{\pi \pi_{ij} - \pi_i \pi_j}{\pi_i^2}\right] \quad \text{for } i, j = 1, 2 \quad \text{and } i \neq j, \tag{8}$$

Notice that if $\pi(m_1, m_2)$ is submodular in (m_1, m_2), i.e., $\pi_{ij} \leq 0$, then the above expression is negative. In other words, the best reply functions of agents 1 and 2 are downward-sloping. If $\pi(m_1, m_2)$ is log-supermodular in (m_1, m_2) [$\log \pi(m_1, m_2)$ is supermodular in (m_1, m_2)], i.e., $\pi \pi_{ij} - \pi_i \pi_j \geq 0$, then $\pi_{ij} \geq 0$, and hence $b_1'(m_2), b_2'(m_1) \geq 0$, i.e., m_1 and m_2 are strategic complements.

Next, consider $\theta \geq \theta^{\pi}$, i.e., (ICH$_i''$) binds for both agents. Then differentiating the first order condition (7) we get

$$b_i'(m_j) := \frac{dm_i}{dm_j} = \pi_{ij}(m_i, m_j)(L - H + r) \quad \text{for } i, j = 1, 2 \quad \text{and } i \neq j, \tag{9}$$

The above expression is positive (negative) as $\pi_{ij} \geq (\leq) 0$. Since $\pi \pi_{ij} - \pi_i \pi_j \geq 0$ implies $\pi_{ij} \geq 0$, $\pi(m_1, m_2)$ being submodular (log-supermodular) in (m_1, m_2) is a sufficient condition for m_1 and m_2 are strategic substitutes (complements).

Now consider the effort incentive constraint of agent $i = 1, 2$:

$$\frac{1}{2} s_i r \pi_i(m_i, m_j) = m_i$$

which defines the implicit functions $m_i(s_i, s_j)$ for $i, j = 1, 2$ and $i \neq j$. Differentiating the above we get

$$\frac{\partial m_i}{\partial s_i} = \frac{1}{2} r \pi_i, \qquad \frac{\partial m_i}{\partial s_j} = -\frac{\pi_j}{s_j \pi_{ij}} \quad \text{for} \quad i, j = 1, 2 \quad \text{and} \quad i \neq j.$$

When $\theta \geq \theta^{\pi}$, the equilibrium incentives are given by:

$$\rho \pi_i^2(m_i(s_i, s_j), m_j(s_i, s_j)) = m_i(s_i, s_j) \pi_i(m_i(s_i, s_j), m_j(s_i, s_j)) + \pi(m_i(s_i, s_j), m_j(s_i, s_j)).$$

Tedious calculations, using the above partial derivatives, show that

$$\frac{ds_i}{ds_j} = \frac{\frac{\pi_j}{s_j \pi_{ij}} + \frac{1}{2} r \pi_j b_i'(m_j)}{\frac{1}{2} r \pi_i + \frac{\pi_i b_i'(m_j)}{s_i \pi_{ij}}}.$$

Notice that the denominator of the above expression is always positive since $\pi_{ij} \le 0$ implies $b_i'(m_j) \le 0$, and $\pi\pi_{ij} - \pi_i\pi_j \ge 0$ implies $\pi_{ij} \ge 0$ and $b_i'(m_j) \ge 0$. When $\pi_{ij} \le 0$, we have $b_i'(m_j) \le 0$, and hence the numerator of the above expression is negative. Therefore, s_i and s_j are strategic substitutes. On the other hand, when $\pi\pi_{ij} - \pi_i\pi_j \ge 0$, we have $\pi_{ij} \ge 0$ and $b_i'(m_j) \ge 0$, and hence the numerator of the above expression is positive. Therefore, s_i and s_j are strategic complements. Finally, consider the case when $\theta \ge \theta^\pi$, i.e., (ICH$_i''$) does not bind for both agents. In this case the equilibrium incentives s_i and s_j are determined by

$$\frac{1}{2}s_i r = \frac{1}{2}s_j r = L - H + r. \tag{10}$$

Clearly, the equilibrium incentives offered by each MFI is constant, and does not depend that of the other MFI. Therefore, in this case we have $ds_i/ds_j = 0$. The above findings are summarized in the following lemma.

Lemma 1 *Let m_i and s_i for $i = 1, 2$ respectively be the equilibrium monitoring effort chosen by agent i and the equilibrium incentives offered by MFI i to agent i. Then a sufficient condition for the equilibrium monitoring efforts and incentives to be strategic substitutes (complements) is that the probability of success function $\pi(m_1, m_2)$ is submodular (log-supermodular) in (m_1, m_2).*

Notice that $\pi(m_1, m_2) = m_1 + m_2 - m_1m_2$ is a special case of the general probability of success function discussed in this section. Therefore, we must be able to generalize Proposition 6(a)-(c) under the probability of success function $\pi(m_1, m_2)$ that satisfies the assumptions we have made at the beginning of this section with the restriction that $\pi_{12}(m_1, m_2) < 0$. Notice that $\pi(m_1, m_2)$ can in general be represented as the following:

$$\pi(m_1, m_2) = \pi(0, m_2) + \alpha(m_2)m_1, \quad \text{or} \quad \pi(m_1, 0) + \alpha(m_1)m_2,$$

since $\pi_{ii} = 0$, i.e., π_i depends only on m_j, and the partial derivatives are symmetric. Further, $\pi_{ij} < 0$ implies that both $\alpha'(m_j) < 0$ and $\alpha'(m_i) < 0$. We have also assumed that $\pi_i \le 1$ for $i = 1, 2$ which implies $\alpha(m_j) \le 1$ for $j = 1, 2$. Now consider the first order condition at the symmetric interior equilibrium effort level $m_1 = m_2 = m := m(2)$, which is given by:

$$\rho(\theta, r)[\alpha(m)]^2 = m\alpha(m) + \pi(m, m) \iff m = \rho(\theta, r)\alpha(m) - \frac{\pi(m, m)}{\alpha(m)}.$$

Recall that the equilibrium effort under the single MFI is given by:

$$m(1) = \frac{1}{2}R(\theta, r) > \rho(\theta, r).$$

Since $\rho(\theta, r) \ge \rho(\theta, r)\alpha(m) > \rho(\theta, r)\alpha(m) - \pi(m, m)/\alpha(m) = m(2)$, we prove that $m(1) > m(2)$. The second inequality holds since $\alpha(m) \le 1$. The symmetric equilibrium shares $s := s(2)$ must satisfy the effort incentive constraint, i.e.,

$$\frac{1}{2}sr = \frac{m}{\alpha(m)} \equiv f(\theta, r). \tag{11}$$

Recall that

$$\frac{1}{2}R(\tilde{\theta}_1; r) = L - H + r,$$
$$f(\theta^\pi; r) = L - H + r.$$

We first show that $f(\theta, r)$ is decreasing in θ. From the first order condition, it is easy to show that $dm/d\theta < 0$. Therefor,

$$f_\theta(\theta, r) = \frac{\alpha(m) - m\alpha'(m)}{[\alpha(m)]^2}\frac{dm}{d\theta} < 0$$

since $\alpha'(m) < 0$. Next, we show that $(1/2)\rho(\theta, r) \geq f(\theta, r)$, which is equivalent to

$$\frac{1}{2}\rho(\theta, r) \geq \frac{m}{\alpha(m)} \iff \frac{1}{2}\left[\frac{m}{\alpha(m)} + \frac{\pi(m, m)}{[\alpha(m)]^2}\right] \geq \frac{m}{\alpha(m)} \iff \frac{\pi(m, m)}{m} \geq \alpha(m).$$

The above always holds since

$$\frac{\pi(m_1, m_2)}{m_1} = \frac{\pi(0, m_2)}{m_1} + \alpha(m_2) \geq \alpha(m_2).$$

From the above it follows that $\rho(\theta, r) > f(\theta, r)$ which implies $\tilde{\theta}_1 > \theta^\pi$. Also, $\rho(\theta, r) \geq 2f(\theta, r)$ implies that $s^*(1) > s^*(2)$ where $s^*(n)$ is the interior solution of $s(n)$ for $n = 1, 2$. On the other hand, $L - H + r = \bar{s}(1)r < \bar{s}(2)r = 2(L - H + r)$ where $\bar{s}(n)$ is the corner solution of $s(n)$ for $n = 1, 2$. Thus, following the same logic as in Proposition 6 we can conclude that there is a unique $\theta^* \in (\theta^\pi, \tilde{\theta}_1)$ such that $s(1) \gtreqless s(2)$ if $\theta \lesseqgtr \theta^*$. The above findings are summarized in the following proposition.

Proposition 8 *Suppose the number of active MFI(s) increases from one to two. Further, suppose the probability of success function $\pi(m_1, m_2)$ satisfies $\pi(0, m_2) \geq 0$, $\pi(m_1, 0) \geq 0$, $\pi_i(m, m) = \alpha(m) \in [0, 1]$ for $i = 1, 2$, and $\pi_{12}(m, m) = \alpha'(m) < 0$. Then,*

(a) *competition exacerbates the incentives of the agents to collude with the borrower, i.e., $\theta^\pi < \tilde{\theta}_1$.*
(b) *The equilibrium monitoring effort under competition is lower than that under a single MFI.*
(c) *There exists a unique $\theta^* \in (\theta^\pi, \tilde{\theta}_1)$ such that incentives under competition are more high-powered if and only if $\theta < \theta^*$.*

Clearly, Proposition 6(a)-(c) is a special case of the above proposition since $\alpha'(m) = -1$.

7.2. Effects of a change in motivation

In this subsection we analyze the effects of a change in the motivation level of one MFI, say MFI 1. In order to analyze the effects of a change in motivation on the equilibrium we only consider the interior optima since the corner solutions do not depend on the level of motivation. Let θ_1 and θ_2 be the levels of motivation of MFIs 1 and 2, respectively. Then the first order conditions for the interior optima are given by:

$$\rho_1\pi_1^2(m_1, m_2) - m_1\pi_1(m_1, m_2) = \pi(m_1, m_2), \tag{12}$$

$$\rho_2\pi_2^2(m_1, m_2) - m_2\pi_2(m_1, m_2) = \pi(m_1, m_2), \tag{13}$$

where $\rho_i = \rho(\theta_i, r)$ for $i = 1, 2$. The above two equations define the best reply functions in monitoring of agents and 2, respectively. Let the initial levels of motivation are given by $\theta_1 = \theta_2 = \theta$. In this case the equilibrium is symmetric as discussed in the previous subsection. Now suppose that θ_1, the motivation of MFI 1 increases from θ to $\theta' < \theta^\pi$, whereas the level of motivation of the other MFI remains at its initial level $\theta_2 = \theta$. We assume that that the increase in θ_1 is bounded above by θ^π so that the new equilibrium is still an interior equilibrium. The following proposition proposition analyzes the effect of an increase in θ_1 on the equilibrium monitoring efforts.

Proposition 9 *Following an increase in the level of motivation of MFI 1,*

(a) *The equilibrium monitoring effort induced by MFI 1 decreases from its initial levels;*
(b) *The equilibrium monitoring effort induced by MFI 2 increases (decreases) from its initial level if $\pi(m_1, m_2)$ is submodular (log-supermodular) in (m_1, m_2).*

Proof We first prove parts (b) and (c). Consider the following first order conditions for the interior optima:

$$\rho_1\pi_1^2(m_1, m_2) - m_1\pi_1(m_1, m_2) = \pi(m_1, m_2),$$
$$\rho_2\pi_2^2(m_1, m_2) - m_2\pi_2(m_1, m_2) = \pi(m_1, m_2).$$

Differentiating the above two equations with respect to ρ_1 we get

$$\frac{dm_1}{d\rho_1} - b_1'(m_2)\frac{dm_2}{d\rho_1} = \frac{\pi_1}{2}, \tag{14}$$
$$-b_2'(m_1)\frac{dm_1}{d\rho_1} + \frac{dm_2}{d\rho_1} = 0. \tag{15}$$

The above system yields

$$\frac{dm_1}{d\rho_1} = \frac{\pi_1}{2\Delta_m}, \quad \frac{dm_2}{d\rho_1} = \frac{\pi_1 b_2'(m_1)}{2\Delta^m}, \text{ where } \Delta_m \equiv 1 - b_1'(m_2)b_2'(m_1) > 0.$$

From the above it follows that

$$\frac{dm_1}{d\theta_1} = -\frac{\pi_1(L-H+r)}{2\Delta_m(1-\theta_1)^2} < 0,$$
$$\frac{dm_2}{d\theta_1} = -\frac{\pi_1 b_2'(m_1)(L-H+r)}{2\Delta_m(1-\theta_1)^2} = b_2'(m_1)\cdot\frac{dm_1}{d\theta_1}.$$

The last expression is positive (negative) as $b_2'(m_1) \leq (\geq) 0$. Since the submodularity (log-supermodularity) of $\pi(m_1, m_2)$ implies that $b_2'(m_1) \leq (\geq) 0$, the result follows. ■

Although the effect of an increase in θ_1 on the equilibrium monitoring efforts is unambiguous, its effect on equilibrium incentives may be ambiguous. The following proposition confirms this assertion.

Proposition 10 *Following an increase in the level of motivation of MFI 1,*

(1) *if $m_i\pi_j\left|\pi_{ij}\right| > \pi_i^2$ for $i, j = 1, 2$ and $i \neq j$, then*
  (1a) *the equilibrium incentives offered by MFI 1 decrease from their initial levels;*
  (1b) *The equilibrium incentives offered by MFI 2 increase (decrease) from their initial levels if $\pi(m_1, m_2)$ is submodular (log-supermodular) in (m_1, m_2).*
(2) *If $m_i\pi_j\left|\pi_{ij}\right| < \pi_i^2$ for $i, j = 1, 2$ and $i \neq j$, then*
  (2a) *the equilibrium incentives offered by MFI 1 increase from their initial levels;*
  (2b) *The equilibrium incentives offered by MFI 2 decrease (increase) from their initial levels if $\pi(m_1, m_2)$ is submodular (log-supermodular) in (m_1, m_2).*

Proof The effort incentive constraint of agent $i = 1, 2$ is given by:

$$\frac{1}{2}s_i r\pi_i(m_i, m_j) = m_i.$$

The above equations define implicitly $m_i = m_i(s_i, s_j)$ with

$$\frac{\partial m_i}{\partial s_i} = \frac{1}{2}r\pi_i, \quad \text{and} \quad \frac{\partial m_i}{\partial s_j} = -\frac{\pi_j}{s_j\pi_{ij}} = -\frac{r\pi_j^2}{2m_j\pi_{ij}} \quad \text{for} \quad i,\, j = 1, 2.$$

Since

$$dm_i = \frac{1}{2}r\pi_i\, ds_i - \frac{\pi_j}{s_j\pi_{ij}}\, ds_j \quad \text{for} \quad i,\, j = 1, 2,$$

from the system of equations (14) and (15) it follows that

$$\begin{bmatrix} \frac{r\pi_1}{2} & -\frac{\pi_2}{s_2\pi_{12}} \\ -\frac{\pi_1}{s_1\pi_{12}} & \frac{r\pi_2}{2} \end{bmatrix} \begin{bmatrix} \frac{ds_1}{d\theta_1} \\ \frac{ds_2}{d\theta_1} \end{bmatrix} = \begin{bmatrix} \frac{dm_1}{d\theta_1} \\ b_2'(m_1) \cdot \frac{dm_1}{d\theta_1} \end{bmatrix} \quad \Longleftrightarrow \quad Ad = b.$$

Notice that

$$\Delta_s := \det(A) = \frac{r^2\pi_1\pi_2}{4m_1m_2\pi_{12}^2}\,[m_1m_2\pi_{12}^2 - \pi_1\pi_2],$$

and hence $\text{sign}[\Delta_s] = \text{sign}[m_1m_2\pi_{12}^2 - \pi_1\pi_2]$. Let A_i be the matrix obtained by replacing the i-th column of A by the column vector b, and $\Delta_i = \det(A_i)$. Then,

$$\Delta_1 = \pi_2\left[\frac{r}{2} + \frac{b_2'(m_1)}{s_2\pi_{12}}\right] \cdot \frac{dm_1}{d\theta_1}.$$

Notice that when $\pi(m_1, m_2)$ is submodular, i.e., $\pi_{12} < 0$, we have $b_2'(m_1) < 0$, and hence $b_2'(m_1)/s_2\pi_{12} > 0$. On the other hand, log-supermodularity of $\pi(m_1, m_2)$ implies that $\pi_{12} > 0$ and $b_2'(m_1) > 0$, and hence $b_2'(m_1)/s_2\pi_{12} > 0$. Therefore, $\Delta_1 > 0$. Next,

$$\Delta_2 = \pi_1\left[\frac{rb_2'(m_1)}{2} + \frac{1}{s_1\pi_{12}}\right] \cdot \frac{dm_1}{d\theta_1}.$$

Therefore, $\Delta_2 > (<)\, 0$ if $\pi(m_1, m_2)$ is submodular (log-supermodular).

Now, first consider the case when $m_1\pi_2\,|\pi_{12}| > \pi_1^2$ and $m_2\pi_1\,|\pi_{12}| > \pi_2^2$. The above two inequalities together imply that $m_1m_2\pi_{12}^2 > \pi_1\pi_2$, i.e., $\Delta_s > 0$. In this case

$$\frac{ds_1}{d\theta_1} = \frac{\Delta_1}{\Delta_s} > 0.$$

On the other hand,

$$\frac{ds_2}{d\theta_1} = \frac{\Delta_2}{\Delta_s} \gtrless 0 \;\text{ as }\; \pi(m_1, m_2) \;\text{ is submodular (log-supermodular)}.$$

Next, consider the case when $m_1\pi_2\,|\pi_{12}| < \pi_1^2$ and $m_2\pi_1\,|\pi_{12}| < \pi_2^2$. These two inequalities together imply that $m_1m_2\pi_{12}^2 < \pi_1\pi_2$, i.e., $\Delta_s < 0$. In this case

$$\frac{ds_1}{d\theta_1} = \frac{\Delta_1}{\Delta_s} < 0.$$

On the other hand,

$$\frac{ds_2}{d\theta_1}\frac{\Delta_2}{\Delta} \lesseqgtr 0 \text{ as } \pi(m_1, m_2) \text{ is submodular (log-supermodular)}.$$

This completes the proof of the proposition. ■

Let us explain the intuition behind the above proposition. From the effort incentive constraints it is easy to show that

$$\frac{\partial m_i}{\partial s_j} = -\frac{r\pi_j^2}{2m_j \pi_{ij}}.$$

Now, suppose that $\pi(m_1, m_2)$ is log-supermodular. Then the above expression is negative. On the other hand, it is also easy to show that

$$\frac{\partial m_i}{\partial s_i} = \frac{1}{2} r\pi_i > 0.$$

Let us now assume that

$$m_2 |\pi_{12}| > \frac{\pi_2^2}{\pi_1} \iff \frac{\partial m_1}{\partial s_1} > \left|\frac{\partial m_1}{\partial s_2}\right|, \tag{A1}$$

$$m_1 |\pi_{12}| > \frac{\pi_1^2}{\pi_2} \iff \frac{\partial m_2}{\partial s_2} > \left|\frac{\partial m_2}{\partial s_1}\right|. \tag{A2}$$

Recall Proposition 9. An increase in θ_1 implies that m_1 decreases, and also m_2 decreases since $\pi(m_1, m_2)$ is log-supermodular. The changes in m_1 and m_2 following a change in θ_1 can be caused by the changes in the incentive schemes s_1 and s_2. Now, given our assumptions A1 and A2, for both m_1 and m_2 to decrease we must have both s_1 and s_2 decreasing as a result of an increase in θ_1. Note that s_1 decreases m_1 also decreases. On the other hand, when s_2 decreases, m_1 increases. But the net effect of an increase in θ_1 on m_1 is negative since A1 holds. Similarly, under log-supermodularity, a decrease in s_1 causes m_2 to increase, but a decrease in s_2 causes m_2 to decrease. Since A1 holds, the net effect of an increase in θ_1 on m_2 is also negative. This is the intuition behind the first part of the above proposition under the log-supermodularity of $\pi(m_1, m_2)$. Similar intuition goes through for the remaining parts of the proposition.

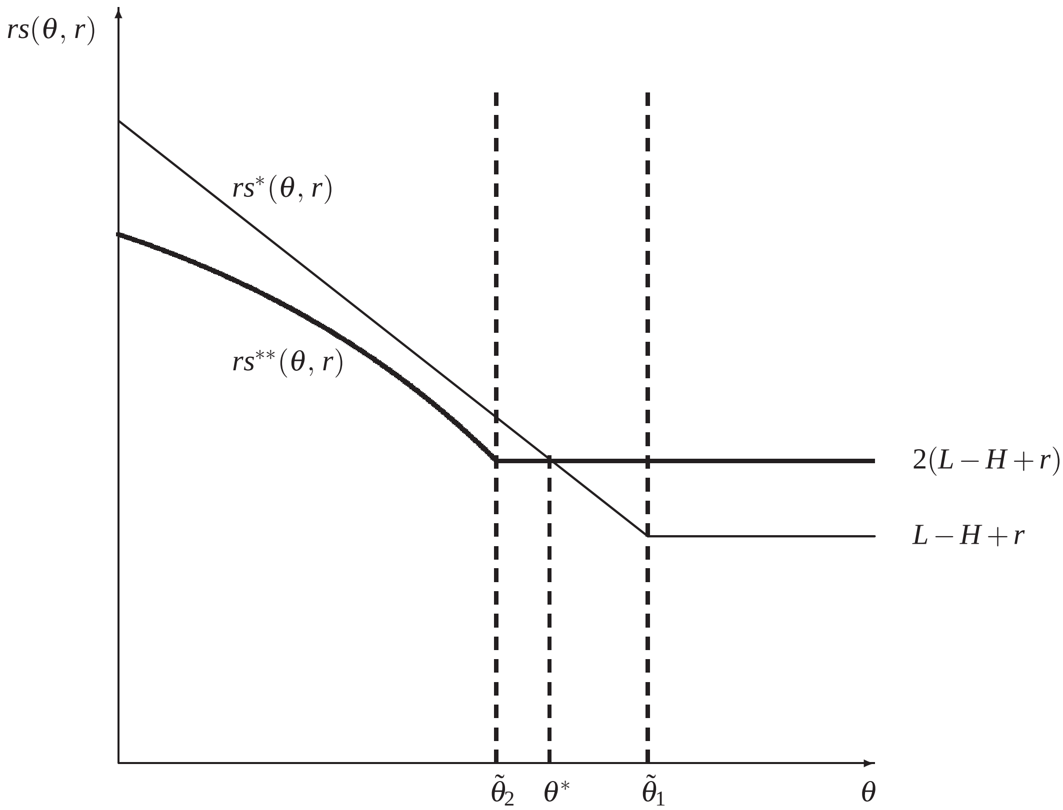

Figure 1: Incentives under single MFI and competition

References

Armendáriz, Beatriz and Jonathon Morduch (2010), *The Economics of Microfinance*, second edition. The MIT Press, Cambridge, Massachusetts and London, England.

Aubert, Cécile, Alain de Janvry, and Elisabeth Sadoulet (2009), "Designing Credit Agent Incentives to Prevent Mission Drift in Pro-poor Microfinance Institutions." *Journal of Development Economics*, 90, 153–162.

Banerjee, Abhijit V., Pranab Bardhan, Esther Duflo, Erica Field, Dean Karlan, Asim Khwaja, Dilip Mookherjee, Rohini Pande, and Raghuram Rajan (2010), "Help Microfinance, Don't Kill It." *Indian Express*. November 26. URL: http://www.indianexpress.com/news/help-microfinance-don-t-kill-it/716105/0.

Basu, Karna (2012), "Commitment Savings in Informal Banking Markets." Mimeo, Hunter College, CUNY.

Bazoberry, Eduardo (2001), "We Aren't Selling Vacuum Cleaners: PRODEM's Experiences with Staff Incentives." *MicroBanking Bulletin*, 11–13.

Bernheim, Douglas and Michael Whinston (1986), "Common Agency." *Econometrica*, 54, 923–942.

Besley, Timothy J. and Maitreesh Ghatak (2005), "Competition and Incentives with Motivated Agents." *The American Economic Review*, 95, 616–636.

Besley, Timothy J. and Maitreesh Ghatak (2006), "Sorting with Motivated Agents: Implications for School Competition and Teacher Incentives." *Journal of the European Economic Association, Papers and Proceedings*, 4, 404–414.

Besley, Timothy J. and John McLaren (1993), "Taxes and Bribery: The Role of Wage Incentives." *The Economic Journal*, 103, 119–141.

Binmore, Ken, Ariel Rubinstein, and Asher Wolinsky (1986), "The Nash Bargaining Solution in Economic Modelling." *The RAND Journal of Economics*, 17, 176–188.

Bonanno, Giacomo and John Vickers (1988), "Vertical Separation." *Journal of Industrial Economics*, 36, 257–265.

Bond, Philip and Ashok S. Rai (2002), "Collateral Substitutes in Microfinance." Mimeo, Northwestern University.

de Quidt, Jonathan, Thiemo Fetzer, and Maitreesh Ghatak (2012), "Market Structure and Borrower Welfare in Microfinance." BREAD Working Paper No. 360.

Dixit, Avinash, Gene Grossman, and Elhanan Helpman (1997), "Common Agency and Coordination: General Theory and Application to Government Policy Making." *Journal of Political Economy*, 105, 752–769.

Fischer, Greg and Maitreesh Ghatak (2010), "Repayment Frequency in Micro nance Contracts with Present-Biased Borrowers." Mimeo, London School of Economics.

Gal-Or, Esther (1991), "Duopolistic Vertical Restraints." *European Economic Review*, 35, 1237–1253.

Ghatak, Maitreesh and Hannes Mueller (2011), "Thanks for Nothing? Not-for-Profits and Motivated Agents." *Journal of Public Economics*, 95, 94–105.

Godel, Moritz Immanuel (2003), *Goals, Tasks and Incentives in Microfinance Institutions*. Ph.D. thesis, University College London. M. Phil. Dissertation.

Guha, Brishti and Prabal Roy Chowdhury (2013), "Micro-Finance Competition: Motivated Micro-Lenders, Double-Dipping and Default." Forthcoming, *Journal of Development Economics*.

Hermes, Niels and Robert Lensink (2007), "The Empirics of Microfinance: What Do We Know?" *The Economic Journal*, 117, F1–F10.

Hoff, Karla and Joseph E. Stiglitz (1998), "Money-Lenders and Bankers: Price-Increasing Subsidies in a Monopolistically Competitive Market." *Journal of Development Economics*, 55, 485–518.

Hölmstrom, Bengt (1982), "Moral Hazard in Teams." *The Bell Journal of Economics*, 13, 324–340.

Hölmstrom, Bengt and Jean Tirole (1997), "Financial Intermediation, Loanable Funds, and the Real Sector." *The Querterly Journal of Economics*, 112, 663–691.

Holtmann, Martin (2002), "Developing Staff Incentive Schemes." Technical report, MicroSave.

Kahn, Charles and Dilip Mookherjee (1995), "Market Failure and Moral Hazard with Side Trading." *Journal of Public Economics*, 58, 159–184.

Kahn, Charles and Dilip Mookherjee (1998), "Competition and Incentives with Nonexclusive Contracts." *The RAND Journal of Economics*, 29, 443–465.

Kranton, Rachel and Anand Swamy (1999), "The Hazards of Piecemeal Reform: British Civil Courts and the Credit Market in Colonial India." *Journal of Development Economics*, 58, 1–24.

Malegam, Yezdi 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." Technical report, Reserve Bank of India.

McIntosh, Craig, Alain de Janvry, and Elisabeth Sadoulet (2005), "How Rising Competition among Microfinance Institutions Affects Iincumbent Lenders." *Economic Journal*, 115, 987–1004.

McIntosh, Craig and Bruce Wydick (2005), "Competition and Microfinance." *Journal of Development Economics*, 71, 271–298.

McKim, Andrew and Matthew Hughart (2005), "Staff Incentive Schemes in Practice: Findings from a Global Survey of Microfinance Institutions." Technical report, Microfinance Network.

Navajas, Sergio, Jonathon Conning, and Claudio Gonzalez-Vega (2003), "Lending Technologies, Competition and Consolidation in the Market for Microfinance in Bolivia." *Journal of International Development*, 15, 747–770.

Parameshwar, Devyani, Neha Aggarwal, Roberto Zanchi, and Sagar Siva Shankar (2009), *Inverting the Pyramid: Indian Microfinance Coming of Age*, 3rd edition. Intellecap.

Rey, Patrick and Joseph E. Stiglitz (1988), "Vertical Restraints and Producers' Competition." *European Economic Review*, 32, 561–568.

Roodman, David (2012), *Due Diligence: An Impatient Inquiry into Microfinance*. Center for Global Development.

Roth, Alvin E. (1979), *Axiomatic Models of Bargaining*. Springer-Verlag, Berlin.

Steege, Jean (1998), "The Rise and Fall of Corposol: Lessons Learned from the Challenges of Managing Growth." Technical report, Microenterprise Best Practices.

Van Tassel, Eric (2002), "Signal Jamming in New Credit Markets." *Journal of Money, Credit and Banking*, 34, 469–490.

Woller, Gary and Mark Schreiner (2003), "Poverty Lending, Self-Sufficiency, and the Six Aspects of Outreach." Working paper, Marriot School, Brigham Young University.