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Market Structure and Borrower Welfare in Microfinance *

Jonathan de Quidt, Thiemo Fetzer, and Maitreesh Ghatak[†]

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Abstract

Motivated by recent controversies surrounding the role of commercial lenders in microfinance, we analyze borrower welfare under different market structures, considering a benevolent non-profit lender, a for-profit monopolist, and a competitive credit market. To understand the magnitude of the effects analyzed, we simulate the model with parameters estimated from the MIX Market database. Our results suggest that market power can have severe implications for borrower welfare, while despite possible information frictions competition typically delivers similar borrower welfare to non-profit lending. In addition, for-profit lenders are less likely to use joint liability than non-profits.

Keywords: microfinance; market power; for-profit; social capital

JEL codes: G21, O12, D4, L4, D82

Commercialization has been a terrible wrong turn for microfinance, and it indicates a worrying "mission drift" in the motivation of those lending to the poor. Poverty should be eradicated, not seen as a money-making opportunity.

Muhammad Yunus, New York Times, January 14th 2011[1]

The recent controversy about the activities of some microfinance institutions (henceforth, MFIs) has stirred a broader debate about commercialization and mission drift in the sector.[2] The success of MFIs across the world has been tremendous over the last two decades, culminating in the Nobel Peace Prize for the Grameen Bank and its founder Dr. Muhammad Yunus. However, these recent controversies that charge some MFIs of profiteering at the expense of the borrowers, which seemingly contradicts the original purpose of the MFI movement, namely making capital accessible to the poor to lift them out of poverty, have cast a shadow on the industry.[3] According to some critics, commercial lenders were attracted by the high repayment rates of poor borrowers, and stepped in charging very high interest rates in unregulated markets with little client protection. While the discussion has been mostly about "commercialization", there is an implicit assumption that these lenders enjoy some market power, for example, in Yunus's statement that microcredit has "[given] rise to its own breed of loan sharks".[4] This critique is acknowledged within the MFI sector and has led to calls for tougher regulations, culminating in India with the formation of the Malegam Committee.[5]

This raises a sharp contrast with much of the existing microfinance literature, both theoretical and empirical, which has typically assumed lenders to be non-profits or to operate in a perfectly competitive market, and which more generally ignores the

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[1]Accessible at `http://www.nytimes.com/2011/01/15/opinion/15yunus.html`

[2]For instance, SKS in Andhra Pradesh, India, Banco Compartamos of Mexico, LAPO of Nigeria. See, for example, MacFarquahr (New York Times, April 13, 2010), and Sinclair (2012).

[3]In addition, the results from several randomized experiments in India, Mongolia, Morocco, and the Philippines suggest that while microfinance has a positive effect in starting small businesses, but it did not have a statistically significant effect reducing poverty. See Banerjee et al. (2010), Attanasio et al. (2011), Crépon et al. (2011), and Karlan and Zinman (2009). By design these studies look at a single MFI and its borrowers rather than addressing industry or market level issues. Nevertheless the results suggest the need to look at factors that might be limiting the impact of microfinance on its stated goal of poverty alleviation.

[4]The New York Times, 14th January 2011.

[5]However, others have argued that this might stifle the sector and without commercialization capital markets cannot be harnessed and microfinance cannot grow. See, for example, Michael Schlein, chief executive of Accion in a letter to The New York Times, January 23rd, 2011, available at `http://www.nytimes.com/2011/01/24/opinion/lweb24micro.html`.

issue of market structure in considering the welfare effects of microfinance.[6] Most of this work has studied the remarkable repayment rates achieved by MFIs. In a world where lenders are not acting in the best interests of borrowers, we need to look beyond repayment rates. Accordingly, we focus on the types of loans offered, interest rates and borrower welfare in addition to repayment rates. Our paper analyzes the consequences of for-profit or commercial lending in microfinance, with and without market power, compared to a benevolent non-profit maximizing borrower welfare subject to a break-even constraint on these outcome variables.

To our knowledge, this is the first paper to formally address the issues that are at the heart of these policy debates. Using a simple model we ask whether MFIs' celebrated lending methods (in particular, joint liability lending) can be a tool of rent extraction in the hands of a for-profit lender; whether the social capital that MFIs are thought to leverage to extend credit to collateral-poor borrowers might also be a resource that a lender can exploit; whether information asymmetries could limit the welfare gains from competition; whether commercialization leads to a change in the use of joint liability. We then simulate the model using empirical parameter estimates. Thus we are able to go beyond modeling these various relationships and comment on their relative importance, and relate them to the policy discussion.

Our model is one of strategic default or limited enforcement where borrowers have no collateral, similar to Besley and Coate (1995). We consider lenders offering individual and joint liability loans, (henceforth, IL and JL), and contrast the behavior of a benevolent non-profit lender with for-profit monopolistic or competitive lenders. A for-profit lender with market power can extract rents from borrowers, through higher interest rates, that are positively related to the level of social capital that these borrowers share. This is because under JL, borrowers leverage their social capital to guarantee one another's repayments. The more social capital they have, the higher the interest payment their agreement can guarantee, and this is exploited by the lender. However, somewhat surprisingly, it turns out that borrowers are always at least as well off under potentially "exploitative" JL as under IL. This is because the lender has to give more rents to borrowers (through lower interest rates) to ensure incentive compatibility. Otherwise a borrower will not be willing to repay on behalf of her partner, should she default.

Next we introduce competition. As is standard, we model a zero-profit, compet-

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[6]Exceptions are Cull et al. (2007), Cull et al. (2009) and Baquero et al. (2012).

itive equilibrium with free entry. However, the existing literature typically assumes, implicitly or explicitly, that borrower histories are shared between lenders, such that a borrower whose contract is terminated can never borrow again. Under free entry the lender then offers the borrower her welfare-maximizing contract which in our case is the contract offered by the non-profit. Since our paper looks to analyze the possible dangers of commercialization, we instead assume (as is common in practice) that borrower credit histories are not shared between lenders.[7] Then, entry by new lenders undermines borrowers' incentive to repay existing lenders. This is the enforcement externality highlighted by Hoff and Stiglitz (1997) in the context of standard (IL) loans. To incentivize repayment there must be credit rationing in equilibrium so that defaulting borrowers may have to wait some time to find a new lender, analogous to the incentive-based efficiency wage literature (e.g., Shapiro and Stiglitz (1984)).

Rather than focusing only on existing borrowers, we consider the welfare of all *potential* borrowers, including those currently unable to access credit. Rationing implies that the ordering of welfare across market structures is ambiguous; welfare could be higher under monopoly for-profit lending than competition. Many argue that commercialization is necessary to achieve maximum outreach by giving lenders greater access to financial markets. In our model, we shut this channel down, assuming that all lenders face the same, constant opportunity cost of funds. The fact that competition leads to credit rationing suggests another force in the opposite direction: a single large lender, whether non-profit or for-profit, can achieve greater outreach than the competitive market.

We also find that for-profit lenders, with and without market power, are less likely to use JL than a non-profit lender (they require more social capital to be willing to do so), due to the extra rents that must be given to borrowers under JL. This result is consistent with the evidence presented in Cull et al. (2009) that non-profits tend to use group-based lending methods, whereas for-profit lenders tend to use individual-based lending methods. It is also consistent with the (perceived) trend away from the use of JL, to the extent that this coincides with increasing commercialization of microfinance. A common explanation for this trend is that borrowers prefer the flexibility of IL lending. Our model rules this channel out, but yields a complementary one: IL may be more profitable to lenders, due to the more

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[7]In a related paper, McIntosh and Wydick (2005) present a model where lenders share only a "black list" of defaulting borrowers, so are unable to fully distinguish good from bad risks.

relaxed constraints on interest rates. The result has a second implication, often missed in the policy debates. Our model speaks to any lender with market power, using dynamic incentives to enforce repayment. In their efforts to regulate MFIs, as a current bill being discussed in the Indian Parliament attempts to do, regulators should not ignore similar behavior by standard IL-using commercial lenders who may not be formally registered as MFIs.

Our model also enables us to simply analyze the effect of interest rate caps. In a competitive market with zero-profit lenders, the potential for caps to improve welfare is limited, and risks shutting down the industry. However, with a monopolist lender a cap can reduce the rate borrowers face. It may also induce the lender to switch from IL to JL lending, further improving welfare.

Finally, we simulate the model using parameters estimated from the MIX Market (henceforth, MIX) dataset and existing research. We initially expected that the monopolist's ability to leverage borrowers' social capital would have large welfare effects. We find that forcing the monopolist to use JL when he would prefer IL increases borrower welfare by a minimum of 12% and a maximum of 20%. Meanwhile, switching to a non-profit lender delivers a much larger welfare gain of between 54% and 73%. The qualitative sizes of these effects result are robust to alternative parameter values. Secondly, we find that despite its effect on undermining repayment incentives, competition delivers similar borrower welfare to the non-profit benchmark. Taking these results together suggests that regulators should be attentive to lenders with market power, but that fostering competition rather than heavy-handed regulation can be an effective antidote. Thirdly, we find that for our parameter values, the non-profit lender would offer JL to all borrowers, irrespective of their level of social capital. The for-profit lenders, with and without market power, only switch to JL lending when borrowers have social capital worth around 15% of the loan size.

Turning to related literature, our model is along the lines of Besley and Coate (1995) who show how JL can induce repayment guarantees within borrowing groups, with lucky borrowers helping their unlucky partners with repayment when needed. They show a trade-off between improved repayment through guarantees, and a perverse effect of JL, that sometimes a group may default *en masse* even though one member would have repaid had they received an IL loan. Introducing social sanctions, they show how these can help alleviate this perverse effect by making full repayment incentive compatible in more states of the world, generating welfare improvements that can be passed back to borrowers. Rai and Sjöström (2004) and

Bhole and Ogden (2010) are recent contributions to this literature, both using a mechanism design approach to solve for efficient contracts (neither include the social capital channel).

Social capital is a concept widely discussed in the development and broader economics literature (Sobel (2002) gives an excellent overview). Even within the microfinance literature there are many approaches, for instance Besley and Coate (1995) model an exogenously given social penalty function, representing the disutility an agent can impose on her partner as a punishment. We model social capital as an asset, worth S to each member of a pair of individuals, that either can credibly threaten to destroy as a punishment.[8]

There is a great deal of evidence that social interactions are important in group borrowing.[9] Feigenberg et al. (2011) study the effect of altering loan repayment frequency on social interaction and repayment, claiming that more frequent meetings can foster the production of social capital and lead to more informal insurance within the group. It is this insurance or repayment guarantee channel on which our model focusses. They also highlight that peer effects are important for loan repayment, even without explicit JL, through informal insurance, and that these effects are decreasing in social distance.

Following the move by Grameen Bank and BancoSol, among others, to use of IL lending, it has been popularly perceived that use of JL is dying out (for instance, see Armendáriz de Aghion and Morduch (2010)). However, although we do not have detailed data on contract types, it is clear that "solidarity groups" are still widely used at present.[10] In our sample of 715 MFIs from around the world that reported to the Microfinance Information Exchange (MIX) in 2009, the total share of solidarity group lending by number of loans is 54%.[11] Moreover, these data do not include the important Self-Help Groups (SHGs) in India, who typically take JL loans from commercial banks intermediated by an NGO, of which 4.8m groups had outstanding

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[8]Alternative approaches include Greif (1993), where deviations in one relationship can be credibly punished by total social ostracism. Bloch et al. (2008) and Karlan et al. (2009) present models where insurance, favor exchange or informal lending are embedded in social networks such that an agent's social ties are used as social collateral to enforce informal contracts.

[9]See, for example Cassar et al. (2007), Wydick (1999), Karlan (2007), Giné et al. (2010).

[10]The MIX states that "loans are considered to be of the Solidarity Group methodology when some aspect of loan consideration depends on the group, including credit analysis, liability, guarantee, collateral, and loan size and conditions."

[11]By total value of loans, however, it is only worth 18%, which reflects the fact that group loans are typically smaller. See the discussion and figure in the Appendix.

loans in March 2011 (see NABARD (2011)), and to whom our results are similarly relevant.[12]

The plan of the paper is as follows. In section 1 we lay out the basic model and analyze the choice of contracts by a non-profit lender who maximizes borrower welfare and a for-profit monopolist. In section 2 we analyze the effects of introducing competition to the market. We then simulate the model in section 3, allowing an empirical interpretation of the key mechanisms analyzed. Section 4 concludes.

1   The Model

We assume that there is a set of risk neutral agents or "borrowers", each of whom has access to a technology costing one unit of output each period that produces R units of output with probability $p \in (0,1)$ and zero otherwise. Project returns are assumed to be independent. In each period the *state* is the vector of output realizations for the set of borrowers under consideration, so when we consider an individual borrower the relevant state is $Y \in \{0, R\}$, while for a pair of borrowers it is $Y \in \{(0,0), (0,R), (R,0), (R,R)\}$. The outside option of the borrower is assumed to be zero. Borrowers cannot save and have no assets, so they must borrow 1 unit of output at the start of the period to finance production, and consume all output net of loan repayments at the end of the period. Since they have no assets their liability in any given period is limited to their income in that period. Borrowers have infinite horizons and discount the future with factor $\delta \in (0,1)$.

Each period, the state is common knowledge for the borrowers but not verifiable by any third party, so the lender cannot write state-contingent contracts. Borrowers can write contingent contracts with each other but these can only be enforced by social sanctions.

There is a single lender who may be a non-profit who is assumed to choose a contract that maximizes borrower welfare subject to a zero-profit condition, or alternatively a for-profit who maximizes profits.[13] The lender's opportunity cost of

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[12]There is some emerging evidence on the relative roles of IL and JL. Giné and Karlan (2011) and Attanasio et al. (2011) find no significant difference between group and individual repayment probabilities, although repayment rates are very high under both control and treatment groups. They are not strictly comparable as in the first study groups were retained under IL while in the second groups are not used either under IL or JL.

[13]We do not explore the organizational design issues that might cause non-profits to behave differently than postulated above, as for example in Glaeser and Shleifer (2001).

funds is $\rho \geq 1$ per unit. We assume (purely for simplicity) that the for-profit lender does not discount, i.e. he chooses the contract to maximize current-period profits only. We also assume that the lender has sufficient capacity to serve all borrowers that want credit.

Since output is non-contractible, lenders use dynamic repayment incentives as in, for example, Bolton and Scharfstein (1990). Following much of the microfinance literature we focus attention on IL or JL contracts. The IL contract is a standard debt contract that specifies a gross repayment r, if this is not made, the borrower is considered to be in default and her lending relationship is terminated. Under JL, pairs of borrowers receive loans together and unless both loans are repaid in full, both lending relationships are terminated. The lender can choose the interest rate and whether to offer IL or JL. Borrowers are homogeneous in the basic model so the lender offers a single contract in equilibrium.

In order to highlight the potential for rent extraction by the lender, we assume he fully commits to a contract in the first period by making a take-it-or-leave it offer specifying r and either IL or JL. If JL is offered, the members of the borrowing group then agree on an intra-group contract or *repayment rule*, specifying the payments each borrower will make in each possible state of the world.

Once the loan contract has been offered, it is fixed for all periods and cannot be renegotiated. Meanwhile, the borrowers cannot commit to a repayment rule until the loan contract is signed. Thus the lender's first-mover advantage enables him to influence the borrowers' repayment rule through the choice of loan contract offered.[14]

Throughout the paper we assume the following timing of play. In the initial period:

1. The lender enters the community and commits to an interest rate and either IL or JL for all borrowers.

2. If JL is offered, groups form and agree a repayment rule.

Then, in this and all subsequent periods until contracts are terminated:

1. Loans are disbursed, the borrowers observe the state and simultaneously make repayments (the repayment game).

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[14]Allowing for weaker commitment or renegotiation would reduce the lender's rent-extraction, either because the borrowers could hold out for a more favorable contract, or because they might expect him not to carry out the threat of termination after default. See Genicot and Ray (2006) for a model of a lender with varying degrees of bargaining power.

2. Conditional on repayments, contracts renewed or terminated.

1.1 Intra-group contracting

Under JL, borrowers form groups of two individuals $i \in \{1, 2\}$, which are dissolved unless both loans are repaid. Once the loan contract has been written the borrowers agree amongst themselves and commit to a repayment rule or repayment guarantee agreement that specifies how much each will repay in each state in every future period.[15] In order to prevent the group from being cut off from future finance, a borrower may willingly repay the loan of her partner whose project was unsuccessful. We assume that deviation from the repayment rule is punished by the destruction of the borrowers' social capital worth S, introduced in 1.2 below.[16] Some examples of possible rules are "both borrowers only repay their own loans," or "both repay their own loans when they can, and their partner's when she is unsuccessful."

The agreed repayment rule can be seen as a device that fixes the payoffs of a two-player "repayment game" for each state of the world. Since the state is common knowledge to the borrowers, each period they know which repayment game they are playing. Either a borrower pays the stipulated amount, or she suffers a social sanction and may also fail to ensure her contract is renewed. The repayments stipulated in the rule must constitute a Nash equilibrium (i.e. be feasible and individually incentive-compatible). As such games may not have a unique equilibrium, we assume that the pre-agreed rule enables the borrowers to coordinate on a particular equilibrium by fixing beliefs about their partner's strategy. This in turn implies that social sanctions never need to be enacted on the equilibrium path since there will be no deviations from the rule and the state is common knowledge.

For simplicity, we restrict attention to repayment rules that are symmetric (i.e., do not condition on the identities of the players), and stationary (depend only on the current state and social capital). Thus we can focus on a representative borrower (symmetry) with a time-independent value function (stationarity). Symmetry

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[15]It is plausible that such agreements could expand to include others outside the group. For simplicity we assume that this is not possible, perhaps because borrowers' output realizations or borrowing and repayment behavior are only observable to other borrowers within their group.

[16]In a related paper, de Quidt et al. (2011), we show how social sanctions can enable borrowers to guarantee repayments even without an explicit JL clause. Such contracts are useful when there are states of the world in which a JL group would default but an IL borrower could repay (e.g. one partner is successful but cannot afford to repay both loans). Given the simple distribution of output in our setup, these "implicit" JL contracts are dominated by explicit JL and/or IL.

prevents one borrower from taking advantage of the other using their social capital as leverage (e.g. requiring them to repay all of their income every period).

Since the repayment rule is chosen by the borrowers it seems natural to focus on pure strategy, joint welfare maximizing equilibria. Welfare maximization has three key implications. Firstly, the total repayment in any state will be either zero or $2r$. Secondly, borrowers will always default if r exceeds the representative borrower's discounted continuation value of the lending arrangement, otherwise the group is better off defaulting. This forms our first key constraint on the lender. Thirdly, provided the continuation value *does* exceed r, the rule maximizes the probability that both loans are repaid, as repayment is always jointly preferable to default.

1.2   Social Capital

Here we briefly introduce the notion of social capital used in the paper. We assume that pairs of individuals in the village share some pair-specific social capital worth S in discounted lifetime utility, that either can credibly threaten to destroy (after which $S = 0$). If the threat is to terminate a friendship, S represents the value of that friendship in excess of that generated by the borrowing relationship. Thus the total value a member stands to lose if the borrowing group and friendship are terminated is $V + S$, where V is the value of access to credit. S represents the present value of various forms of social interaction, such as socializing, contributions to public goods and favor-exchange or other arrangements supported by the pair's relationship.

We assume that each individual i in the community has a large number, say, n friends or candidate borrowing partners, each worth S_i, valued jointly at nS_i.[17] Thus each friendship that breaks up represents a loss of S_i. For simplicity we assume that S_i is constant and equal to S within the community and observable to the lender.

One way to conceptualize S is as the net present value of lifetime payoffs in a repeated "social game" played alongside the borrowing relationship, similar to the multi-market contact literature, such as Spagnolo (1999), who models agents interacting simultaneously in a social and business context, using one to support cooperation in the other. There are many interesting insights that can arise from this approach; for example the timing of play in social and repayment games will be important in general, which sheds light on the kinds of social interactions that will

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[17]It is true that the more friends one has, potentially the lower the value of any individual friend. Provided new friends are not perfect substitutes for old ones, this is not a problem for the analysis.

be able to support microfinance. In some contexts, microfinance can also help to support social interactions. We analyze these and others in ongoing related work.

As an illustration, suppose the borrowers play the following "coordination" stage-game each period: if both play A, both receive s. If one plays A and the other, B, both receive -1. If both play B, both receive 0. Clearly, both (A, A) and (B, B) are Nash equilibria in the stage-game. If players expect to play (A, A) forever, their expected payoff is $S = \frac{s}{1-\delta}$. However, switching to (B, B) forever as a social sanction is always a credible threat, and can be used to support the repayment rule.

In reducing social interactions to a single variable, S, we inevitably miss key channels through which social capital influences day-to-day life in developing countries. However, we believe the concept as we model it has empirical relevance. A simple conjecture is that rural communities would tend to have higher S than urban ones, since informal contracting and coping mechanisms play more important roles in rural communities, and presumably individual friends are closer substitutes in densely populated urban areas. Similarly, we only consider credible social sanctions, so we would expect S to be relatively low between family members (breaking ties is difficult), consistent with many MFIs' restrictions on multiple family members joining JL groups.

1.3 Loan contracts

We now consider contract choice by the lender. One concern might be that borrowers deliberately bring a stranger to the borrowing group to prevent the lender exploiting their social capital. By the following observation we can ignore this possibility.[18]

Observation 1 *JL borrowers always group with their "best friend", i.e., the one with whom they share the highest social capital.*

With a single lender, contract termination means no credit ever again (unlike under competition in section 2, when a borrower cut off by one lender can later obtain a loan from another). Since borrowers must be given a rent for dynamic incentives to be effective, their participation constraint will be satisfied.

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[18]The observation follows from the lender's ability to pre-commit to a contract type and interest rate. Once the contract has been written, the symmetry and joint welfare maximization of the repayment rule implies that bringing a better friend cannot make them worse off, but may make them better off. Thus the lender only needs to know the maximum value of social capital for each pair in the community.

If a borrower's contract is renewed with probability π, it must be that her expected per-period repayment is πr. Thus the value of access to credit for a representative borrower is $V = pR - \pi r + \delta \pi V$, which simplifies to:

$$V = \frac{pR - \pi r}{1 - \delta \pi}. \tag{1}$$

We now introduce the three key constraints, before moving on to discuss the choice between IL and JL. The first is the Limited Liability Constraint (LLC), that is a borrower cannot repay more than R when successful, and cannot repay at all when unsuccessful.

Next, before even considering social sanctions, we must ensure that the interest rate is lower than the value of future access to credit. If not, then an IL borrower will simply take the first loan and default. A JL group will also take the first loan, and collude against the lender, agreeing that both borrowers should default. This is because repayment of both loans is not jointly welfare maximizing. The constraint is $\delta V \geq r$, or, using 1, $\delta pR \geq r$. Intuitively, the net benefit of delaying a strategic default by one period must be positive. We term this Incentive Constraint 1 (IC1). We define r_{IC1} as the interest rate at which IC1 binds:

$$r_{IC1} \equiv \delta pR.$$

Under JL, IC1 puts an important limit on the lender's ability to exploit the borrowers' social capital. No matter how large their social capital he cannot extract repayments that exceed the value of future credit access. When IC1 holds, JL borrowers are always willing to repay their own loan provided their partner is also repaying.

Lastly, under JL there is a second repayment incentive constraint. It must be incentive compatible for a borrower to repay two loans should her partner be unsuccessful. Here, what is in the best interests of the group might not be in the best interests of the individual, hence the need for social sanctions. A borrower who fails to make this repayment when the repayment rule requires it will lose both their social capital and their access to credit. This gives us Incentive Constraint 2 (IC2), which is $2r \leq \delta(V + S)$.

1.3.1 Individual Liability

Under IL, if borrowers repay when successful, $V^{IL} = \frac{p(R-r^{IL})}{1-\delta p}$. By IC1 we require $r \le r_{IC1}$. The LLC requires $r \le R$, which is more slack than IC1.

IL lending can earn non-negative profits as long as expected repayment at r_{IC1}, equal to pr_{IC1}, exceeds the opportunity cost of funds, ρ. To use IL lending as a benchmark, we retain this throughout as an assumption.[19]

Assumption 1 $\delta p^2 R > \rho$.

1.3.2 Joint liability

Suppose that the repayment rule requires borrowers guarantee one another's repayments, and therefore both loans are repaid whenever at least one borrower is successful.[20] Thus the repayment probability is $1 - (1-p)^2 = p(2-p)$ which we define as:

$$q \equiv p(2-p).$$

Since the repayment rule is symmetric, each borrower's expected repayment is qr^{JL} per period. Thus we have $V^{JL} = \frac{pR-qr^{JL}}{1-\delta q}$.

As usual, IC1 is $r^{JL} \le r_{IC1}$. The LLC is $2r^{JL} \le R$. To ensure that a borrower willingly guarantees her partner's repayment, we check that the cost of contract termination and social sanction is greater than the cost of repaying two loans, $2r$. Thus IC2 is $\delta(V^{JL} + S) \ge 2r^{JL}$. Solving this, we obtain $r^{JL} \le r_{IC2}(S)$, defined as:

$$r_{IC2}(S) \equiv \frac{\delta[pR + (1-\delta q)S]}{2 - \delta q}.$$

Note that $r_{IC2}(S)$ is increasing in S; this is the margin on which the lender is able to exploit the borrowers' social capital. Also, $r_{IC2}(0) < r_{IC1}$, so IC2 is tighter than IC1 in the neighborhood of $S = 0$ (without any social sanctions IC2 must be harder to satisfy than IC1 since it involves repaying twice as much). There exists a threshold, $\bar{S}$, at which r_{IC1} and $r_{IC2}(S)$ intersect:

$$\bar{S} \equiv pR.$$

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[19]This Assumption also implies that the projects yield strictly positive social surplus, i.e. $pR > \rho$.

[20]We can ignore any JL contracts where the interest rate is too high for borrowers to guarantee one another's repayments. It is straightforward to check that for any lender these are dominated by either IL, or JL with a lower interest rate.

Under JL, any one of the three constraints could potentially bind, but the LLC and IC1 do not depend on S, so for simplicity we assume IC1 is tighter. This assumption is not necessary for our key results to go through, and some of our welfare conclusions would be stronger if we reversed it. We assume:

Assumption 2 $\delta p \leq \frac{1}{2}$.

JL can be used profitably provided that revenue when the tightest of IC1 and IC2 binds exceeds the opportunity cost of capital, i.e. $q \min \{r_{IC1}, r_{IC2}(S)\} \geq \rho$. This condition is strict for $S = \bar{S}$ by Assumption 1 and $q > p$. Thus we can find a threshold, $\hat{S} < \bar{S}$, equal to the lowest feasible value of S (possibly zero) at which JL earns non-negative profits. We obtain:

$$\hat{S} \equiv \max \left\{ 0, \frac{(2 - \delta q)\rho - (2 - p)\delta p^2 R}{\delta q(1 - \delta q)} \right\}.$$

A simple sufficient condition that we shall make use of throughout for $\hat{S} = 0$ (i.e. JL is always profitable) is $p \leq \delta q$ or

$$1 + \delta p - 2\delta \leq 0. \tag{2}$$

1.4   Non-profit lender

Now we characterize equilibrium contracts when there is a single non-profit lender who maximizes borrower utility subject to a zero profit constraint.[21] This benchmark is identical to the standard "competitive" lender in most models of microcredit, with lenders earning zero profits in equilibrium (e.g. Ghatak and Guinnane (1999)). We distinguish here between the non-profit lender and competitive profit-maximizing lenders because they differ when there is incomplete information sharing between lenders, as analyzed in section 2.

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[21]This is by no means the only possible model of non-profit lending. For example, McIntosh and Wydick (2005) model a non-profit lender maximizing *outreach*, the number of clients reached. We stick with this particular version since it is identical to the motivation of the lender in Rai and Sjöström (2004) and Bhole and Ogden (2010), and also achieves the constrained first best.

The zero-profit interest rates and borrower utilities under IL and JL are:

$$\hat{r}^{IL} = \frac{\rho}{p} > \hat{r}^{JL} = \frac{\rho}{q}$$

$$\hat{V}^{IL} = \frac{pR - \rho}{1 - \delta p} < \hat{V}^{JL} = \frac{pR - \rho}{1 - \delta q}$$

As $\hat{V}^{JL} > \hat{V}^{IL}$ the nonprofit always offers JL for $S \geq \hat{S}$. Intuitively, the repayment guarantee enables borrowers to repay more frequently, reducing the termination probability, while the extra repayments are compensated by a lower interest rate. To summarize:

Proposition 1 *With a nonprofit lender, borrowers are strictly better off with JL than IL. The lender offers JL at $\hat{r}^{JL}$ whenever $S \geq \hat{S}$, otherwise he offers IL at $\hat{r}^{IL}$. Borrower utility under nonprofit lending is*

$$\hat{V} = \begin{cases} \hat{V}^{IL} & S < \hat{S} \\ \hat{V}^{JL} & S \geq \hat{S} \end{cases}.$$

Observation 2 *$\hat{V}$ is the maximum borrower utility from access to microfinance achievable under strict dynamic incentives.*

1.5 For-profit monopolist lender

The for-profit lender with monopoly power chooses the interest rate and contract type to maximize the per-period profit from each borrower. He will charge the highest possible interest rate under each contract, subject to the tightest of IC1 and IC2. He then simply picks the contract that maximizes expected revenue (since the opportunity cost of funds is identical under both). He always earns positive profits by Assumption 1.

The monopolist's interest rate and borrower utility under IL and JL are:

$$\tilde{r}^{IL} = r_{IC1}$$

$$\tilde{V}^{IL} = \frac{pR - pr_{IC1}}{1 - \delta p} = pR$$

$$\tilde{r}^{JL}(S) = \min\{r_{IC1}, r_{IC2}(S)\}$$

$$\tilde{V}^{JL}(S) = \frac{pR - q\min\{r_{IC1}, r_{IC2}(S)\}}{1 - \delta q} \geq pR.$$

It follows that borrowers are weakly better off under JL than IL, strictly when IC2 is binding. This somewhat surprising result is discussed further below. $\tilde{r}^{JL}(S)$ is increasing ($\tilde{V}^{JL}(S)$ decreasing) for all $S < \bar{S}$. The lender's per-period, per-borrower profits for contract type i, interest rate r^i and repayment probability π^i are:

$$\Pi^i = \pi^i r^i - \rho.$$

JL is offered when revenue (πr) is higher than under IL, i.e. when $q\tilde{r}^{JL}(S) \geq p\tilde{r}^{IL}$. This is strict for $S > \bar{S}$, implying a threshold $\tilde{S} < \bar{S}$ such that JL is offered for all $S \geq \tilde{S}$ and IL otherwise. $\tilde{S}$ is given by:

$$\tilde{S} \equiv \max\left\{0, \frac{p^2 R(p - \delta q)}{q(1 - \delta q)}\right\}.$$

Condition (2), which was *sufficient* but not necessary for JL to break even for all $S \geq 0$, is *necessary and sufficient* for the monopolist to offer JL for all $S \geq 0$. This is because of the following observation.

Observation 3 $\tilde{S} \geq \hat{S}$, *with the relation holding strictly if $p > \delta q$. Therefore, the for-profit monopolist lender offers JL over a (weakly) smaller range of S than the non-profit lender.*

This is the source of inefficiency in the model. The monopolist is unable to extract sufficiently high rents when S is small, and so offers IL, when JL would be efficient. See section 1.6 for further discussion. One implication of this result is perhaps missed in the policy debates. Our model speaks to any lender with market power, using dynamic incentives to enforce repayment. Regulators should be alert to abuses by standard, IL-using lenders, who may or may not be formally registered as MFIs or even consider themselves to be MFIs.

Borrower utility under the monopolist depends on S in two ways. Firstly, higher S may induce the lender to switch to JL, and secondly higher S increases $\tilde{r}^{JL}$ when IC2 is binding. We summarize the results in the following proposition.

Proposition 2 *With a monopolist for-profit lender, borrowers are weakly better off with JL than IL, strictly if $S < \bar{S}$. The lender offers JL at $\tilde{r}^{JL}(S)$ whenever $S \geq \tilde{S}$, otherwise he offers IL at $\tilde{r}^{IL} = r_{IC1}$. Borrower utility is:*

$$\tilde{V}(S) = \begin{cases} \tilde{V}^{IL} & S < \tilde{S} \\ \tilde{V}^{JL}(S) & S \geq \tilde{S} \end{cases}.$$

$\tilde{V}(S)$ is equal to pR for $S < \tilde{S}$ and $S \geq \bar{S}$, increases discontinuously at $\tilde{S}$, and strictly decreasing until equal to pR at $\bar{S}$. Lender profits are equal to:

$$\tilde{\Pi}(S) = \begin{cases} \delta p^2 R - \rho & S < \tilde{S} \\ pr_{IC2}(S) - \rho & S \in [\tilde{S}, \bar{S}) \\ \delta pqR - \rho & S \geq \bar{S} \end{cases}.$$

This function is strictly increasing for $S \in [\tilde{S}, \bar{S})$.

The fact that borrowers are weakly better off with JL even when the lender is a monopolist is somewhat surprising and deserves some discussion. There are two effects here. Suppose there is no social capital and yet $\widetilde{S} = 0$, i.e., JL is preferred to IL. Under JL the tightest incentive constraint is the one that requires a borrower to pay back both her own and her partner's loan. Naturally, the borrower has to be given more rents. Now suppose borrowers have some social capital. Under IL the lender has no ability to exploit the borrowers' social capital, while he does under JL. He can choose the interest rate to induce the borrowers to guarantee one another's repayments and repay more often. He can increase the interest rate as their social capital increases. However, he will never make them worse off under JL than IL, because intra-group contracting limits his rent-extraction through IC1. When $S < \bar{S}$ they will be strictly better off, because the lender must give more rents to the borrowers in order to satisfy IC2.[22]

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[22] In fact, borrowers will be better off under JL for a large class of stochastic production functions including, for example, the uniform and exponential distributions. A proof is available upon request.

This result is policy-relevant, because it raises questions about what exactly constitutes "exploitative" behavior by the lender. The use of group lending to leverage borrowers' social capital has been criticized for putting stress on borrowers and suggested as an important motivation for the tendency of some lenders to move toward individual loans.[23] In our model, a monopolist using JL is bad for borrowers, but he is even worse with IL. The problem is market power, not the form of lending, and restricting contract choice may be bad for both efficiency and equity. Given the recent controversy over for-profit microlending, these concerns would appear to be much more serious.

1.6   Profits and borrower welfare

We are now able to analyze the welfare of borrowers and the lender's profits for all values of S under IL and JL. For the purposes of this discussion we will distinguish between V, the borrowers' utility from access to finance, total borrower welfare that also takes into account the direct payoffs from social capital, and aggregate welfare that includes profits.

We have seen that with a monopolist for-profit lender, over the interval $S \in [\tilde{S}, \bar{S})$, borrower utility from access to finance is higher under JL than IL but decreasing in social capital. However, the story is more positive when we consider borrower welfare as a whole. Focussing on the utility the borrower derives purely from the specific friendship in question, that is, the social capital S plus the $\tilde{V}$ built upon that relationship, we obtain the following proposition:

Proposition 3 *Borrower welfare, measured as $W(S) = V(S) + S$ is strictly increasing in S, even with a for-profit monopolist lender who exploits social capital.*

Proof.   Under the for-profit monopolist, for $S < \tilde{S}$ or $S \geq \bar{S}$, $\tilde{W}'(S) = 1$. $\tilde{W}(S)$ increases discontinuously at $\tilde{S}$. For $S \in [\tilde{S}, \bar{S})$, $\tilde{W}'(S) = 1 - \frac{\delta q}{2 - \delta q} > 0$. ■

This proposition shows that although the lender "taxes" the benefits of social capital, the marginal tax rate is strictly smaller than one and hence more social capital is always beneficial to the borrowers.

Lastly we turn to aggregate (borrower and lender) welfare from microfinance. Profits represent a loss of borrower welfare, so for comparability we discount the

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[23]See, for example, Grameen II at `http://www.grameen.com/`.

lender's profits according to the borrowers' discount rate. Therefore the net present value of a profits from a contract with repayment probability π is $\Pi_\delta(S) = \frac{\pi r - \rho}{1 - \delta \pi}$. This gives us a borrower-centric definition of efficiency:

Definition 1 *An* efficient *contract maximizes* $V(S) + \Pi_\delta(S)$.

Aggregate welfare under non-profit lending is $\hat{V}$ since the lender earns zero profits, and as already noted is the maximum attainable subject to the zero profit condition. Therefore the social welfare loss under monopoly lending is $\hat{V}(S) - \tilde{V}(S) - \Pi_\delta(S)$. This object is zero for $S < \hat{S}$ and $S \geq \tilde{S}$, and equal to $\frac{\delta p (1-p)(pR - \rho)}{(1 - \delta p)(1 - \delta q)} > 0$ for $S \in [\hat{S}, \tilde{S})$, because the monopolist inefficiently offers JL. We have the following result:

Proposition 4 *Monopoly for-profit lending is inefficient when* $S \in [\hat{S}, \tilde{S})$.

The effect is particularly stark as the lender puts no weight on future profits from a given borrower (which would benefit from the higher renewal probability under JL). However it can be shown that the result also holds for non-myopic lenders.

1.7 Interest rate caps

In the simulation section we analyze the welfare implications of market power in detail. However the model allows us to easily make one policy-relevant remark on the effect of interest rate caps (a key component of the Indian Microfinance Bill). The first-order effect is that the lender will be forced to cut his rates, essentially a transfer to the borrowers, increasing borrower welfare. There is a second-order effect on contract choice as well. If the lender is offering JL he will continue to do so. However, if he is offering IL but the cap lies below $\tilde{r}^{JL}(S)$, he will switch to JL, further improving borrower welfare. The reason is that the lender must now charge the same rate under IL and JL, but the JL repayment rate is higher. Thus in our framework, correctly calibrated interest rate caps can be an effective tool for borrower protection. However, since in our model the lender always supplies the whole market, we cannot comment on quantity effects.

2 Competition

We now extend the core model to allow for competition in the lending market, with a setup analogous to Shapiro and Stiglitz (1984). Entry by competitors imposes an

enforcement externality on existing lenders by tightening the borrowers' repayment constraints. This happens because the probability of a defaulting borrower being able to obtain a loan from another lender increases with entry. The higher is this probability, the weaker the incentive effects of the lender's termination threat.[24] The analysis thus far and in much of the literature assumes this probability is zero, so default leads to exclusion from future borrowing from *any* lender. We take the opposite approach here. A defaulting borrower has her contract terminated but is free to rematch with another lender in a subsequent period.

Our framework gives a simple and tractable model of competitive equilibrium in microfinance that focusses attention on the effect of social capital on credit rationing. Social capital partially mitigates the enforcement externality by substituting for the weakened dynamic incentive. The effect of competition on borrower welfare is ambiguous, and borrowers may be better off with a for-profit monopolist lender.

Until now, we have assumed that the single lender has full information on borrowers' histories, and permanently excludes all defaulters. In this section, we assume a large number of lending "branches" that may belong to the same or different lenders, but which cannot share information. Therefore defaulters can go on to borrow at another branch, the source of the enforcement problem. Formally, this is identical to assuming the lender forgets all borrowers' histories. We refer to this case as "competition".[25]

We assume there is a set of lenders, each of whom have one or more "branches", capable of serving two IL borrowers or one JL pair. The population mass of branches is l, while we normalize the population of borrower pairs to 1.[26] There is no communication of borrowers' histories between lenders or between branches of a given lender. If $l < 1$ there will be rationing in the credit market: not all borrowers can obtain a loan in a given period. If $l > 1$ then some lenders will have excess capacity.

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[24]This enforcement problem is analyzed by Hoff and Stiglitz (1997) in the context of the effect of lending subsidies on competition and enforcement effort by lenders. They focus on the effect of competition on equilibrium interest rates in a monopolistically competitive setting where the lenders exert effort to enforce loan repayments. We present a perfectly competitive model that focusses on credit rationing. McIntosh and Wydick (2005) analyze how weak information sharing between lenders may induce impatient borrowers to take out multiple loans, undermining the lenders' portfolio quality.

[25]We do not consider other, more nuanced approaches to information sharing, which are analyzed in the growing literature on credit bureaus in microfinance, see for instance De Janvry et al. (2010) and references therein.

[26]The industry could be a single lender with mass l branches, mass l lenders with one branch each, or something else in between.

Every borrower has a large number of potential partners, with each of whom they share social capital S, so any borrower who breaks a social tie (losing utility worth S) can always find another borrowing partner with the same social capital. At the start of a period, borrowers will be either "matched", in an existing relationship with a lender, or "unmatched", waiting to find a lender. Since branches are atomistic the probability of a borrower rematching to a branch at which she previously defaulted is zero, so an unmatched borrower's matching probability does not depend on her history. Unmatched branches post a contract offer and are costlessly and randomly matched to borrowers until all borrowers are matched or there are no more unmatched lenders. Each period, loans are made according to the contracts agreed, the repayment game is played, and any defaulters have their contracts terminated, rejoining the pool of unmatched borrowers. We note the following:

Observation 4 *There is credit rationing in equilibrium, i.e. $l < 1$.*

If this were not the case, there would be no dynamic repayment incentives, so all borrowers would default. Although formally trivial this result has an interesting implication. A common response to concern about commercialization is that access to funds from profit-motivated investors will enable much greater outreach.[27] By assuming all lenders face the same, constant opportunity cost of capital, we shut down that channel. The opposite message emerges: the enforcement externalities in competitive credit provision lead to *lower* outreach than either under a single non-profit or for-profit lender.

Since there is rationing, every branch will operate at full capacity every period, irrespective of the contract offered, with defaulting borrowers immediately replaced. Therefore each branch can act as a local monopolist, offering the more profitable of IL and JL at the highest r that satisfies the (modified) IC1 and IC2. Instant costless replacement of defaulters means that even patient lenders will simply maximize per-period profits. In equilibrium, entry occurs until lenders earn zero profits, at the intersection of the zero-profit interest rate and the tighter of IC1 and IC2. We assume that if both IL and JL break even, lenders offer the borrowers' preferred contract, JL, which rules out mixed equilibria.[28]

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[27]See for example the letter from Michael Schlein, chief executive of Accion to The New York Times, January 23rd, 2011, available at `http://www.nytimes.com/2011/01/24/opinion/lweb24micro.html`.

[28]There is at most one value of S, termed $\tilde{\tilde{S}}$, at which mixed equilibria could occur so this assumption is innocuous.

Suppose that proportion η branches offer IL loans, and $1 - \eta$ offer JL. Market scale is l. Therefore there are ηl IL borrowers, of which $(1-p)\eta l$ default each period, and $(1-\eta)l$ JL borrowers, of which $(1-q)(1-\eta)l$ default each period. The total proportion of unmatched borrowers is $P \equiv (1-p)\eta l + (1-q)(1-\eta)l + (1-l)$, so an unmatched borrower matches with an IL branch with probability $\frac{(1-p)\eta l}{P}$, and a JL branch with probability $\frac{(1-q)(1-\eta)l}{P}$. In equilibrium, $r^{IL} = \frac{\rho}{p}$ and $r^{JL} = \frac{\rho}{q}$. We denote the utility of an unmatched borrower by U. We obtain:

$$\tilde{\tilde{V}}^{IL} = \frac{pR - \rho}{1 - \delta p} + \frac{\delta(1-p)U}{1 - \delta p}$$

$$\tilde{\tilde{V}}^{JL} = \frac{pR - \rho}{1 - \delta q} + \frac{\delta(1-q)U}{1 - \delta q}$$

$$U = \frac{(1-p)\eta l}{P}\tilde{\tilde{V}}^{IL} + \frac{(1-q)(1-\eta)l}{P}\tilde{\tilde{V}}^{JL} + \frac{\delta(1-l)}{P}U$$

$$= \chi(l, \eta)\frac{pR - \rho}{1 - \delta}.$$

The function χ is defined as follows:

$$\chi(l, \eta) \equiv \frac{(1-p)(1-\delta q)\eta l + (1-q)(1-\delta p)(1-\eta)l}{(1-\delta p)(1-\delta q)(1-l) + (1-p)(1-\delta q)\eta l + (1-q)(1-\delta p)(1-\eta)l}$$

$$\chi(l, \eta) \in [0, 1], \ \chi_l \geq 0, \ \chi_\eta \geq 0.$$

The last two relations are due to the fact that greater scale or a higher proportion of (more frequently defaulting) IL borrowers increase the matching probability and thus welfare of an unmatched borrower. It is straightforward to check that borrower welfare is (weakly) higher under JL for all χ. Also note that as $\chi \to 1$, $\tilde{\tilde{V}}$ and U approach $\frac{pR-\rho}{1-\delta}$, which is the first-best welfare.

Total welfare from microfinance is the combined welfare of matched and unmatched borrowers, equal to:

$$Z \equiv \eta l\tilde{\tilde{V}}^{IL} + (1-\eta)l\tilde{\tilde{V}}^{JL} + (1-l)U$$

$$= \left[\frac{\chi(l, \eta)}{1 - \delta} + l(1 - \chi(l, \eta))\left(\frac{\eta}{1 - \delta p} + \frac{1 - \eta}{1 - \delta q}\right)\right](pR - \rho)$$

The modified framework implies that each lender will face a new IC1 (and IC2 under JL). The constraints now reflect the fact that the borrowers' outside option upon default is improved (they become unmatched and may re-borrow in future),

and so are tighter than before. As χ, and thus U increases, the tightest of these two constraints becomes tighter. This is the competition effect that constrains existing lenders' interest rates. We derive the constraints in Appendix A.1

2.1 Equilibrium

In equilibrium, it must not be profitable to open a new branch offering either IL or JL. Two key thresholds in the following analysis are $\tilde{\tilde{S}} \equiv \frac{p-\delta q}{\delta q(1-\delta q)}\rho$, and $\bar{\bar{S}} \equiv \frac{\rho}{\delta q}$.

Proposition 5 *If $\tilde{\tilde{S}} \leq 0$, the competitive equilibrium is JL-only lending, with market scale strictly increasing in S for $S < \bar{\bar{S}}$, and equal to a constant, $\bar{\bar{l}}$ for $S \geq \bar{\bar{S}}$. If $\tilde{\tilde{S}} > 0$, the equilibrium for $S < \tilde{\tilde{S}}$ is IL-only lending at fixed scale $\underline{l}$. At $\tilde{\tilde{S}}$, all lending switches to JL at scale $\tilde{\tilde{l}} > \underline{l}$, then increases continuously in S to $\bar{\bar{l}}$, at $\bar{\bar{S}}$. Welfare, Z, is strictly increasing in scale, l, and therefore weakly increasing in S.*

The proof can be found in Appendix A.1. The intuition of the proof is simple. For a given contract type, lender entry occurs until the tightest of IC2 and IC1 bind. Our assumptions guarantee that there is an equilibrium where lenders offer IL and break even at sufficiently small scale, but when S is small the JL IC2 may be too tight for JL to be offered. As S increases, the JL IC2 is relaxed to the point that all lending switches to JL. Thereafter, JL is offered and scale increases in S until IC1 binds. Aggregate welfare from microfinance, Z, is improved as S increases because this enables a relaxation of credit rationing.

Comparing the key S thresholds, we have the following result:

Proposition 6 *$\hat{S} \leq \tilde{\tilde{S}} \leq \tilde{S}$, with both inequalities strict when $p > \delta q$. Therefore the competitive market is weakly less likely to offer JL than the non-profit, but more likely than the for-profit monopolist.*

The result follows from the fact that profit-motivated lending branches open until the slackest repayment constraint (between IL and JL) binds. The tighter IC2 under JL discourages its use, just as under the monopolist.

This result is interesting because it is consistent with the (perceived) trend away from JL. Our model predicts that a commercialized microfinance market will exhibit this tendency, whether competition is weak or strong. A common story that is told to explain this trend is that lenders are responding to borrowers' preference for more

flexible IL loans. Our model rules this channel out, but yields another: for-profit lenders (competitive or otherwise) benefit from the slacker repayment constraints under IL.

2.2 Interest rate caps

In the competitive market, lenders earn zero profits so interest rate caps have less potential to improve borrower welfare and might even shut down the industry. However, there is one situation in which they could be effective. In the region $S < \tilde{\tilde{S}}$ the market offers IL contracts at interest rate $\frac{\rho}{p}$, higher than the zero profit rate under JL. Therefore a cap between $\frac{\rho}{p}$ and $\frac{\rho}{q}$ would force the lenders to switch to JL, albeit at a smaller scale. However, this could still be welfare improving. To see this, note that in the neighborhood of $\tilde{\tilde{S}}$, aggregate welfare in a JL-only equilibrium is strictly higher than in an IL-only equilibrium.

2.3 Comparing market structures

The following proposition shows that the ranking (by borrower welfare) of the market structures considered in this paper is ambiguous.

Proposition 7 *When market scale is sufficiently small, total welfare is higher under monopolistic lending than competitive lending. As scale approaches 1, the first-best welfare is achieved, dominating non-profit lending.*

Proof. Under monopolistic lending, total welfare is equal to $\tilde{V} \geq pR$, since all borrowers receive loans. Under competitive lending, $\lim_{l \to 0} Z = 0$, and $\lim_{l \to 1} Z = \frac{pR - \rho}{1 - \delta}$, the first best. ∎

Example 1 *Competition is dominated by monopolistic lending when S is small and ρ is large, since $\lim_{\rho \uparrow \delta p^2 R} \lim_{S \downarrow \tilde{S}} l(S) = 0$.*

Example 2 *Competition dominates non-profit lending when R is large and ρ is small, since $\lim_{\delta p^2 R - \rho \to \infty} \underline{l} = 1$, while borrower welfare under the non-profit is strictly smaller than the first best.*

Proposition 7 follows from the observation that when market scale under competition is small, the cost of credit rationing outweighs the benefits of lower interest

rates and the potential to borrow again after defaulting. By eliminating the enforcement externality generated by competition, the monopolist solves the credit rationing problem. When scale is large, borrowers are essentially able to borrow every period, so there is no longer the inefficiency generated by dynamic incentives.

The result we want to emphasize is the first part of Proposition 7, that competition might be dominated by monopoly, since this reflects the genuine concern about externalities in uncoordinated competition. The second part, that competition might dominate the non-profit, arises because of the assumption that the non-profit must use strict dynamic incentives, while competition mimics a contract with probabilistic termination on default, akin to Bhole and Ogden (2010). When credit rationing is small, this is superior to the non-profit's contract offer. We discuss relaxing the assumption of strict dynamic incentives in Appendix A.3.[29]

It is also interesting to consider what happens if we allow some branches to act like our non-profit, preferring the contract that maximizes borrower welfare. The interesting result is that provided for-profits are free to open new branches, the equilibrium will always be the competitive one. Free entry ensures that in equilibrium only one contract breaks even. Therefore, in an IL-only equilibrium, the non-profit branches are unable to switch to the borrowers' preferred JL, as this will be loss-making (the zero-profit interest rate violates IC2).

To summarize, the single non-profit lender is equivalent to perfect competition with full information sharing whereby defaulters can never borrow again. The for-profit monopolist is equivalent to a single (myopic) profit-maximizing lender or cartel with full information sharing. Lastly the competition model represents competition with no information sharing. Although reality will of course be a more complex mixture of these cases, interestingly they are not strictly ordered in a welfare sense. We now simulate the model for real-world parameters to further explore the welfare effects of changing market structure.

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[29]We assume strict dynamic incentives because this is what lenders seem to use in practice and because the analysis is much simpler. However, if the non-profit chose to use stochastic renewal, he could achieve at least the same welfare as competition. For example by choosing the appropriate renewal probability he can mimic the contract faced by the matched borrowers under competition. However, he can do better by offering this contract to all borrowers. Moreover, sometimes the competitive market offers IL when JL would be better for the borrowers. In Appendix A.3 we analyze a relaxed dynamic incentive, namely, renewing the group's contracts with certainty following repayment and with probability $\lambda \in [0, 1]$ following default. We find that the monopolist and competitive market always set $\lambda = 0$, while the nonprofit does use stochastic renewal, achieving higher borrower welfare than the competitive market. However, reassuringly, simulating this contract shows that the increase in welfare is relatively small.

3   Simulation

In this section we carry out a simple simulation exercise to get a sense of the order of magnitude of the effects analyzed in the theoretical analysis. We draw on plausible values for the key parameters of the model, mostly estimated using 2009 data from MIXMarket.org, an NGO that collects, validates and publishes financial performance data of MFIs around the world.

Throughout the analysis the numeraire is the loan size, so borrower welfare and social capital are measured in multiples of this. Loan sizes of course vary widely but in South Asia a typical microfinance loan is of the order of $100-200. The full sample results give a good picture of the basic empirical predictions of the model. The non-profit always offers JL, at a net interest rate of 15.9%, while the for-profit monopolist's interest rate is 38.2% when he offers IL, which occurs for social capital worth less than 0.15. When he switches to JL, the interest rate falls to 34.5%, but this difference is eroded as social capital increases, until eventually IC1 binds at social capital worth 0.40 and IL and JL interest rates equalize. Borrower utility from access to microfinance, V, is 2.76 with a non-profit lender, while the maximum value with a for-profit (at the point of he switching from IL to JL) is only 1.80, reducing to 1.60 under IL or when S is large.

Under competition, IL is offered for social capital worth less than 0.13, and JL thereafter. Market scale varies from 67% of borrowers served under IL, to 78% under JL when S is sufficiently large (note that these predictions should be thought of as local rather than national or regional market penetration). IL is offered for social capital worth less than 0.13 and aggregate welfare from microfinance, Z (which includes matched and unmatched borrowers) is 2.49. This is higher than welfare under a monopolist, so the welfare effect of credit rationing is clearly not too severe. For social capital worth more than 0.13, JL is offered at increasing market scale, with welfare increasing to a maximum of 2.90 for $S \geq 0.33$, higher even than welfare under the non-profit. This possibility was raised in Example 1 and is discussed further below.

The discussion proceeds as follows. First we modify the model to allow for larger group sizes, and also discuss the possibility that the LLC may bind (which we ruled out for the theoretical discussion for simplicity). Second, we describe the estimation of the model parameters. Third, we discuss the results using the full global sample of MFIs. Fourth, we perform some sensitivity checks and finally we discuss the results

when parameters are estimated at the regional level.

3.1   Group size and limited liability condition

We make one modification to the framework, modeling larger groups of size five instead of two.[30] Theoretically, small groups disadvantage JL, since they require very large "guarantee payments" and hence a very tight LLC. For simplicity, we retain the notion of S from the benchmark model - a deviating member loses social capital with the other members worth a total of S. In addition to this, we need to allow for the possibility that the LLC (which also depends on n and m) might be tighter than IC1. This is straightforward to implement in the simulations.

   With a group of size n, borrowers will agree to guarantee repayment provided at least some number, m, of members are successful, defining a guarantee payment of $\frac{nr}{m}$ per successful member, so for example if $n = 5$ and $m = 4$, each successful member would repay 1.25r when one member fails. It is easy to see that the group size does not affect IC1, that is, $\delta pR \geq r$ is still necessary. There will be a different IC2 for each value of m, corresponding to the payment that must be made when only m members are successful. In equilibrium, borrowers will repay for every $m \geq m^*$, where m^* is the smallest m such that repayment is incentive compatible. By reducing the interest rate the lender can increase the number of states of the world in which repayment takes place, generating a (binomial) repayment probability of $\pi(n, m, p)$. We discuss the derivation of the constraints in detail in Appendix A.4.

3.2   Data and Parameter values

The model's key parameters are R, p, ρ and δ. The numeraire throughout is the loan size, assumed to be identical between IL and JL, and the loan term is assumed to be 12 months. Since social capital and market structure are our key independent variables, we perform the various exercises for the non-profit, for-profit monopolist and competition cases while varying the level of S, computing welfare, interest rates and market scale. Changes in contract choice at the various thresholds of S lead to discontinuous jumps in the value functions, interest rate and market scale. Throughout we use weighted means or regression techniques, weighting by the number of loans outstanding as our unit of analysis is the borrower, thus, assuming one loan per

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[30]Five was the group size first used by Grameen Bank and by other prominent MFIs. An unexplored extension would be to allow the lender to optimally choose the group size.

borrower. We work with data from 715 institutions from the MIX to estimate the parameters and perform extensive sensitivity checks. Details of the construction of the dataset can be found in Appendix C.

Table 1 summarizes parameters in the full sample and across the regions. In addition we report the number of MFIs, number of loans outstanding (million) and the weighted mean interest estimate that was used to calibrate δ. We later compare these interest rate estimates with the non-profit rates predicted by the model. One immediate observation is the extent to which South Asia dominates the sample, comprising 68% of the full sample by number of loans (India comprises 41% of the full sample, and Bangladesh 22%). This observation partly motivates the decision to repeat the exercise by region.

Estimating p We estimate p using cross-sectional data from the MIX on Portfolio At Risk (PAR), the proportion of an MFI's portfolio more than 30 days overdue, which we use as a proxy for the unobserved default probability. This is not an ideal measure for two reasons. Firstly, PAR probably exaggerates final loan losses, as some overdue loans will be recovered. However, MFIs' portfolios are typically growing rapidly (see the discussion of the estimation of ρ below). If loans become delinquent late in the cycle, they will be drowned out by new lending, understating the fraction of a cohort that will subsequently default.

We also need to be mindful of the lending methodology, since the model predicts that JL borrowers will repay more frequently than IL borrowers. Our data allows us to separate the portfolio by lending methodology. Let θ denote the IL fraction of the lender's portfolio. Then we have $1 - PAR = \theta p + (1 - \theta)\pi(n, m, p)$. We estimate this equation by Nonlinear Least Squares (NLS), obtaining full sample estimates of $p = 0.921$ and $m = 3$.[31] Since we do not observe detailed contractual information we treat all "solidarity group" lending as JL, and all individual lending as IL, see the Appendix for more details.

Estimating ρ We estimate ρ using data from the MIX on administrative (x_a) and financial expenses (x_f). To obtain the cost per dollar lent, we need to divide expenses

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[31]However, if p varies at the MFI level, contract choice (reflected in θ) may also be a function of p, so the restriction that the underlying p for IL and JL is the same will be violated. An OLS regression of $1 - PAR$ on θ and a constant estimates a separate probability for IL and JL, but ignores the nonlinearity in the the model and sometimes yields estimates of π that exceed one. In practice, both approaches give very similar estimates, so we focus on the NLS results.

by the total disbursals of that MFI during the year. Since MIX does not report data on disbursals, we hand-collected disbursal data from annual reports of the largest MFIs listed on MIX, for which the (weighted) mean ratio of disbursals to year-end portfolio was 1.91. Therefore, for MFI i we estimate $\rho_i = 1 + \frac{x_{a,i} + x_{f,i}}{GrossLoanPortfolio * 1.91}$. Our full sample estimate is $\rho = 1.098$. Although we calibrate pR and δ using data in real terms, we do not deflate our estimate of ρ since we do not know the timing of expenses throughout the loan term or year.

Estimating δ Since the lender's only instrument to enforce repayment is the use of dynamic incentives, the borrowers' time preferences play an important role in the analysis. Unfortunately, it is not obvious what value for δ to use. Empirical estimates in both developed and developing countries vary widely, and there is little consensus on how best to estimate this parameter (see for example Frederick et al. (2002)). Due to this uncertainty, we calibrate δ as the mid-point of two bounds. We take the upper bound for all regions to be $\delta^U = 0.975$, since in a long-run equilibrium with functioning capital markets $\delta = \frac{1}{1+r^{rf}}$, where r^{rf} is the risk-free real rate of return which we take to be 2.5%, the mean real return on US 10-year sovereign bonds in 1962-2012. For the lower bound we use the model's prediction that $r \leq \delta pR$ by IC1. We estimate the real interest rate charged by MFIs in the MIX data as $r_i = \frac{RealPortfolioYield}{1-PAR}$. To avoid sensitivity to outliers, we then calibrate $\delta^L = \frac{\bar{r}}{pR}$, where $\bar{r}$ is the weighted mean interest rate. Using our calibrated value for pR of 1.6 (see below), we obtain $\delta^L = 0.753$ in the full sample. The midpoint of δ^U and δ^L gives us $\delta = 0.864$.

Estimating R There are few empirical studies that exploit exogenous variation in microentrepreneurs' capital stocks to estimate the returns to capital. We draw our full sample value for the returns to capital from De Mel et al. (2008). They randomly allocate capital shocks to Sri Lankan micro enterprises, and their study suggests annual expected real returns to capital of around 60%.[32] Since expected returns in our model are pR, we use $pR = 1.6$, dividing by our estimate of p to obtain $R = 1.737$.

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[32]In a similar study in Ghana, they find comparable figures. Udry and Anagol (2006) find returns around 60% in one exercise, and substantially higher in others.

Table 1: Summary Statistics and Parameter Estimates

	MFIs	Loans (m)	% Full Sample	IL share (num)[a]	IL share (value)	Interest rate	p	R	ρ	δ
Full Sample	715	65.217	100.0%	46.0%	81.9%	1.206	0.921	1.737	1.098	0.864
Central America	60	1.671	2.6%	93.8%	98.8%	1.190	0.881	1.816	1.112	0.860
South America	133	6.884	10.6%	97.7%	99.3%	1.237	0.928	1.724	1.102	0.874
Eastern Africa	20	2.439	3.7%	38.7%	70.4%	1.152	0.831	1.925	1.115	0.848
Northern Africa	20	1.735	2.7%	37.5%	59.2%	1.227	0.984	1.626	1.115	0.871
Western Africa	48	1.184	1.8%	60.5%	89.2%	1.306	0.882	1.814	1.173	0.896
South Asia	133	44.067	67.6%	34.8%	33.3%	1.180	0.926	1.728	1.083	0.856
South East Asia	85	4.296	6.6%	45.7%	68.3%	1.389	0.988	1.619	1.164	0.922
South West Asia	61	0.865	1.3%	75.0%	93.8%	1.272	0.967	1.655	1.106	0.885

Notes: IL shares are the fraction of the total number or total value of loans reported as IL loans. The interest rate column reports the weighted mean risk-adjusted portfolio yield, i.e. $r_i = \frac{RealPortfolioYield}{1-PAR}$. [a]For 10 observations we use the share by value to compute the overall figures in this column.

3.3   Results

Figure 1 graphically presents the results for the baseline simulation, which were discussed in detail in the introduction to this section. The values for the full sample and all regions of the S thresholds, corresponding interest rates, market scale and welfare are reported in Table 2 and Table 3. Table 2 also reports the contracts used by each type of lender, showing that the non-profit exclusively offers JL in the majority of cases, while the monopolist and competitive market typically offer IL for low S and JL for high S, although sometimes only IL is offered, corresponding to cases when the JL LLC is tight.

The first graph depicts borrower welfare, $\hat{V}$, $\tilde{V}$ and Z, and we also indicate the first-best borrower welfare level, $\frac{pR-\rho}{1-\delta}$. At jumps in the graph the contract switches from IL to JL. The welfare differences between the different market forms are substantial, with the interesting result that competition and non-profit lending are not strictly ordered. As discussed in section 2, this follows from the assumption that the non-profit uses strict dynamic incentives; in our view the key lesson is that non-profit and competition achieve similar performance despite the externality under competition. See also further discussion below.
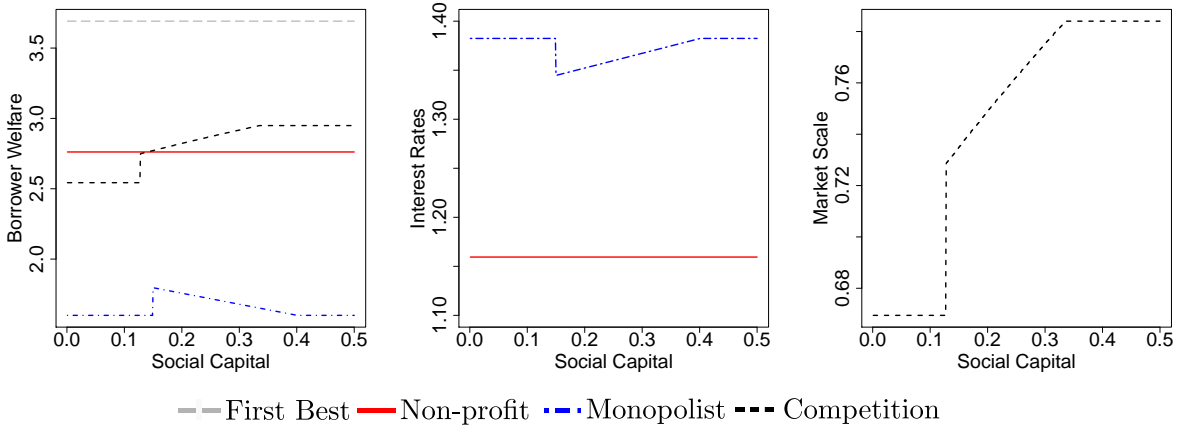

Figure 1: Full Sample Welfare, Interest Rates and Market Scale.

The second panel depicts the interest rates offered by the monopolist and non-profit (competitive interest rates are not reported, but correspond to the zero-profit interest rate for the relevant contract and value of m). We observe that monopolist rates are substantially higher. Furthermore, leverage of social capital affects the interest rate and borrower welfare for $S \in [0.15, 0.40]$ in the full sample. Moving to

Table 2: Lending methods and S thresholds across regions

| | Lending Methods | | | S thresholds | | | |
| | M | NP | C | M | | C | |
				$\tilde{S}$	$\bar{S}$	$\tilde{\tilde{S}}$	$\bar{\bar{S}}$
Full Sample	IL-JL	JL	IL-JL	0.148	0.400	0.126	0.334
Central America	IL-JL	JL	IL-JL	0.333	0.400	0.307	0.363
South America	IL-JL	JL	IL-JL	0.112	0.263	0.097	0.330
Eastern Africa	IL	IL	IL				
Northern Africa	IL	JL	IL-JL			0.188	0.319
Western Africa	IL-JL	JL	IL-JL	0.317	0.400	0.296	0.367
South Asia	IL-JL	JL	IL-JL	0.143	0.400	0.123	0.331
South East Asia	IL	JL	IL-JL			0.146	0.315
South West Asia	IL	JL	IL-JL			0.077	0.315

the third panel, we see how market scale under competition varies with S. Market scale follows the same pattern as the Z function and ranges between 67% and 78%. As previously discussed, this should be interpreted as a measure of local, and not national penetration.

We can now analyze the welfare implications of market power and the lender's choice of contractual form. When the monopolist voluntarily switches from IL to JL at $\tilde{S}$, borrower welfare increases by approximately 12%. If we go further, forcing the monopolist to always use JL the gain is 20% at $S = 0$ (and declining in S). Switching to a non-profit lender delivers a minimum gain of 54% (at $\tilde{S}$) and a maximum of 73% for $S < \tilde{S}$ or $S \geq \bar{S}$.[33] Thus our results underline the importance of constraining market power where it exists.

3.4   Sensitivity analysis

We check the sensitivity of the results by varying each parameter over a reasonable range, while holding the others constant. For simplicity we focus on the results for $S = 0$. The results of these exercises are presented in Figure 2. We only plot the parameter regions in which the model predicts any lending, hence at $S = 0$, there is no lending for $\delta < 0.773$, $p < 0.887$, $\rho > 1.273$ and $R < 1.515$.

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[33]Similarly, we can consider the effect of mandating JL under competitive lending, since for $S < \tilde{\tilde{S}}$ the market equilibrium is IL only. We find that welfare would increase by 2% at $S = 0$, with this gain increasing as S increases, up to 16% at $\tilde{\tilde{S}}$. This illustrates one aspect of the inefficiency of the competitive equilibrium discussed in section 3.6. We graph the welfare effects of mandating JL or IL under monopoly and competition in Figure 3 in the Appendix.

Table 3: Interest Rates, Market Scale and Borrower Welfare

| | Interest Rates | | | Market Scale | | Borrower Welfare | | | |
| | M | NP | | C | | M | NP | | C |
	$\tilde{r}^{IL}$	$\tilde{r}^{JL}(\tilde{S})$	$\hat{r}$ [a]	$\underline{l}$	$\bar{l}$	$\tilde{V}^{JL}(\tilde{S})$ [b]	$\hat{V}$ [a]	$Z(0)$	$Z(\bar{\bar{S}})$
Full Sample	1.382	1.345	1.159	0.669	0.784	1.796	2.761	2.543	2.949
Central America	1.376	1.363	1.251	0.432	0.476	1.648	2.074	1.581	1.733
South America	1.398	1.359	1.154	0.712	0.826	1.830	3.016	2.883	3.313
Eastern Africa	1.357		1.342[a]	0.063			1.642[a]	0.217	
Northern Africa	1.394		1.118	0.935	0.990		3.698	3.535	3.725
Western Africa	1.434	1.419	1.317	0.399	0.449	1.662	2.116	1.706	1.914
South Asia	1.370	1.331	1.137	0.698	0.813	1.800	2.803	2.573	2.967
South East Asia	1.475		1.166	0.955	0.995		5.498	5.351	5.562
South West Asia	1.416		1.117	0.879	0.963		3.983	3.811	4.150

Notes: [a] This is the JL interest rate or borrower welfare with a non-profit except where annotated with [a], in which case the values corresponds to the IL case as there is only IL lending in equilibrium. [b] $\tilde{V}^{IL}$ is equal to $pR = 1.6$ in every case, so not reported.

It becomes clear that welfare under a monopolist lender is not sensitive to any of the parameters, varying little in comparison with the larger effects under competition or non-profit lending (in particular, the monopolist's contract offer does not depend on ρ). For example, as R increases with a non-profit lender, all of the welfare gains are enjoyed by the borrowers. The monopolist, on the other hand, simply increases his interest rate, extracting almost all of the gains. Borrower welfare under competition typically tracks that under non-profit lending quite closely, so our conclusion that non-profit and competition have similar performance seems robust. The large welfare difference between non-profit and monopolist varies in each parameter, but is reasonably robust in the neighborhood of our estimates. It is also interesting to note that for low R, low p and δ welfare may be lower under competition than with a for-profit monopolist, as was theoretically predicted in Proposition 7. The patterns for interest rates are of course similar, and provide a useful check on the results.

In the third row we plot the three key S thresholds, $\hat{S}$, $\tilde{S}$, and $\tilde{\tilde{S}}$, at which non-profit, monopolist and competition switch from IL to JL lending. As predicted by Proposition 6, the non-profit is the most likely to use JL, with $\hat{S} = 0$ over most of the parameter ranges. The monopolist is the least likely, and when δ is large abandons JL altogether as the LLC is too tight relative to IC1. Moreover, our predictions for the thresholds vary very little over most of the parameter ranges. The small non-monotonicities under competition arise due to switching between different values of

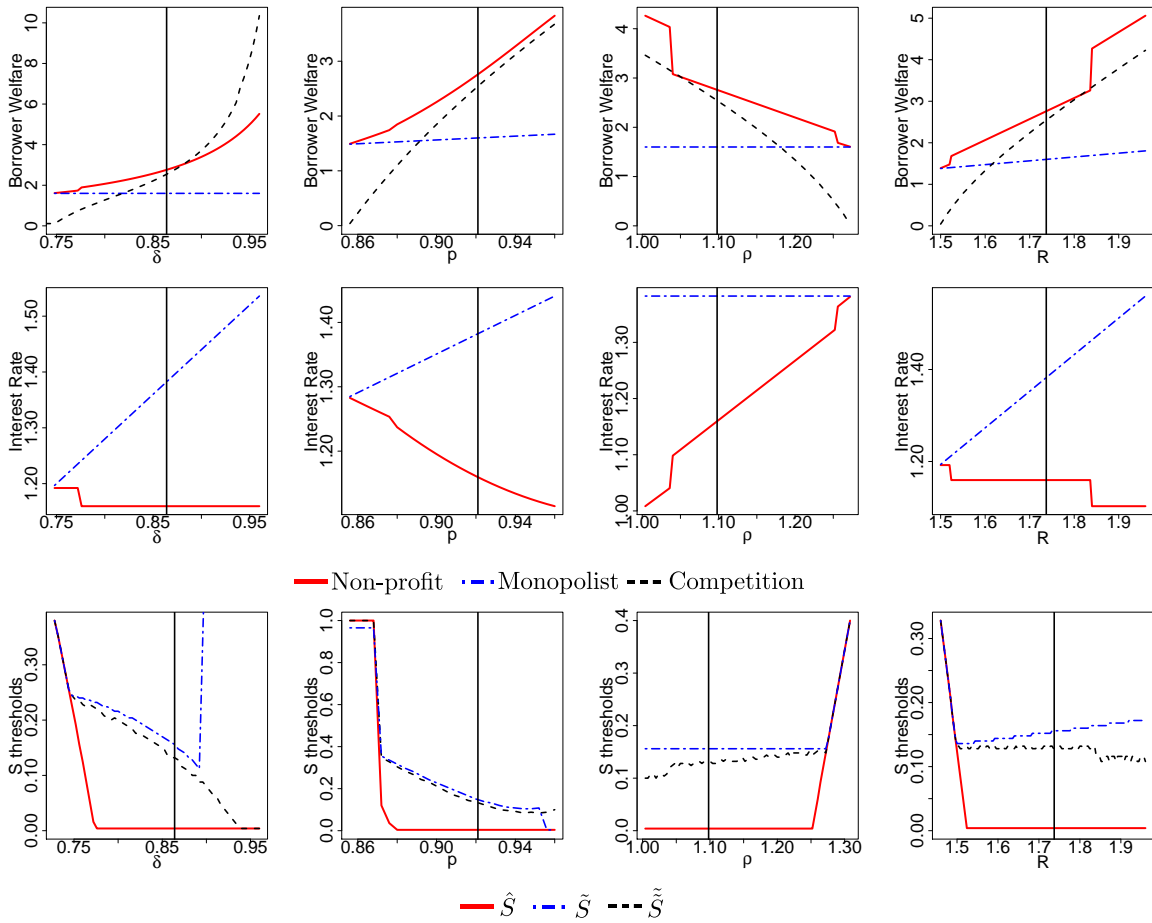m in the neighborhood of $\tilde{\tilde{S}}$.

Figure 2: Sensitivity Analysis. Vertical lines indicate full sample parameter estimates.

Overall, the model gives some fairly robust predictions about contracts offered and the ordering of borrower welfare, and in particular the results highlight the conclusion that market power matters more than contract choice for borrower welfare. The interest rate predictions are more sensitive, but remain reasonable in all cases. With this in mind, we explore the patterns across regions. This allows us to comment on the respective lending types that we would expect to prevail in certain regions and it allows us to comment on the variation in borrower welfare across regions due to different market structures.

3.5 Regional analysis

We now turn to the results at the regional level, presented in Tables 2 and 3. We graph the predicted borrower welfare functions in Figure 5 in Appendix A.5. We focus on seven regions with at least 1% of the total number of outstanding loans, comprising 94.2% of the total. We first observe that our parameter estimates always satisfy Assumption 1, so the model predicts at least IL lending in every region. However, the pattern of contracts offered depends on the market structure. In Eastern Africa, the model predicts only IL lending under all three market structures; the JL LLC is too tight for JL to even break even in these regions, primarily since the low success probability requires high interest rates. In Northern Africa, South East Asia and South West Asia, the non-profit would always offer JL, while the monopolist always offers IL. The relatively high success probabilities mean that the guarantee effect of JL is small relative to the cost to the lender of lower interest rates. In these cases, uncoordinated competition delivers IL for low S and JL for high S.

In all regions except Central America and Eastern Africa we observe that in welfare terms the non-profit and competition achieve similar outcomes. This observation is highlighted in the sensitivity analysis. In Central America the for-profit monopolist outperforms competition for S sufficiently small. In Eastern Africa, which has a very low success probability rendering repayment guarantees very costly for borrowers, competition performs very poorly, while non-profit and for-profit monopolist are almost identical in welfare terms. In line with Proposition 6, we see that the monopolist is less likely to offer JL than the competitive market.

Finally we compare the interest rates computed from the data (reported in Table 1) to the model predictions.[34] The broad pattern we observe is that mean interest rates seem reasonably close to the predicted non-profit rates, suggesting that most MFIs are operating close to their zero-profit constraints. For example, in South Asia the mean observed (net) rate is 18%, while our prediction is 14%. In South America, the difference is larger; the mean rate is 24%, versus a prediction of 15%, and the difference is 11 percentage points in Northern Africa. The results suggest that all three of these have the potential for significant rent-extraction by lenders. South East Asia and South West Asia are the most striking cases, with observed rates 22 and 16 percentage points higher than predicted, respectively. Particularly in South

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[34]Note that we cannot compare these values with the monopolist interest rates. To see this, recall that the IL interest rate is δpR. Since δ^L was calibrated from $\frac{\bar{r}}{pR}$, by construction the monopolist IL rate will exceed the mean rate in the data, $\bar{r}$.

Asia, where Grameen is based, our model predicts that abuse of market power by for-profit lenders would have severe consequences. However, as a whole, interest rates in South Asia are very close to our predictions for a non-profit, suggesting that either competition or pro-borrower motivation of the lenders is constraining this abuse.

3.6 Comparing competition and non-profit lending

A result that emerges from the simulations is that frequently the competitive market dominates the non-profit in welfare terms, despite the enforcement externality that leads to credit rationing. The reason for this is the relatively high repayment probabilities ensure that the population of unmatched borrowers is small, while all borrowers benefit from the ability to reborrow in future. Under the non-profit this is not available due to the assumption that strict dynamic incentives are used.

As we have argued, we do not consider this an unreasonable assumption. However, as mentioned in section 2.3, a benevolent non-profit can deliver at least the same welfare as the competitive market, by renewing borrowers' contracts with probability λ upon default. A simple way to achieve this would be to choose the renewal probability upon default to mimic the competitive outcome. In this case, the value function of the non-profit would be the envelope of the matched utility. We have computed this example and illustrate it in Figure 4 in Appendix A.3. The welfare-effect is not dramatic; borrower welfare under the non-profit increases from 2.761 with strict dynamic incentives to a maximum of 3.239 with the new contract, a 17% gain. Chosing λ optimally, the non-profit can perform even slightly better. We have simulated this as well and observe, that the only difference arises because the non-profit would switch to JL for a lower value of S.

3.7 Discussion

Collecting the simulation results, a picture emerges supporting the discussion in the theoretical analysis. The monopolist for-profit lender does exploit the borrowers' social capital and this has economically meaningful effects on interest rates and welfare. However, these are substantially smaller than the change in interest rates and welfare when switching to a large non-profit lender. The severe "mission drift" implied by a switch to for-profit lending with market power has large consequences for borrower welfare, consistent with the concerns of Muhammad Yunus raised earlier.

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The competition results are more positive. The theoretical welfare effects of competition are ambiguous, as shown in Proposition 7, due to the trade-offs between credit rationing, lower interest rates and the ability of borrowers to reborrow after an involuntary default. However, for the parameters estimated from our full sample and most regions considered, welfare under competition is approximately the same as under non-profit lending. Despite the negative press and industry concerns about competition in microfinance, here modeled as a enforcement externality, our results suggest a more positive view in which competition is able to mitigate the problems of market power. However, some discussion, particularly surrounding the recent crisis in Andhra Pradesh, India, has centered on multiple borrowing and over-indebtedness. These are important issues but not ones that we can address in our framework, so we leave them to future research.

Lastly, the findings corroborate the theoretical prediction that for-profit lenders are less likely to offer JL than the non-profit. In low social capital areas (S smaller than around 0.13-0.15) our competitive or monopolistic lenders would offer IL, while the non-profit continues to offer JL.

4 Conclusion

Motivated by recent debates about commercialization and the trade-off between the objectives of making profits and alleviating poverty this paper studies the consequences of market power in the context of microfinance. We focus on the consequences for borrower welfare going beyond the usual focus on repayment rates and interest rates. The existing literature on microfinance starts with the premise that MFIs are competitive or motivated by borrower welfare and in this paper we showed that there are interesting implications for relaxing this assumption. A lender with market power can extract rents from repayment guarantee agreements between his borrowers, but is ultimately constrained from making those borrowers worse off in the process. We compare borrower welfare under a for-profit with market power, a benevolent non-profit, and a competitive credit market. One of the interesting trade-offs that emerge is that of rent extraction under monopoly with the enforcement externality under competition. We simulated the model using empirical parameter estimates, and found that the consequences of market power for borrower welfare are significant, while the choice of lending method itself is somewhat less

important. Competitive for-profits typically do not perform much worse than our non-profit benchmark, especially when the level of social capital is high. Furthermore, commercial lenders with or without market power are less likely to use JL than the non-profit lender. Our findings suggest that Yunus appears to be correct to be concerned about abuses by for-profit lenders - particularly in South Asia, where Grameen is based, our model predicts considerable scope for abuse of market power by for-profit lenders. However, as a whole, interest rates in South Asia are very close to our predictions for a non-profit lender, weakening the case for concluding there is systemic abuse in practice in this region.

There are several directions for future work that we believe might be promising. For example, Muhammed Yunus argues that the shift from non-profit to for profit, with some institutions going public, led to aggressive marketing and loan collection practices in the quest for profits to serve the shareholders equity. Our paper does not model coercive loan collection methods by lenders, and allowing this might create an additional channel for for-profit and non-profits to behave differently, in a manner similar to the cost-quality trade-off as in the non-profits literature (see, for example, Glaeser and Shleifer (2001)).

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Appendix

A Proofs, Derivations and Simulation Results Omitted in the Paper

A.1 Competition

Consider a repayment probability π. IC1 requires that the value of future access to credit from the current lender, less the repayment amount, exceeds the borrower's outside option which is to return to the pool of unmatched borrowers. At the zero profit interest rate the condition is:

$$\delta V - \frac{\rho}{\pi} \geq \delta U.$$

Simplifying, we obtain

$$\delta pR \frac{1 - \chi(l,\eta)}{1 - \delta\pi\chi(l,\eta)} \geq \frac{\rho}{\pi}.$$

We denote the left hand side by $r_{IC1}^{IL}(\chi)$ under IL (when $\pi = p$) and $r_{IC1}^{JL}(\chi)$ under JL ($\pi = q$).

Unlike the full information case, we have a different IC1 for IL and JL. Note that $r_{IC1}^{JL}(\chi) > r_{IC1}^{IL}(\chi)$, so it is not possible for both IC1s to bind simultaneously. Also note that for all $\chi > 0$, $\frac{dr_{IC1}(\chi)}{d\chi} < 0$ for IL and JL. This is the competition effect through improvements in the borrowers' outside option. Also note that, as before, provided IC1 holds JL borrowers will always be willing to repay their own loans provided their partner is also repaying.

The IC2 under JL requires that repayment of both loans is preferred to losing access to the current lender (rejoining the unmatched pool) and losing the social capital shared with the current partner. The condition is

$$\delta(V + S) - 2\frac{\rho}{\pi} \geq \delta U,$$

which simplifies to

$$\frac{\delta[(1 - \chi(l,\eta))pR + (1 - \delta q)S]}{2 - \delta q - \delta q\chi(l,\eta)} \geq \frac{\rho}{q}.$$

We denote the left hand side by $r_{IC2}(S,\chi)$. $r_{IC2} \leq r_{IC1}^{JL}$ for $S \leq \frac{1-\chi(l,\eta)}{1-\delta q\chi(l,\eta)}pR$ (we

compute the equilibrium value of this threshold below). $\frac{dr_{IC2}(S,\chi)}{d\chi} < 0$ for all $S < \frac{2pR}{\delta q}$ and $\chi > 0$, and these conditions are satisfied whenever IC2 is tighter than IC1. This, again, is the effect of competition.

Proposition 5 If $\tilde{\tilde{S}} \leq 0$, the competitive equilibrium is JL-only lending, with market scale strictly increasing in S for $S < \bar{\bar{S}}$, and equal to a constant, $\bar{l}$ for $S \geq \bar{\bar{S}}$. If $\tilde{\tilde{S}} > 0$, the equilibrium for $S < \tilde{\tilde{S}}$ is IL-only lending at fixed scale $\underline{l}$. At $\tilde{\tilde{S}}$, all lending switches to JL at scale $\tilde{\tilde{l}} > \underline{l}$, then increases continuously in S to $\bar{l}$, at $\bar{\bar{S}}$. Welfare, Z, is strictly increasing in scale, l, and therefore weakly increasing in S.

Proof. In equilibrium, at most one of IL and JL breaks even, so we have:

$$\rho = \max\{pr_{IC1}^{IL}(\chi), \min\{qr_{IC1}^{JL}(\chi), qr_{IC2}^{JL}(S, \chi)\}\}.$$

Since the JL IC1 is strictly more slack than the IL IC1, if $\rho = pr_{IC1}^{IL}(\chi) > qr_{IC2}^{JL}(S, \chi)$, only IL will be used in equilibrium, and if $\rho = qr_{IC2}^{JL}(S, \chi) \geq pr_{IC1}^{IL}(\chi)$ only JL will be used (we assume that JL will be offered when both IL and JL break even).

Solving $\rho = pr_{IC1}^{IL}(\chi)$, for χ we obtain:

$$\tilde{\tilde{\chi}} = \frac{\delta p^2 R - \rho}{\delta p^2 R - \delta p \rho}.$$

Solving $\rho = qr_{IC2}(S, \chi)$ yields:

$$\chi(S) = \tilde{\tilde{\chi}} + \frac{1 - \delta q}{pR - \rho}(S - \tilde{\tilde{S}})$$

$$\tilde{\tilde{S}} = \frac{p - \delta q}{\delta q(1 - \delta q)}\rho \gtreqless 0$$

Now we check the equilibrium contracts. There is no equilibrium with JL lending for $S' < \tilde{\tilde{S}}$, since $\chi(S') < \tilde{\tilde{\chi}}$, in which case the IL IC1 would be slack and new lenders would enter offering IL. By a symmetric argument there is no equilibrium with IL lending for $S'' > \tilde{\tilde{S}}$. At $\tilde{\tilde{S}}$, lending switches from IL to JL, so η changes discontinuously from 1 to 0. This enables us to solve for market scale, using $\chi(\underline{l}, 1) = \chi(\tilde{\tilde{l}}, 0) = \tilde{\tilde{\chi}}$. We obtain the market scale under IL, equal to

$$\underline{l} = \frac{\delta p^2 R - \rho}{\delta p^2 R - p \rho},$$

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and the market scale after the switch to JL, equal to

$$\tilde{\tilde{l}} = \frac{(\delta p^2 R - \rho)(1 - \delta q)}{(\delta p^2 R - p\rho)(1 - \delta q) + p(1 - p)(1 - \delta)\rho}.$$

Since $\chi_l > 0$ and $\chi_\eta > 0$ for all $l > 0$, we have $\tilde{\tilde{l}} > \underline{l}$[1] Lastly note that if $\tilde{\tilde{S}} < 0$, there is never IL lending in equilibrium, $\chi(0) > \tilde{\chi}$ and market scale at $S = 0$ exceeds $\tilde{\tilde{l}}$.

Now consider $S > \tilde{\tilde{S}}$. Lending is JL-only, so $\eta = 0$. Since IC2 is relaxed as S increases, entry will occur to compensate, so l is strictly increasing in S as long as IC1 is slack. IC2 must then intersect IC1 at some $\bar{\bar{S}} > \tilde{\tilde{S}}$, where χ reaches a maximum $\bar{\bar{\chi}}$. Solving $\rho = qr_{IC1}^{JL}(\bar{\bar{\chi}}) = qr_{IC2}^{JL}(\bar{\bar{S}}, \bar{\bar{\chi}})$, we obtain:

$$\bar{\bar{S}} = \frac{\rho}{\delta q}$$

$$\bar{\bar{\chi}} = \frac{\delta pqR - \rho}{\delta pqR - \delta q\rho}$$

Then, solving $\chi(\bar{l}, 0) = \bar{\bar{\chi}}$ yields $\bar{l} = \frac{\delta pqR - \rho}{\delta pqR - q\rho}$, the maximum scale.

For $S \in (\tilde{\tilde{S}}, \bar{\bar{S}})$, market scale is $\frac{(1 - \delta q)\chi(S)}{(1 - q) + q(1 - \delta)\chi(S)}$ which is strictly increasing in S. Collecting results, we have $l(S) = \max\left\{\underline{l}, \min\left\{\frac{(1 - \delta q)\chi(S)}{(1 - q) + q(1 - \delta)\chi(S)}, \bar{l}\right\}\right\}$, IL-only lending for $S < \tilde{\tilde{S}}$ and JL-only for $S \geq \tilde{\tilde{S}}$.

Note that we can allow a weaker form of Assumption 2, namely $\frac{R}{2} \geq \frac{\rho}{p}$, such that the LLC does not bind in the zero-profit equilibrium. ∎

A.2 Mandating JL or IL

In section 3.3 we discussed the welfare effects of mandating JL or IL under monopoly or competitive lending. These are illustrated in Figure 3.

A.3 Stochastic Renewal

Suppose the lender offers either JL or IL, but renews the group's contracts with certainty following repayment and with probability $\lambda \in [0, 1]$ following default. One complication immediately arises. Suppose the state is $(R, 0)$ and the interest rate is

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[1]The interested reader may note that there are many mixed equilibria at $\tilde{\tilde{S}}$, defined by a one-to-one function $l(\eta)$, $\eta \in [0, 1]$, of which $l = \tilde{\tilde{l}}$, $\eta = 0$ is the welfare-maximizing case.

Monopolist   **Competition**
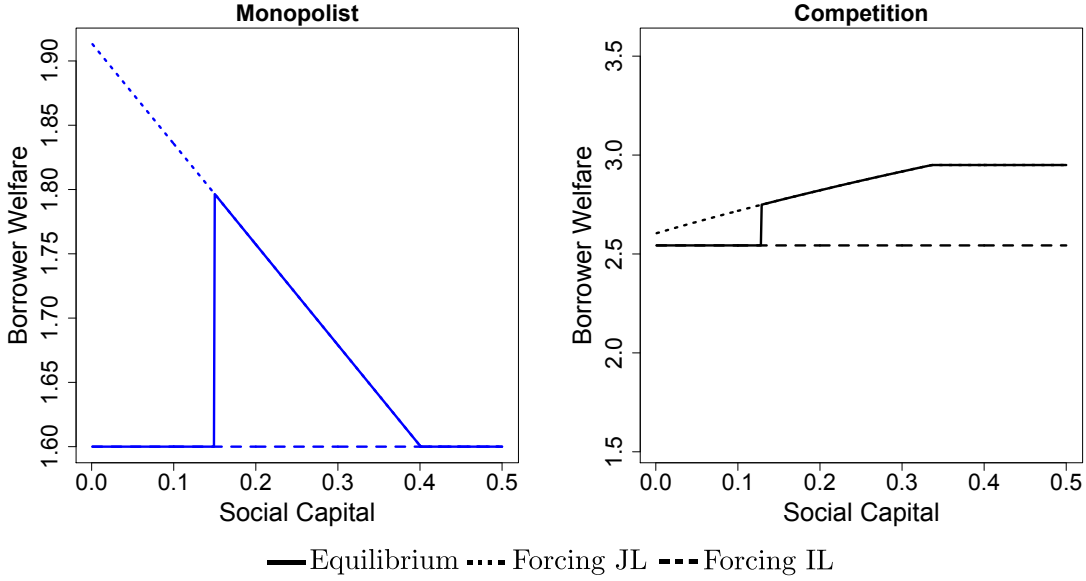
—— Equilibrium ···· Forcing JL --- Forcing IL

Figure 3: Mandating contractual form. Social capital ranges on horizontal axes, borrower welfare on vertical axes.

r. If borrower 1 defaults, her social capital is lost but the group might survive, so her IC2 is $\delta(V(S,r)+S)-2r \geq \delta\lambda V(0,r)$. For a given interest rate r, $V(S,r) \geq V(0,r)$, since without social capital repayment guarantees may not be possible. This may be a key reason why such flexible penalties are not widely used - the borrowing group dynamic may be too badly damaged following a default. To retain the basic structure of our benchmark model, we make the simplifying assumption that if the borrowers' contracts are renewed following a default, the group is dissolved and members matched up with new partners with whom they share the same value of social capital. Default is still costly, since it destroys the social capital of the existing group, but does not adversely affect the dynamic of the group if it survives. This assumption is the analogue of the group reformation assumption in the competition framework.

It is easy to see that the stochastic renewal setup closely mirrors the competition framework. Specifically, for a given S, a single lender could offer a the same contract (IL or JL and the same interest rate) as offered under competition, that renews with probability $\lambda = \frac{U(S)}{\tilde{\tilde{V}}(S)}$ following default. The tightest of IC2 and IC1 would bind, and all borrowers would receive utility $\tilde{V}(S)$.[2] However, the contracts that emerge in

---

[2]To see this, note that for repayment probability π and $r = \frac{\rho}{\pi}$, $\tilde{V} = pR - \rho + \delta(\pi V + (1-\pi)U)$, while the stochastic renewal contract yields $V = pR - \rho + \delta(\pi + (1-\pi)\lambda)V$.

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equilibrium are quite different, as shown in the following proposition.

Proposition 8 *Consider the following modification to the contracting setup: the lender renews the borrowers' contracts with certainty after repayment, and probability λ following default. Equilibrium contracts are as follows:*

1. *Neither the monopolist nor competitive lenders use stochastic renewal: $\lambda = 0$.*

2. (a) *If $\frac{\delta p^2 r}{\rho} \leq \frac{1-\delta p}{1-p}$, the nonprofit offers JL for all $S \geq \hat{S}$ as before, and $\lambda > 0$ for all S (unless the JL IC2 binds at $S = \hat{S}$, in which case $\lambda = 0$ at $\hat{S}$).*

   (b) *If $\frac{\delta p^2 r}{\rho} > \frac{1-\delta p}{1-p}$, there is an $\hat{\hat{S}} \in (\hat{S}, \frac{\rho}{\delta q})$ such that the nonprofit offers IL for all $S < \hat{\hat{S}}$, JL otherwise, and $\lambda > 0$ for all S.*

   (c) *When JL is used, λ and thus borrower welfare V is strictly increasing in S for all $S < \frac{\rho}{\delta q}$.*

3. *Borrower welfare is always higher with the nonprofit lender than under competition.*

Proof. The key relationship to check is the effect of λ on IC1 and IC2. For a given V, higher λ implies weaker penalty for default. However, higher λ increases V by improving the borrower or group's renewal probability. It turns out that the former effect dominates; the constraints are strictly tighter as λ increases.

First consider the single (non-profit or for-profit) lender case. Borrower utility with stochastic renewal and repayment probability π is

$$V = \frac{pR - \pi r}{1 - \delta(\pi + (1-\pi)\lambda)}.$$

The LLC is unchanged. The IC1 is $\delta(1-\lambda)V \geq r$ or

$$\frac{1-\lambda}{1-\delta\lambda}\delta pR \geq r.$$

The IC2 under JL is $\delta[(1-\lambda)V + S] \geq 2r$ or

$$\frac{\delta[(1-\lambda)pR + (1 - \delta(q + (1-q)\lambda))S]}{2 - \delta(q + \lambda(2-q))} \geq r.$$

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Both are strictly tighter as λ increases. To see this for IC2, suppose IC2 binds. Rearranging, we obtain $\frac{dr}{d\lambda} = \frac{pR - \pi r}{2 + \pi a(\lambda)} a'(\lambda)$ where $a(\lambda) = \frac{\delta(1-\lambda)}{1 - \delta(q + (1-q)\lambda)} > 0$, $a'(\lambda) < 0$. Thus the monopolist always sets $\lambda = 0$, since increasing λ forces him to decrease the interest rate.

With competition, the corresponding constraints are

$$\delta(1 - \lambda)(V - U) \geq r \tag{IC1}$$

$$\delta[(1 - \lambda)(V - U) + S] \geq 2r \tag{IC2}$$

U is exogenous from the lender's perspective, and $V - U > 0$ in equilibrium. Using $V = pR - \pi r + \delta[(\pi + (1 - \pi)\lambda)V + (1 - \pi)(1 - \lambda)U]$, we obtain $\delta(1 - \lambda)(V - U) = a(\lambda)(pR - \pi r - (1 - \delta)U)$, from which it is straightforward to check that both IC1 and IC2 are strictly tighter as λ increases. Thus stochastic renewal is never used in competition. To see this, consider an equilibrium with $U = U^*$ where some lender offers IL with $\lambda^* > 0$ and breaks even. This implies that, for his borrowers, $\delta(1 - \lambda^*)(V(\lambda^*) - U^*) = \frac{\rho}{p}$. But then an entrant could offer IL with $\lambda' < \lambda^*$ and earn positive profits since $\delta(1 - \lambda')(V(\lambda') - U^*) > \frac{\rho}{p}$. An analogous argument rules out equilibria with stochastic renewal and JL, and rules out entry by lenders using stochastic renewal in an equilibrium with no stochastic renewal.

The non-profit lender will use stochastic renewal whenever the tightest repayment constraint is slack at the zero-profit interest rate, since increasing λ improves borrower welfare without violating the constraint. We first analyze contract choice under IL and JL, then the choice of contract type.

Under IL, the lender chooses λ to bind IC1. The solution to $\frac{1-\lambda}{1-\delta\lambda}\delta pR = \frac{\rho}{p}$ is $\hat{\lambda}^{IL} \equiv \frac{\delta p^2 R - \rho}{\delta p^2 R - \delta \rho}$, which is strictly positive by Assumption 1.

Under JL, the lender chooses λ to bind the tighter of IC1 and IC2. Just as in the competition setup, IC1 and IC2 intersect at $S = \frac{\rho}{\delta q}$. If IC1 is binding, $\hat{\lambda}^{JL}(S) = \frac{\delta pqR - \rho}{\delta pqR - \delta \rho}$. If IC2 is binding, $\hat{\lambda}^{JL}(S) = \frac{\delta q[pR + (1 - \delta q)S] - (2 - \delta q)\rho}{\delta q[pR + \delta(1-q)S] - \delta(2-q)\rho}$. λ is strictly increasing in S until $S = \frac{\rho}{\delta q}$. However, note that if $S < \hat{S}$, JL is not usable even

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with $\lambda = 0$, and for $S > \hat{S}$, $\hat{\lambda}^{JL}(S) > 0$. Therefore, we have:

$$\hat{\lambda}^{JL}(S) = \begin{cases} 0 & S < \hat{S} \\ \frac{\delta q[pR + (1-\delta q)S] - (2-\delta q)\rho}{\delta q[pR + \delta(1-q)S] - \delta(2-q)\rho} & S \in [\hat{S}, \frac{\rho}{\delta q}) \\ \frac{\delta pqR - \rho}{\delta pqR - \delta\rho} & S \geq \frac{\rho}{\delta q} \end{cases}$$

The nonprofit chooses JL whenever

$$\hat{V}^{JL}(S, \hat{\lambda}^{JL}(S)) \geq \hat{V}^{IL}(\hat{\lambda}^{IL}).$$

Since the numerator is $pR - \rho$ in both cases, JL is used if and only if

$$1 - \delta(q + (1-q)\hat{\lambda}^{JL}(S)) \leq 1 - \delta(p + (1-p)\hat{\lambda}^{IL})$$

or

$$\hat{\lambda}^{JL}(S) \geq \frac{\hat{\lambda}^{IL} - p}{1 - p}.$$

At $\hat{S}$ (i.e. $\hat{\lambda}^{JL}(S) = 0$) this reduces to $\frac{\delta p^2 R}{\rho} \leq \frac{1-\delta p}{1-p}$. If this condition holds, the lender offers JL for all $S \geq \hat{S}$, just as before. Otherwise, he offers JL for $S \geq \hat{\hat{S}}$, with $\hat{S} < \hat{\hat{S}} < \frac{\rho}{\delta q}$, defined implicitly by $\hat{\lambda}^{JL}(\hat{\hat{S}}) = \frac{\hat{\lambda}^{IL} - p}{1-p}$.

To see the last part of the proposition, we have already noted that by mimicking the competitive market the nonprofit can give utility $\tilde{V}$ to each borrower. However, as he is unconstrained by the market equilibrium conditions, he may be able to offer an alternative contract that yields higher borrower welfare. Secondly, since he uses stochastic renewal instead of credit rationing as a motivating device, this contract can be offered to all borrowers, instead of just the matched borrowers as under competition. ∎

Stochastic renewal is more efficient than strict dynamic incentives. Nevertheless we find that the for-profit monopolist and competitive lenders will never use it. As a result, the nonprofit organizational form achieves the highest borrower welfare.[3] Figure 4 shows borrower welfare and λ under the simulated stochastic renewal contract.

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[3]If the monopolist also valued future profits from a given borrower (non-myopic), he *would* use stochastic renewal, since there is now a tradeoff between higher interest rates and increasing the renewal probability. The result for the competitive market only relies on free entry and zero-profit equilibrium and therefore does not depend on the lenders' time horizon.
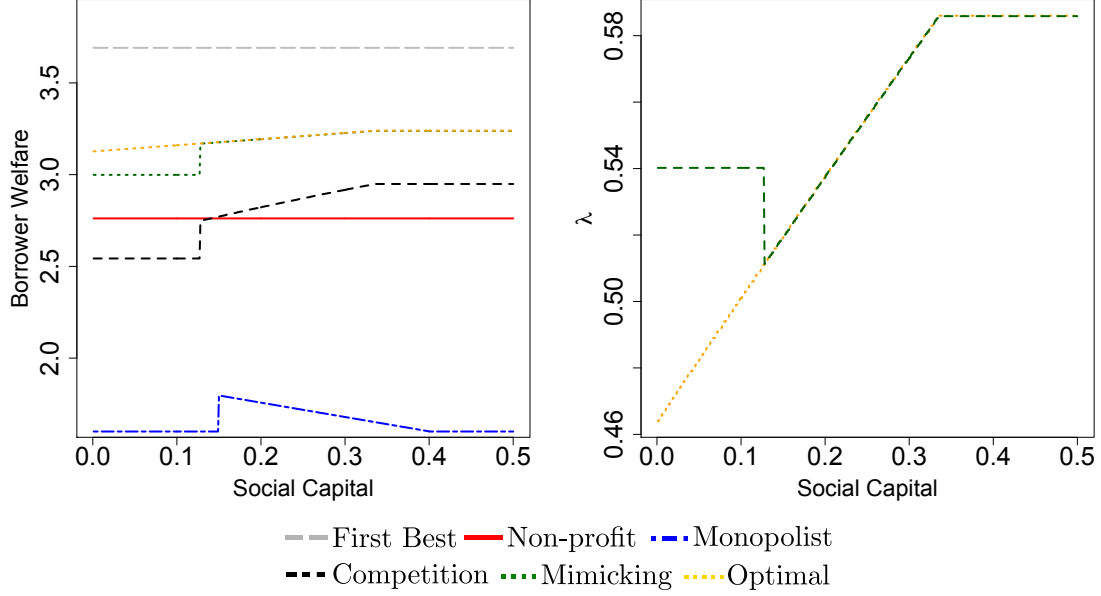
Figure 4: Simulating the stochastic renewal contract. Social capital ranges on horizontal axes, borrower welfare on vertical axes.

A.4 Group size and binding limited liability condition

Consider a group of size n, and suppose the group's loans are repaid whenever at least m members are successful. Then the repayment probability is

$$\pi(n, m) = \sum_{i=m}^{n} \binom{n}{i} p^i (1-p)^{n-i},$$

so

$$V = \frac{pR - \pi(n, m)r}{1 - \delta\pi(n, m)}.$$

IC1 is unchanged: $r_{IC1} = \delta pR$. For the successful borrowers to be willing to repay when exactly m are successful, each repaying $\frac{nr}{m}$, we must have $r \leq r_{IC2}(S, n, m)$, which we can derive as:

$$r_{IC2}(S, n, m) \equiv \frac{\delta m[pR + (1 - \delta\pi(n, m))S]}{n - (n-m)\delta\pi(n, m)}.$$

The LLC requires that the m successful borrowers can afford to repay all 5 loans, i.e. $nr \leq mR$ yielding

$$r_{LLC}(n, m) \equiv \frac{mR}{n}.$$

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For a given $r \leq r_{IC1}$, borrowers will choose the lowest m such that to IC2 and LLC are satisfied, so equilibrium m^* is determined by

$$\min\{r_{LLC}(n, m^*), r_{IC2}(S, n, m^*)\} \geq r > \min\{r_{LLC}(n, m^* - 1), r_{IC2}(S, n, m^* - 1)\}.$$

This m^* then defines the repayment probability function $\pi^*(S, n, r)$.

The non-profit lender chooses the lowest r such that $\pi^*(S, n, r)r = \rho$. The for-profit chooses r to maximize $\pi^*(S, n, r)r$.

Despite this modification, it may be that LLC at m^* is tighter than IC1, in which case the highest interest rate the lender can charge under JL will now be dictated by the LLC and smaller than r_{IC1}. If this is the case and the lender is a for-profit monopolist, borrowers will be *strictly* better off under JL than IL. However, if the LLC is very tight, JL may never be offered. This has three implications for the simulations. Firstly, the value of $\bar{S}$, obtained from the point at which the lender can no longer leverage social capital, depends on whether IC1 or LLC are tightest. Formally, with the group size modification,

$$\bar{S} = \min\left\{ \frac{(n-m)pR}{m}, \frac{[n(1 - \delta p) - (n - m)\delta\pi^*]R}{\delta n(1 - \delta\pi^*)} \right\}.$$

Secondly, the interest rate and borrower welfare at $\bar{S}$ are be lower and higher respectively than the corresponding values under IL, when $r_{LLC} < r_{IC1}$. Thirdly, if r_{LLC} is very tight for every m there may be no value $\tilde{S}$ at which the lender is willing to offer JL.

A.5 Regional welfare predictions

Figure 5 plots the predicted borrower welfare in each of the regions considered in the simulations, as was discussed in section 3.3.

B Simulation Methodology

This Appendix outlines the algorithm used to simulate the core model. The simulation was implemented in Scilab, an open-source alternative to Matlab. Rather than solving the model explicitly, which becomes increasingly complicated with larger groups, we chose to simulate the optimization problem numerically. As the objective
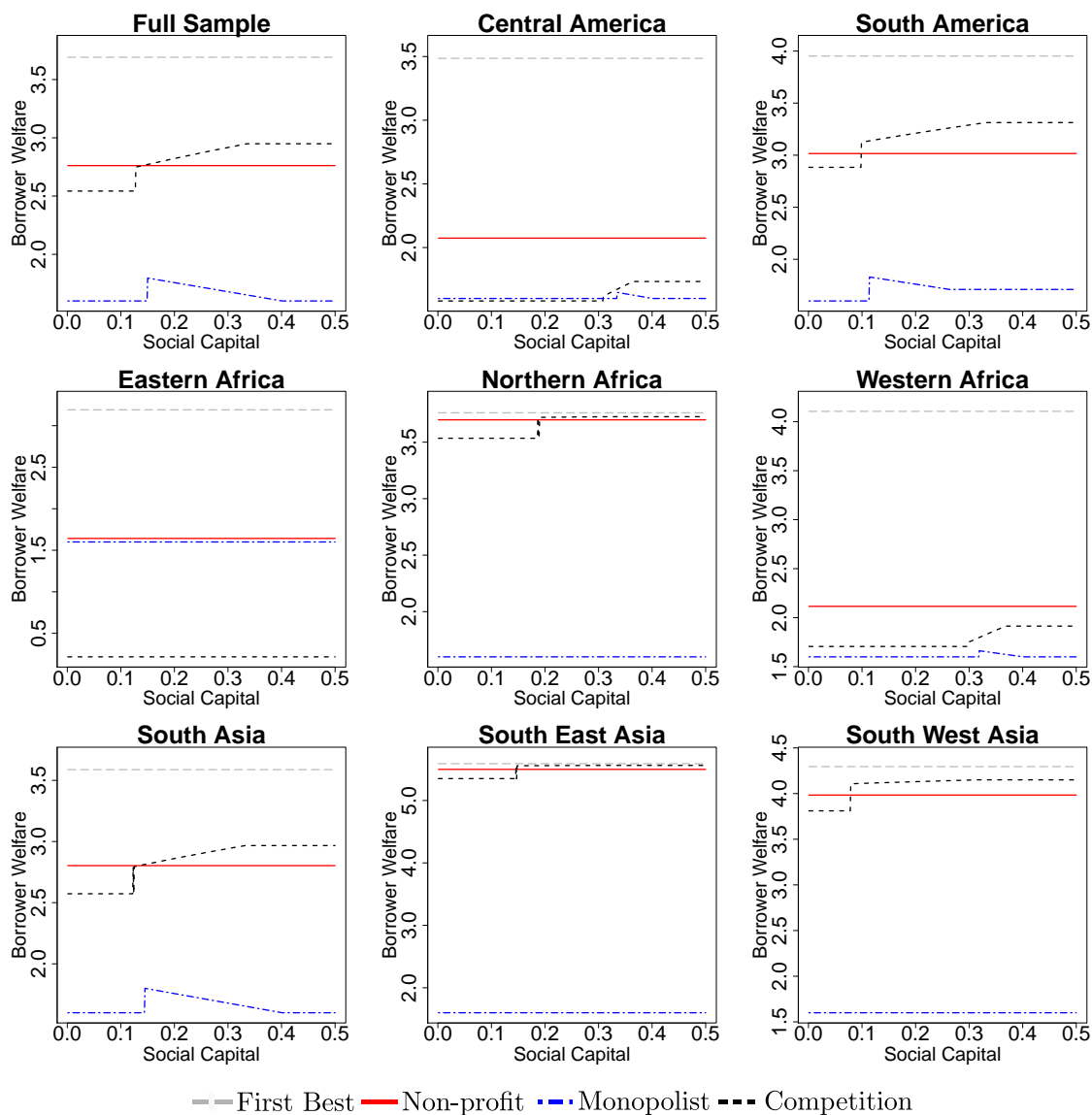
Figure 5: Borrower Welfare: Regional Differences. Social capital ranges on horizontal axes, borrower welfare on vertical axes.

functions are all linear, this is a computationally tractable and simple task.

The simulation consists of two parts. The first part computes the optimal contracts of a non-profit and a monopolist lender, while varying the level of social capital S. The second part computes the competition section.

The section proceeds by presenting annotated pseudo-codes, that illustrates how the code proceeds to arrive at the optimal contracts.

Non-Profit and Monopolist

Here the optimization is very simple, as we do not have to study an entry condition, but just have to evaluate a set of constraints. The optimization procedure is carried out for each level of social capital, which then gives us the value functions we use for the main plots in the paper. Since $n = 5$ throughout we drop the n notation.

For each value of S:

Non-Profit

1. JL: find the set M_{JL}^{ZP} of values for m that satisfy $r_{LLC}(m) \geq \rho/\pi(m)$ and the associated functions $\hat{V}^{JL}(m)$.

2. IL: Find, if it exists, the IL zero-profit equilibrium and the associated $\hat{V}^{IL}$.

3. Choose the contract (IL/JL), value of m and corresponding interest rate that gives borrowers maximal utility.

Monopolist

1. JL: For each $m \in M_{JL}^{ZP}$ find the maximal interest rate $\tilde{r}(m)$ such that $\tilde{r}_{JL}(m) = \min\{r_{IC2}(m), r_{LLC}(m), r_{IC1}\}$ and compute the associated profits $\tilde{\Pi}(m)^{JL} = \pi(m)\tilde{r}^{JL}(m) - \rho$.

2. IL: Compute the maximal interest rate $\min\{r^{IC1}, r^{LLC}\}$ and compute the associated profits $\tilde{\Pi}^{IL} = p\tilde{r}^{IL} - \rho$.

3. Choose the contract that maximizes profits.

Competition

For the competition model, we simulate the entry condition for lenders. For each value of S and U we check whether an entrant could earn positive profits with some contract (recall that in equilibrium there is always excess demand for credit). This will happen as long as the relevant constraints (see below) are slack at the relevant zero-profit interest rate. Hence, for each S we proceed by iteratively increasing U until the most profitable contract breaks even. The details are provided in the following pseudo-code:

For each value of S:

1. Initialize $U = 0$.

2. JL: for all $m = 1, ..., n$, check that all three constraints (LLC, IC2, IC1) are satisfied at the zero-profit interest rate.

3. IL: check that IC1 is satisfied at the zero-profit interest rate.

4. If there exists at least one contract such that all relevant constraints are satisfied, increase U by one unit and repeat from step 2. Otherwise, we have found the equilibrium value of U. The equilibrium contract (either IL or JL and the appropriate value of m) is the one for which all three constraints were satisfied in the previous round of iteration. If two or more contracts are feasible, pick the one that delivers the highest borrower welfare.

5. Given the equilibrium contract, solve U for the equilibrium market scale, and thus find Z.

Optimal Contract with Stochastic Renewal

The algorithm to determine the optimal level of λ is very similar to the one that determines the level of U in the competition simulation. The idea is, that a non-profit adjusts λ as long as the relevant constraints are slack. The key difference is that the non-profit finds the binding level of λ for for all different levels of m and then choses the level of m that provides borrowers with maximal utility. Free-entry competition may not yield the welfare-maximizing level of m. The reason is that entry continues until the slackest constraints eventually binds, which gives a single value for U. Under the optimal stochastic renewal contract, we find the optimal λ for

each level of m respectively and then let the non-profit chose the welfare-maximizing contract. The details are provided in the following pseudo-code:

For each value of S:

1. Initialize $\lambda = 0$.

2. JL: for all $m = 1, ..., n$, check that all three constraints (LLC, IC2, IC1) are satisfied at the zero-profit interest rate.

    (a) if for any m, a constraint is violated, we record the current λ as the optimal one for that particular m.

3. IL: check that IC1 is satisfied at the zero-profit interest rate.

    (a) if the constraint is violated, we record the current λ as the optimal one for IL.

4. As long as there exists at least one contract such that all relevant constraints are satisfied (either IL or all JL), increase λ by one unit and repeat from step 2.

5. Evauate the value functions at the respective optimal λ and chose the contract that maximizes utility.

C   Data Appendix

The dataset we work with comes from MIXMarket.org, an organization that collects, validates and publishes financial performance data of MFIs around the world. The MIX provides a set of reports and financial statements for each MFI reporting to it. The financial statements and reports were downloaded in March 2011, the relevant data was then extracted into a database using an automated script. The variables we use in this paper come from the MFIs' Overall Financial Indicators, the Income Statement, the Balance Sheet and the Products and Clients report. The Balance sheet and the Income statements are regular financial statements, while the Financial Indicators report variables such as Portfolio at Risk and the Products and Clients report include the number of loans by methodology.

The variables we use from the Balance Sheet are Value of IL Loans, Value of Solidarity Group Loans and overall Gross Loan Portfolio. From the Income statement

we use the Operating Expense and the Financial Expense to compute the expense per dollar lent as described in the main text. From the Financial Indicators report, we use the Portfolio at Risk numbers, along with the Real Portfolio Yield to compute the risk adjusted real yields. From the Products and Clients report, we extract the Number of IL Loans and Number of Solidarity Group Loans, which we refer to in the main table and the text.

We work with a sample of 715 institutions for the year 2009. We chose the year 2009 as that is the year for which we have the largest number of institutions reporting lending methodology.[4]

The MIX data does not give us information whether JL is used, but they state that "loans are considered to be of the Solidarity Group methodology when some aspect of loan consideration depends on the group, including credit analysis, liability, guarantee, collateral, and loan size and conditions." We will refer to the share of loans falling into this category as JL share loans.

Sometimes the data on lending methodology by number of loans or by volume does not correspond exactly to the reported total portfolio or number of loans outstanding because of data entry errors, missing data or number of borrowers rather than number of loans reported. In these cases we assume that the errors are not biased toward either IL or JL, so we compute the share from the data we have. For example, if a lender reports $1m of loans, but $450k IL and $450k solidarity group lending, we compute an IL share of 50% and apply this to the whole portfolio. Of the 715 institutions in the sample, 143 have such incompleteness in the value data, 16.7% of the total Gross Portfolio is unaccounted for. As for the number of loans (which are not used in the estimation), 10 have no data so we use the value shares as a proxy, and 222 institutions have incomplete data; a total of 11.4% of the number of loans are unaccounted for. In total 304 institutions have some incompleteness in these data.

The relationship between the two is illustrated in Figure C. Points lying on the 45 degree line correspond to lenders where the IL share by value is the same as the IL share by number. Each point corresponds to an MFI, with those in red, the "portfolio data incomplete", corresponding to the observations where the methodology

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[4]In 2009, 911 (out of a total of 1106) provide some data on lending methodology by volume coming from the Balance Sheets. Of these, we exclude 154 "village banks" for which lending methodology is unclear. Furthermore, we lose 41 observations due to missing data on the key variables used for the simulation: Portfolio at Risk, Operating Expense, Financial Expense and Real Portfolio Yield. Lastly, we drop one MFI that reports PAR greater than 100%.

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breakdown does not exactly match the portfolio figures as discussed in the previous paragraph. From this graph we learn three things. Firstly, the pattern of the data is very similar when we compare "complete" and "incomplete" observations, which suggests we need not be concerned about the incomplete cases. Secondly, most points lie to the north west of the 45 degree line, indicating that IL loans tend to be larger then JL loans (an issue we do not explore in this paper). This has been previously observed in Cull et al. (2007). Thirdly, although we do observe some lenders offering both IL and JL, the majority of lenders use predominantly one or the other. 72% of lenders (accounting for 68% of loans by number and 84% by value) have 95% of their portfolio in either IL or solidarity lending.
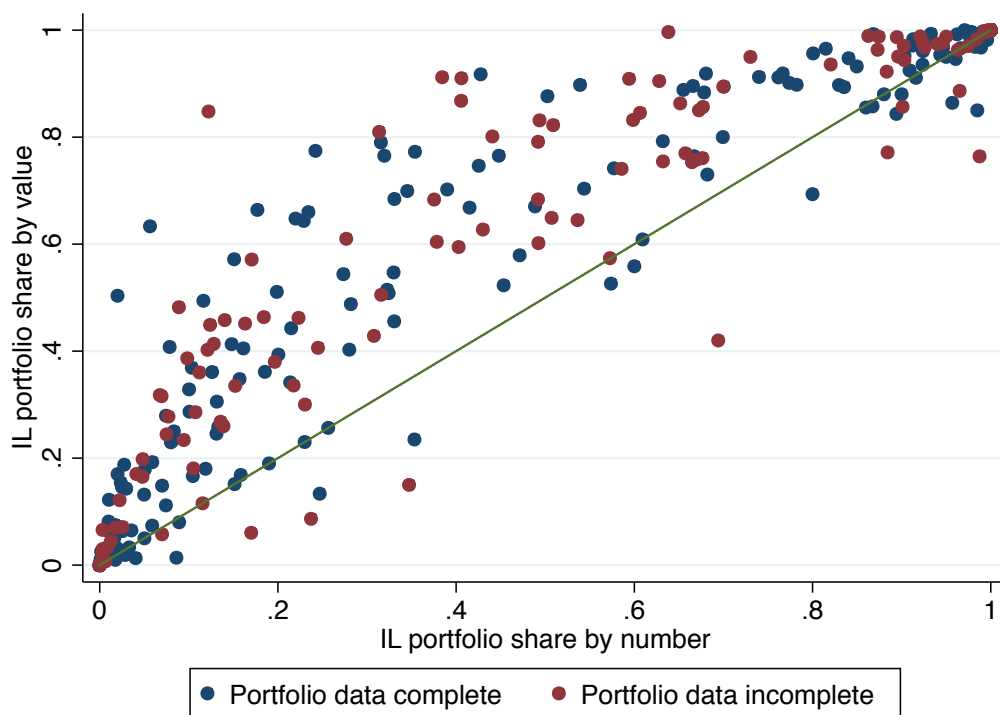

Figure 6: IL Share by Value and by Number