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Bank-insured RoSCA for microfinance: Experimental evidence in poor Egyptian villages☆

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ABSTRACT

Microfinance institutions (MFIs) have continued to grow over the past few decades, both in numbers of clients and portfolio sizes. The growth of these MFIs has enabled greater access to credit in many of the world's less developed nations. However, recent studies have shown that very many of the poor – especially Muslims – remain unbanked. Confounding this problem in many Muslim countries is the poor's propensity to reject microfinance, when available, on religious grounds. In this paper we develop an alternative microfinance model which aims to establish credit unions for the poor in which the bank plays the role of a guarantor in the familiar rotating savings and credit association (RoSCA). We test the performance of this model against a stylized sequential Grameen-style microcredit provision in a "laboratory experiment in the field" conducted in poor Egyptian villages. Our model of bank-insured RoSCAs is shown to solve coordination-failure problems that may otherwise prevent the spontaneous development of informal RoSCAs in practice. Empirically, our bank-insured RoSCA model generated significantly higher takeup and repayment rates than the Grameen model. This suggests that this model, by overcoming the religious barriers to credit, can be a useful alternative to Grameen-style microfinance.

1. Introduction

Despite advances made by microfinance institutions in giving the poor access to credit, recent studies have estimated that 2.7 billion adults in the developing world remain unbanked, cf. CGAP (2009). Even among those who have access to some basic banking services, there is evidence of significant credit constraints, cf. Banerjee and Duflo (2004). Confounding this problem in the Middle East are religious and social injunctions, especially in the modern era for Muslims, against interest-based borrowing, grounded in the ancient prohibition of usury.

In this regard, the Muslim poor, in particular, have shown significant rates of rejection of traditional microloans. This coincides with large, and in some cases increasing, incidences of poverty and financial exclusion among Muslim populations. Researchers from the Islamic Development Bank estimated that in the six countries with largest Muslim populations (Indonesia, India, Pakistan, Bangladesh, Egypt and Nigeria) the number of people living on less than $2 per day far exceeds

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half a billion (their estimate is 628 million), cf. Obaidullah and Khan (2008). Recent studies have also included survey results that show Muslims to be highly excluded from access to banking products and services, with exclusion rates reaching as high as 88% in Pakistan (Obaidullah and Khan, 2008, p. 64). Finally, for Muslims with access to microloans, surveys have suggested that up to 40% reject such loans on religious grounds, cf. CGAP (2008, 2009).

Despite the fast growth of "Islamic finance,"[1] its ability to engage the Muslim poor, who comprise half of all the Muslims in the world, has been meager. As of 2008, "Islamic microfinance" was estimated to reach only 380,000 customers, only one half of one percent of total microfinance outreach, cf. CGAP (2008). A few recent papers (cf. Ahmed, 2002; Dhumale and Sapcanin, 1998; Abdul and Rahim, 2007) have attempted to explain the current progress or lack thereof, but it is safe to say that the religious-legal-arbitrage methods used in "Islamic Finance" (cf. El-Gamal, 2006), which have met some success among the middle and upper classes, have not been sufficiently appealing to the poor.

The impact of microfinance on poverty alleviation is not as significant or well established as one might think,[2] and the objective of this study does not extend to measuring the impact of microfinance availability. Our objective is introduce a new model of microlending that is Islamically permissible and test it against the standard model of interest-based sequential group microlending (as practiced earlier, for instance, by the Grameen Bank of Bangladesh). We compare the rates of takeup and repayment of the standard model and our alternative model which is built upon the indigenous rotating savings and credit association (RoSCA), known in Egypt as the *gam*ʿ*iya*. This institution is used extensively and was approbated by both classical and contemporary Islamic jurists, including the most conservative.[3]

The dominant microfinance model of lending relies on the payment of a predetermined fixed rate of interest on microloans. However, the payment of fixed rates of interest is regarded by many Muslims as prohibited. The alternative model that we study is a new variation on rotating savings and credit associations (RoSCAs). RoSCAs are indigenous to most developing countries and widely used especially by those who have limited access to formal finance. Classical RoSCAs are interest free, and commonly used both as sources of credit and savings recommitment mechanisms, as discussed in Section 2. The survival of RoSCAs depends on leveraging social capital among participants and their social networks, which in turn requires a mechanism for punishing defectors. Despite these admirable qualities traditional RoSCA's potentially suffer from a "coordination failure" problem which our improved model works to solve.

The two models we test are similar in structure but differ fundamentally with regards to the bank's involvement. In what we call the Grameen model (sequential lending to members of the group) the bank plays an active role by injecting capital through its initial loan, collects interest on the loan, and penalizes all group members in the case of default by any group member. We experiment with low, medium, and high levels for these penalties and analyze the experimental subjects' behavior under the different designs. Players are allowed to avoid bank penalties by extending a one-period interest-free loan to their partners who may otherwise default.

In the insured-RoSCA model, the group members sequentially lend capital to each other, without interest, and the bank takes a relatively passive initial role as a guarantor. The bank charges a small fee for its credit-insurance services. In case of non-repayment by a RoSCA member, the bank takes on the defaulting member's payment obligations to the rest of the group and treats the defaulter as a debtor who is now responsible to repay the bank both principal and interest on the amount they failed to pay the group.

We conduct laboratory experiments in the field, using very poor subjects in rural Egypt who are eligible for microloans, and compare the takeup and repayment rates of randomly assigned subjects under the two designs. We find that the insured-RoSCA model elicits much higher rates of takeup by participants, and at least as high rates of repayment, compared to the Grameen model. The rest of the paper proceeds as follows: In Section 2, we outline the extensive forms of a sequential Grameen-style microlending structure as well as our proposed alternative, a bank-insured fixed-order RoSCA, and analyze the equilibria for different parameter values. In Section 3, we describe the experimental design and the demographics of our sample. In Section 4, we report and discuss the results of statistical data analyses. Section 5 concludes the paper, acknowledging the limited scope of its results, which nonetheless serve as a useful "proof of concept."

[1] Islamic Finance is a term used to refer to the universe of financial products that claim to specifically take into account, and conform to, Islamic Law. Most notably in this case the majority of these products attempt to circumvent the use of usury in lending situations by using a variety of strategies (cf. El-Gamal, 2006).

[2] Experimental studies have reported generally positive or neutral effects of microfinance. For example, Banerjee et al. (2013) studied the introduction of microcredit into a new market in randomly selected Hyderabad slums. They found an increase in MFI borrowing in the treated areas along with an increase in expenditure on durable goods and new business investments. Significant positive impacts on household health and education were not found in their study, but the authors contend that it may take more time for significant differences to be observed. In another randomized study in peri-Urban Manila, Karlan and Zinman (2011) have found that, if anything, business size was reduced, and no change in consumption was observed, but that income did increase for men. Using a similar randomized evaluation methodology as they did in Manila, Karlan and Zinman (2010) looked at the expansion of consumer credit in South Africa and found that increased access to credit for marginal applicants significantly improved outcomes: treated borrowers were found to be more likely to retain their jobs, less likely to experience hunger, and had more positive outlooks on life in general. A variety of more recent experimental studies also find tepid impacts (e.g. Augsburg et al., 2012; Angelucci et al., 2013; Attanasio et al., 2011; Crépon et al., 2011).

[3] A list of the positive opinions, ranging from neutral permissibility to positive approbation are listed in Arabic in a study by Dr. A. Al-Jibrin, and posted at: http://www.mktaba.org/vb/showthread.php?t=13001 (accessed 23.05.11). Moreover, there is reason to believe that mutual structures such as credit unions built on RoSCAs are consistent with the letter and spirit of classical Islamic jurisprudence, cf. El-Gamal (2007).

2. Models

Our baseline model represents a variation on the classical peer-monitoring microfinance model used by many MFIs around the world, most famously by Grameen Bank. The alternative model that we propose adds to the familiar fixed-order rotating savings and credit association model by combining it with a banker (in our case the experimenter) as guarantor (henceforth, guaranteed-RoSCA, or RoSCA model for short).

There is an extensive theoretical economics literature on RoSCAs, which are generally treated as part of informal finance. Ambec and Treich (2007) showed that RoSCAs are similar to other pre-commitment mechanisms to enhance savings, one of the vehicles through which microfinance is likely to help alleviate poverty. In a series of influential papers, Besley et al. (1992, 1993, 1994) had earlier analyzed the mechanisms and efficiency properties of various RoSCA structures, concluding that some types of RoSCAs enhance welfare through credit provision. Random-turn RoSCAs were seen to perform particularly well in theory,[4] but we restrict attention in our study to a RoSCA with fixed collection order, because bidding and random RoSCAs are not common in the Middle East, and may be considered akin to gambling, which is also forbidden in Islamic scripture, along with usury or *ribā* (interpreted most widely by contemporary Muslim jurists and laity as the prohibition of interest-based loans, regardless of the interest rate).[5]

We address the possibility of coordination failure in the standard RoSCA structure by introducing bank insurance,[6] whereby the banker guarantees the stream of payments and loans to any member of the RoSCA who continues to make required payments on time. Those who default become debtors to the bank, and if they default on their debt to the bank, the latter applies the same group punishment as in the Grameen design (a proxy for all types of punishments exercised in reality, including exclusion from access to credit for a period, reduction of credit ceilings, etc.). Thus, our two models are similar to some extent, with the notable difference that the Grameen model starts with loans from the bank, and allows for within-group loans in case of impending default, while the alternative design starts with RoSCAs and allows for indebtedness to the bank in case of impending default.

Both models include a penalty p for defaulting on debts to the bank, which is charged to all players in the defaulter's group. We also introduce a penalty q, which is a proxy for loss of social capital when one defaults on debt to another individual. The true value of this penalty is unknown ex ante and applies only to the defaulter.[7] It must be noted that q may be nontrivial, as Karlan (2007) has observed significant loss of social capital due to loan defaults in Peru.

The models differ on one other key dimension: the timing of payments. In the Grameen model, the second player need not contribute capital in round one, whereas in the RoSCA model, the second player is effectively a lender to the first player in round one. To focus strictly on other aspects of the model, we assume that the second player has no outside option, e.g. in the form of investment or expedited consumption. This assumption is not unreasonable because most investments require a fixed initial cost greater than what prospective, credit-constrained, micro-investors can afford individually. Similarly our design affords clients a dynamic incentive due to imminent loans that may be sufficient to forego current consumption temptations, hence serving as a savings recommitment mechanism. The second mover in a RoSCA is thus both lender and saver, participating in a bank-insured savings vehicle. [8]

2.1. The Grameen game

The extensive form representation of a simplified sequential microfinance model (henceforth, Grameen) is shown in Fig. 1. Each player starts with one unit of capital and has the opportunity to partake in an investment opportunity that will return the principal and yield an additional guaranteed return of $2r$ after one period (this "return" could also serve as a measure of incremental utility from consumption smoothing). This opportunity requires an investment of two units of capital, which is currently out of the reach of the participant. She is then informed of her financing option, which in this case is a bank loan that requires repayment of principal plus interest at rate i ($i < 2r$, hence borrowing to invest is profitable).

[4] RoSCAs with random allocation were found to be superior when individuals have identical tastes. In Besley et al. (1994), the authors compared bidding RoSCAs and random ones to formal credit markets. They found that the allocations achieved by credit markets were more efficient than those reached by bidding RoSCAs. However, random RoSCAs were found under certain conditions to yield higher level of *ex ante* expected utility.

[5] The Arabic *ribā* shares the root, meaning, and scriptural prohibition of the Hebrew *ribīt*, which coincides with interest in many but not all contract forms, cf. El-Gamal (2003). The second Islamic financial prohibition is against *gharar*, or excessive and unnecessary risk taking, which would not invalidate non-commutative financial contracts. It would be possible to structure "Islamic" variations on the random-order RoSCA, but we decided to use the fixed-order form because of its familiarity.

[6] By "coordination failure," we refer to the possibility of subjects failing to begin a RoSCA on their own due to the uncertainty surrounding the likelihood of group members defaulting strategically on their obligation to the RoSCA or failing otherwise to make their periodic contributions. Although RoSCA's are a commonly used financial instrument in the developing world they are not as widely used as they might be due to these concerns as discussed in Ray (1998), Anderson and Baland (2002) and Sinn (2013).

[7] It is possible that the lender adversely affected by the default would also suffer from the social betrayal they experienced. For simplicity we assume this is negligible.

[8] Banerjee and Duflo (2011) dedicate most of their Chapter 8 to the question "why the poor don't save more," noting, for example, the difficulty that poor Indian women face to resist the temptation of spending their money on sweet tea. They refer to Ashraf et al. (2006) as an illustration of how "[d]esigning financial products that share the commitment features of the microfinance contracts, without the interest that comes with them, could clearly be of great help to many people", c.f. Banerjee and Duflo (2011, Kindle location 3222). Savings mobilization and credit provision with minimal cost along the equilibrium path is likewise a central objective of this paper.

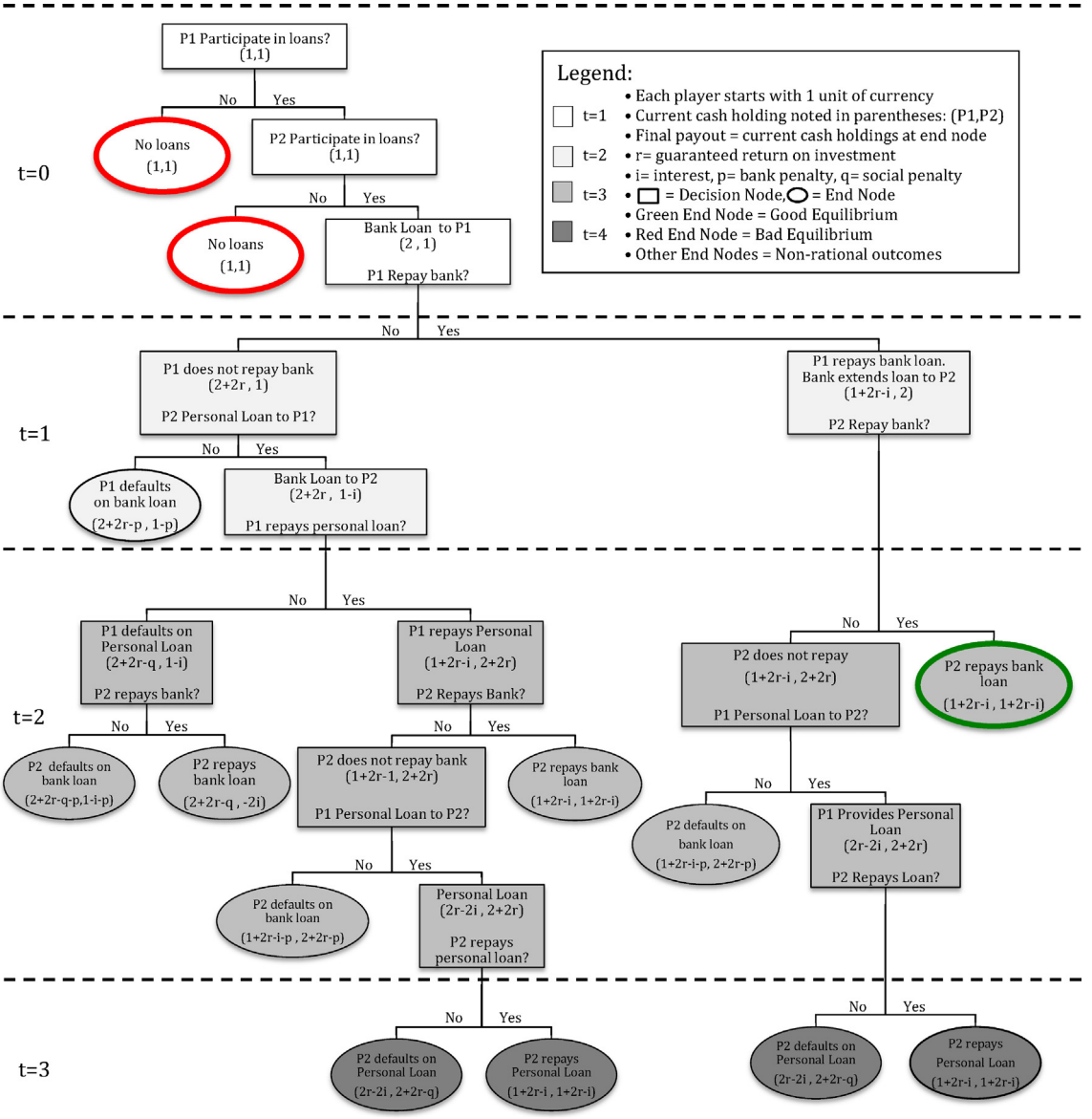

Fig. 1. Grameen extensive form game.

In period $t = 0$, Player 1 and Player 2 each have to decide whether or not to participate in sequential borrowing from the bank. For readability, let us assume Player 1 is female and Player 2 is male. If either player decides not to participate, the game ends in period $t = 0$ with both players retaining their initial capital. We call this the "bad (or opt-out) outcome," because neither player receives a loan or invests, thus foregoing the value added from investment.

If they both choose to participate, Player 1 receives a loan from the bank, and invests her capital in a project that has a guaranteed return $2r$. After receiving her capital and profits, Player 1 has the option to repay her loan to the bank or to renege. If she chooses to repay, the bank will then extend a loan to Player 2, and we move to period $t = 1$ along the right branch of the extensive form.

2.1.1. The right branch

In period $t = 1$, along the right branch, Player 2 has the option to repay the bank, after investing and collecting his profits, at which point the game ends at $t = 2$, or he can renege. If the game ends at $t = 2$, we call this "the good equilibrium" (see analysis below), where each player received a loan, invested, received profits $2r$ and paid interest $i < 2r$.

If Player 2 reneges, Player 1 has the option to pay off Player 2's debt and avoid the bank's penalty (a one period loan between the players). If Player 1 refuses, Player 2 would have defaulted and both players are punished by the bank (incurring penalty

p each).[9] (*Note:* These inter-player loans would arise more naturally if negative income shocks were possible. In the current case, a default by Player 1 would arise only from moral hazard,[10] and Player 2 may then be forced to pay off Player 1's debt in order to avoid incurring the high penalty p. We should not observe this behavior along the equilibrium path.)

If Player 1 repays Player 2's debt, we continue to period $t = 3$ along the right branch, and Player 2 then has the opportunity to repay Player 1, in which case we get the same payoffs as the "good equilibrium," but because the path includes reneging, we consider this outcome inferior. If Player 2 chooses to default on the one period loan given to him by Player 1, then Player 1 loses her capital, and Player 2 keeps it along with profits, but suffers the social-capital penalty q for defaulting on the loan from Player 1. The game ends in either case.

2.1.2. The left branch

If we reach period $t = 1$ after Player 1 reneges on her loan to the bank, Player 2 then has the opportunity to pay off her debt so as to avoid facing the bank's penalty for default, and losing the opportunity to receive a loan. If Player 2 decides against this then Player 1 would have defaulted, and the game ends at $t = 1$ with both players suffering the bank-imposed penalty p.

If Player 2 pays off Player 1's debt, then we move to period $t = 2$ along the left branch, with Player 2 receiving the bank loan, but not having enough to invest. Player 1 then has the opportunity to repay Player 2 or default on the loan Player 2 extended to her. If she defaults, she alone suffers the social penalty q. Player 2 may then repay his bank loan (ending up with negative payment $= -2i$), or default on the bank, ending up with $1 - i - p$ and subjecting Player 1 to the penalty p as well. In either case, the game ends in period $t = 2$.

If Player 1 repays the inter-player loan, then as Player 2 gets this repayment, he can invest and earn the return $2r$. If he repays the bank loan, then again the game ends in period $t = 2$ with the same payoffs as the "good equilibrium," but the outcome is deemed inferior because the path involves reneging on the first bank loan.

If Player 2 does not repay the bank, Player 1 may pay it off for him. If she does not, then the game ends in period $t = 2$ after both players incur the penalty p for defaulting on the bank. If she does pay it off, then Player 2 may repay her, again reproducing the "good equilibrium" payoffs, but very inefficiently, or he may refuse to repay the loan, in which case he keeps the money but suffers (alone) the penalty q.

2.1.3. Equilibrium analysis

First, we consider the case where q is sufficiently high. Because we are assuming that returns are guaranteed, q is always incurred if one player repays the other's loan and interest to the bank, and then the debtor refuses to pay the other player back.

If $q > (1 + i)$, there will never be any default on the inter-player loan. Therefore, each player knows that even if the other one were to default on the bank loan, they would not default on the loan that they receive from their partner. Therefore, by backward induction, both players will agree to the sequential loans, and both will repay their loans, ending at the "good equilibrium."[11]

If $q < (1 + i)$, then, unfortunately, a player would have the financial incentive to default on the loan from his partner. Regardless of whether p is small or large, if Player 1 gets the bank loan, she would keep her $2 + 2r$, and threaten to default on the bank loan. If Player 2 refuses to cover Player 1's debt, he ends up with $1 - p$, and should have opted out. If Player 2 extends an implicit loan to Player 1, then Player 1 would default on it, and Player 2 would again end up with less than his capital, and would prefer to opt out. Therefore, if $q < (1 + i)$, regardless of the value of p, the game should always end in the "bad equilibrium" with both players refusing to participate (again, for parsimony, because Player 1 knows that Player 2 will opt out when q is small, she is indifferent between participation and opting out, and we choose the more efficient path to the same payoffs).

2.1.4. Discussion

This dichotomous result, depending only on whether or not q is high, is not surprising. Grameen Bank and other microlenders often use peer monitoring, and at times shared liability, as mechanisms to leverage social capital of the micro-borrowers who are not likely to have other forms of collateral acceptable to the banks. Large q is a proxy for high social capital. In practice, microfinance participants often form RoSCAs or otherwise extend credit to pay off debts of group members in order to avoid penalties, cf. de Aghion et al. (2005, p. 88), which is also consistent with our analysis, assuming that q is sufficiently high.

It is also noteworthy that the dichotomy for good vs. bad equilibrium does not depend on p. Perhaps this is one explanation for why Grameen Bank itself has fully abandoned the more draconian joint liability model and continued to experience high

[9] Although in this case only the first player seems to behave "badly" the bank penalizes both of them to set up the incentive structure for "good-equilibria" discussed below. For a similar reason, most microfinance operators include some form of collective punishment if a member of the group defects, even if it falls short of joint liability.

[10] For example, there is evidence that some husbands have urged their wives strategically not to repay their loans to Grameen Bank, and measures to convince the husbands otherwise were needed, c.f. Dowla and Barua (2006, p. 150).

[11] The same payoff can be reproduced along three other paths with no default on RoSCAs, but with delay. We assume that indifference between these nodes will always be resolved in favor of the most efficient.

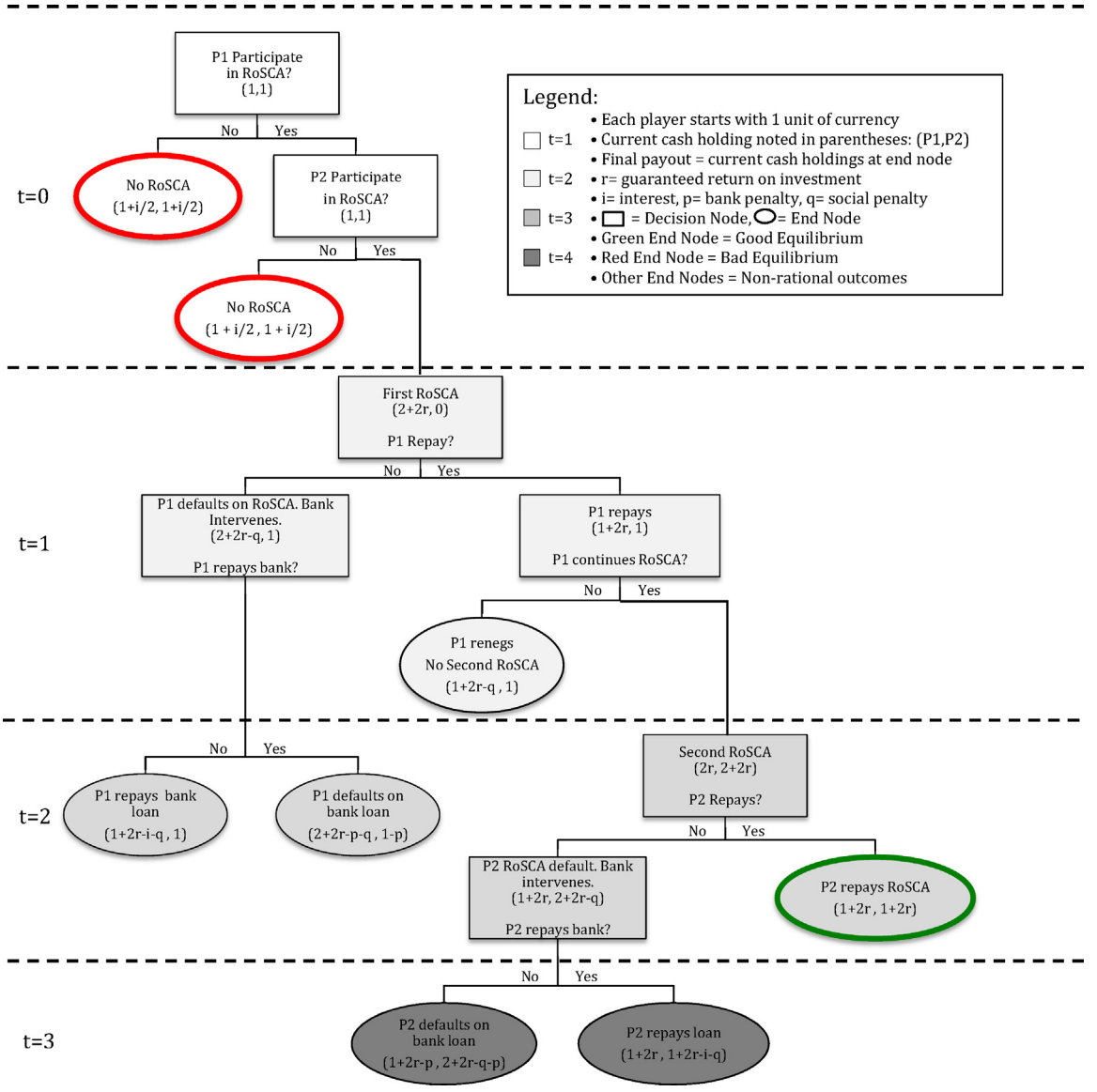

Fig. 2. Guaranteed RoSCA extensive form game.

rates of repayment,[12] cf. Dowla and Barua (2006). The model leverages the grouping of debtors, including the ability to borrow from the group fund, which is akin to RoSCA, using the subjects' social capital as collateral, i.e. relying on a high q. As we show later in this section, it may be superior to reverse the order of the bank's loan and the RoSCA, in the process obtaining good equilibrium behavior even when q is not very high.

2.2. The guaranteed-RoSCA game

The extensive form of our Guaranteed-RoSCA Model is shown in Fig. 2. The starting point is the same as in the Grameen game: each player is endowed initially with one unit of capital, and faces the same opportunity to invest two units of capital (one of which must thus be borrowed) to earn a profit of $2r$.

[12] de Aghion et al. (2005, p. 127) claim that Grameen loans "are seldom enforced exactly as they should be on paper." In the case of a group with one defaulting member and other group members who are still in good standing bank employees would attempt to get as much of the loan paid back as possible and then drop the defaulting member from the rest of the well-performing group, allowing them to continue their relationship with the bank. Gine and Karlan (2013) also provide experimental evidence that group liability contracts with a Philippine lender did not increase repayment, relative to individual liability loans that still maintained group meetings.

The two players have to decide whether or not to participate in sequential bank-guaranteed RoSCAs. If they decide to proceed, they are required each to pay a fee to the bank, which will then guarantee the RoSCAs against default. It is assumed that this fee for participation is very small compared to capital, interest, and profit amounts (in our experiments, subjects paid an administrative fee of $s = i/2$, half of the interest charge). Therefore, we ignore it in our analysis by subsuming it in the initial endowment.[13] Although this fee can be translated into an effective interest rate, it differs from interest because it does not increase with deferment, and it satisfies the Islamic requirements for the permissibility of a loan. This is because fixed fees to cover administrative costs are allowed by all religious scholars, while most object to interest.

The game prompts players to form a RoSCA first and only requires bank intervention in the case of default. In other words, we reverse the order of events in the Grameen model. Since the inter-player loan comes first, bank loans should be rare and defaults on bank loans even rarer still, thus making the insurance premium fee paid for participation minimal.

If either player chooses to opt out of the game, we end up with the "bad outcome," each player keeping their capital and the game ending in period $t = 0$. If they choose to participate and pay the small fee,[14] we move into period $t = 1$, with Player 1 receiving the first loan, investing, and receiving the return $2r$.

2.2.1. Right branch

Player 1 may then repay the RoSCA loan, along the right branch of the game. Player 1 may choose to end the game in period $t = 1$, suffering (alone) the social penalty q or she may choose to extend a loan to the other player, thus starting the second part of the RoSCA, in which case we move to period $t = 2$ with Player 2 investing and receiving the return $2r$.

Player 2 may then end the game in period $t = 2$ by repaying the loan from Player 1, and we label this the "good equilibrium," which is only reproduced this way with both RoSCAs taking place and being repaid on time. Notice also that because the fee for participation is (assumed to be) smaller than the interest rate i, this is a more efficient outcome than the "good equilibrium" under the Grameen game.

Player 2 may also choose to default at $t = 2$, in which case the bank intervenes to repay Player 1, and Player 2 suffers the social penalty q. If Player 2 then chooses to repay the bank loan, he also has to pay principal plus interest $1 + i$. Alternatively, Player 2 may default on the bank loan, keeping $2 + 2r - q$, and subjecting both players to the bank's default penalty p.

2.2.2. Left branch

If Player 1 chooses to default on the first RoSCA, then the bank intervenes to repay Player 2, and Player 1 suffers the social penalty q. In period $t = 2$, Player 1 may then repay the bank $1 + i$, or keep $2 + 2r - q$ and both players suffer the default penalty p.

In the "bad" equilibria those who default are forced to pay interest to the bank. Although dealing in interest is not allowed under Islamic law the RoSCA structure maintains its permissibility due to the "good" equilibrium being interest-free. As long as an individual is able to avoid default, the guaranteed RoSCA serves as a sharia-compliant financing product.

2.2.3. Equilibrium analysis

Even though the extensive form of this game is much simpler than our Grameen game, the equilibrium analysis is slightly more nuanced, and much more interesting.

If the social penalty $q > 1$, the size of the interest free loan in the model, we never get defaults on RoSCAs, or reneging on promises to extend them, and obtain the "good equilibrium" in a straight forward way.

This produces "good equilibrium" outcomes for the range $1 < q \leq 1 + i$ under the guaranteed-RoSCA design, that we would not see in the Grameen design but only adds a relatively small range of parameters.[15] The more interesting result is that even if q is small, where the Grameen design would yield only the bad equilibrium, a large value of p can make it possible for the RoSCAs to take place.

If p is sufficiently large, each player knows that the other player would rather not default on a bank loan. This in turn implies that each player would not default on a RoSCA, because that would trigger the bank to step in and take the place of the defaulter in the RoSCA. The defaulter would then be liable for that same amount to the bank in the form of a loan. The default on a RoSCA would result in a personal penalty q, and then either a payment of $1 + i$ to the bank, or a penalty of size p for both players – which, by design, can be made large enough to make defaulting to the bank unattractive.

Therefore, if $p > (1 + i)$, the player would never default on the bank loan, and thus would be better off repaying the RoSCA (at 1) instead of repaying the bank loan (at $1 + i$). This adds another large part of the parameter space, where $q < (1 + i)$ but $p > (1 + i)$, where the guaranteed RoSCA produces the "good equilibrium" but the Grameen model does not (as shown in Fig. 3).

[13] This fee is a sunk cost conditional on deciding to opt-in and does not affect equilibrium play beyond that decision. Empirically we find takeup of the RoSCA model to be higher than takeup of the Grameen model. Removing this fee would most likely lead to even stronger takeup results conditional on it not serving as a positive selection tool.

[14] We add the small fee to the original endowment instead of subtracting it from every future node, without loss of generality, for ease of representation in the extensive form.

[15] Throughout, we are assuming that the participation fee or insurance premium $s \ll i < 2r$.

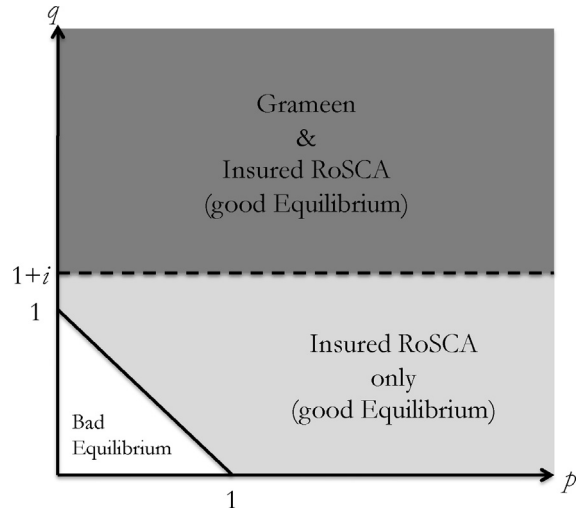

Fig. 3. Equilibria for various parameter values.

Finally, there remains the case where neither p nor q are sufficiently large by themselves, but $p+q$ is sufficiently large. The relevant nodes for determining the threshold for $p+q$ are the nodes where a player contemplates defaulting on the RoSCA and then defaulting on the bank loan. In that case, they incur both penalties $p+q$, and get to keep the single unit borrowed under the RoSCA. Therefore, if $(p+q)>1$, we obtain the "good equilibrium" under the guaranteed RoSCA model, adding a large segment of the parameter space where we obtain the good equilibrium only under this model.

2.2.4. Discussion

One interesting interpretation is the following: q may be high enough for the Grameen (and RoSCA) models to work, but subjects' beliefs about q may be biased downward. In this case, there is coordination failure: If only subjects knew how high q really was, they would spontaneously form RoSCAs, or at least accept microloans from Grameen-like banks. By introducing the bank as a guarantor of RoSCAs, with an announced $p>1-q$ (which can obviously be guaranteed without knowing q by setting $p>1$), the coordination failure is solved, and the RoSCAs are formed, helping individuals to save and invest. In this case, the default rates should be extremely small, and therefore the participation fee (insurance premium) collected by the bank can be correspondingly small.[16]

Of course, the social penalty q is unobserved, and the bank's collective penalty p is a control parameter. In the experimental analysis below, we vary p to test if the frequency of takeup increases in this parameter, as predicted by our model. For a fixed value of p, and assuming that pairs of subjects draw values of q from some distribution, our analysis suggests that we should see more frequent takeup and repayment (the "good equilibrium") under the guaranteed RoSCA model as compared to the Grameen model. Our experimental results support this theoretical analysis.

3. Experimental design and data

We conducted a series of experiments in various poor villages in rural Egypt with the help of the Egyptian Ministry of Local Development (MoLD).[17] Employees of MoLD, whom the local villagers trust as providers of microloans, because of their official posts,[18] were trained to conduct the experiments using the design and instructions translated in Appendix 3.

Data about the subjects' familiarity with different types of finance were not collected, but a recent survey of a representative sample of the Egyptian population (the Egypt Labor Market Panel Survey 2012) helps shed light on the issue.[19] It shows that both formal and informal loans are prevalent in the Egyptian population, with informal loans being slightly more common. It also shows that the majority of formal loans are interest-bearing while the majority of informal loans are not.

[16] Assuming the insurance charges here are actuarially fair.

[17] MoLD has an ongoing project, the Local Development Fund (LDF) that has been active since the 1970s. The LDF offers small to medium size loans to entrepreneurs in most of the 29 governorates in Egypt (with very limited operations in Cairo and Alexandria), its operations suffer severe bureaucratic difficulties due to the cumbersome procedures they must follow to approve loans.

[18] The employees were based in Cairo and had no prior relationship with any of the subjects in our experiments. We find no experimenter effect in our analysis.

[19] This study is conducted by the Economic Research Forum, and the data are available at http://erfdataportal.com/index.php/catalog/45.

This is suggestive evidence that the sample has similar experience with both formal (in this case, Grameen) and informal (in this case, RoSCA) finance.[20]

3.1. Design and location selections

The experiments were conducted during January and February, 2010. In preparation, the experimental team conducted pilot experiments in three villages in upper and lower Egypt during September and October, 2009, in part to refine the experimental design and instructions (for ease of understanding), as well as to measure the demographics in various villages and choose the ones most suited for the microfinance experiments. Out of 20 models that we tested with 50 subjects, the two models described in Section 2 were selected for ease of understanding (we used "Monopoly" money in the pilots and real money in the actual experiments).

For the full experiments we selected one village Southwest of Cairo (Disya, Fayoum, one of the poorest areas in the country) and two villages Northwest of Cairo (Feesha and Aryamon,[21] Beheira), also among the poorest. Loan officers were instructed to recruit subjects who would be interested in and eligible for a microloan (not exceeding EGP 1000 ≈ $190).[22] More subjects than we could accommodate showed up for each session, and those who were turned back were paid a show up fee of EGP 5.

At the beginning of each experimental session, subjects sat in a large hall, and listened to the instructions, which included a physical demonstration of an example game.[23] At no point in the explanation was there any discussion of the Islamic (im)permissibility of either model so as not to frame the subjects' choices.[24] Subjects were then given the opportunity to ask questions, which were all answered in public. Most of the subjects were illiterate, and therefore they were neither shown the extensive form diagrams above nor handed a copy of the instructions. When all questions were answered subjects were instructed to pair up for the experiment on their own. Few of them did not choose their counterpart, and we paired them up randomly. Many of the pairs knew each other beforehand, however data about the exact nature of their social relationships were not collected.[25] Communication between subjects was not restricted at any point in the experiment.

After all subjects were grouped in pairs, each pair was assigned at random an experimenter to explain again every step of the game. The experimenter proceeded to administer a practice game with the assigned pair to confirm that they understood the game correctly.[26] The actual game usually took less than fifteen minutes to complete, and the entire experimental session lasted less than half a day.

The initial capital given to each subject was EGP 14 (≈ $2.5), given in cash. The investment opportunity required EGP 20, and promised a guaranteed return of the original capital along with an additional EGP 4 profit, also given in cash. Loans could only be taken in the amount of EGP 10, and the interest on a bank loan was EGP 2. The insured RoSCA participation fee was set at EGP 1. Subjects who participated kept the money in their possession at the end of the game. After the game we administered, subjects answered few survey questions to gather demographic data for use in our analysis. Subjects were paid a survey participation fee of EGP 5, in addition to their money from the game.

3.2. Data

We conducted a total of 12 experimental sessions in Fayoum, eight using the RoSCA and four using the Grameen design. We conducted 13 sessions in Beheira, six using the Grameen and seven using the RoSCA design. The total number of subjects was 354. For logistical reasons, and to ensure that all subjects received the same instructions, we randomized treatment (Grameen vs. RoSCA design) by day. Within each day, we randomized the value of the penalty p by session over the set {zero, low= EGP 6, medium= EGP 11, or high= EGP 13}. Player type (1 vs. 2) was randomized for each pair. At the beginning of each session, subjects sat in a large hall, listened to the instructions and watched an example game being demonstrated. The floor was then opened for questions which were answered in public. Subjects were then asked to choose a partner amongst those who were in the room. The numbers of observed games (i.e. pairs) for each location and design are shown in Table 1.

[20] The questions asked in the ELMPS 2012) do not line up directly with the two models of financing that we are testing here (as our models are highly stylized) but the formal/informal divide is informative.

[21] We had planned to conduct two days of experiments in Feesha, Beheira. On the second day, however, word that researchers were giving out money to partake in a small game spread rapidly and we faced excessive demand for participation, with some subjects getting aggressive. The local officials were unable to calm the prospective subjects, and we were forced to move to nearby Aryamon instead. There is no reason to believe that the populations of these nearby villages within the same district differ significantly. Table A1 in Appendix A shows that the demographic characteristics of the subjects in the two villages were statistically equivalent, and very different from Disya, Fayoum.

[22] This strategy meant that our data may have potentially oversampled people that were already comfortable with the idea of microfinance in general. This may tilt our results in favor of the Grameen model, because those who reject interest-bearing loans categorically would be less likely to respond to the recruitment call. This makes our result of higher takeup rates under the RoSCA model more remarkable.

[23] Translated instructions are provided in Appendix 3.

[24] As there is no central religious authority in Islam, individuals can hold a variety of opinions about the permissibility of different financial products. Avoiding explicit mention of different scholarly opinions and the biases that may arise from them allows for a cleaner comparison of the two models.

[25] Collection of data on social relationship would have allowed for a more sophisticated treatment of the social punishment for default "q". At this point, with no proxies available, the social punishment is assumed to be i.i.d.

[26] The researchers did not encounter instances in which, after the practice game, individuals claimed to be confused by the game.

Table 1
Summary of experimental observations.

Governorate	Village	Day	Model	Penalty	# Observations
Fayoum	Disya	1	RoSCA	Zero	0
				Low	7
				Medium	7
				High	14
		2	Grameen	Zero	6
				Low	14
				Medium	7
				High	7
		3	RoSCA	Zero	0
				Low	7
				Medium	14
				High	7
Beheira	Feesha	4	Grameen	Zero	7
				Low	11
				Medium	10
				High	6
	Aryamon	5	RoSCA	Zero	7
				Low	14
				Medium	15
				High	12
Total (Pairs)					172

Table 2
Summary of participant demographics.

Governorate	Gender	%	% Literate	% Employed	% Married	% Head of household
Fayoum	Male	12	23	86	86	95
	Female	88	27	24	75	54
	(Mean)		27	32	76	59
Beheira	Male	56	75	76	76	76
	Female	44	55	21	60	44
	(Mean)		66	52	69	62

Table 2 shows the distributions of variables that we use in our econometric analysis below, and Table 3 shows the distributions of demographic and socioeconomic variables. The overall illiteracy rate in our sample was 35%. Less than half of our sample was unemployed, and most of the unemployed were women. In the meantime, nearly half of the women in our sample were the heads of their households. The average age of participants was 38 and the average monthly household income was EGP 300 ($\approx$ \$55; i.e. our show-up fee for each subject was equal to the average household daily income). Almost every household in the sample owned a television set, and approximately 40% reported having a satellite dish connection (typically shared). Similarly, 36% of the sample owned a cell phone. The socio-demographic data for the three villages reflect the overall poverty levels in the governorates, Fayoum being the second poorest in Egypt, and Beheira the 12th poorest, cf. UNDP (2008).

Table 3
Socioeconomic data.

Governorate	Variable	# Obs	Mean	S.D.	Min	Max
Fayoum	Age	174	39	13	18	72
	HH income	137	283	174	30	1200
	HH size	180	5	2	1	11
	Own TV?	180	0.7	0.5	0	2
	Own cell phone?	180	0.3	0.5	0	3
Beheira	Age	160	37	12	18	81
	HH income	151	337	227	40	1000
	HH size	163	5	2	1	15
	Own TV?	164	0.9	0.4	0	1
	Own cell phone?	164	0.5	0.5	0	1

Note: HH income is for entire household.

Table 4
Outcome by model and penalty.

Bank penalty	Model	% Opt Out	% Good Eq.	% Default	*N*
Zero	Grameen	15	46	38	26
	RoSCA	0	57	43	14
Low	Grameen	32	56	12	50
	RoSCA	21	61	18	56
Medium	Grameen	29	71	0	34
	RoSCA	6	89	6	72
High	Grameen	15	85	0	26
	RoSCA	3	97	0	66
Total	Grameen	25	63	12	136
	RoSCA	9	82	10	208
	p value	(0.000)	(0.000)	(0.292)	344

Table 5
Logit for Opt Out (1), and conditional logit for defect given takeup (2, baseline = equilibrium).

	(1) logit: Opt Out?	(2) clogit: Defect | Takeup?
RoSCA	−1.282**	0.216
	(−2.63)	(0.31)
Penalty	−0.230	−1.611***
	(−0.97)	(−3.88)
Both female	−0.340	1.501*
	(−0.65)	(2.09)
At least 1 literate	−1.373*	−1.988*
	(−2.45)	(−2.27)
Beheira governorate	1.877**	1.894*
	(3.13)	(2.02)
Constant	−0.926	
	(−1.66)	
Observations	172	146
	$\chi^2(5) = 22.06$	$\chi^2(5) = 41.60$
	Pseudo $R^2 = 0.151$	Pseudo $R^2 = 0.398$

t statistics in parentheses.
+ $p < 0.1$.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

4. Data analysis

4.1. Exploratory data analysis

Table 4 shows the aggregate proportions of play (Opt Out; Good Equilibrium; or some Default/Defection) by experimental treatment (Grameen versus RoSCA). The takeup rates for the Grameen treatment were approximately 75%, and for the RoSCA design were 91%. "Good Equilibrium" play, where all loans are extended and paid back, was 63% in the Grameen design and 82% in the RoSCA design. As predicted by our model, formal ANOVA tests (superseded by the regression analysis in Section 4) showed statistical significance of the higher takeup rates under the RoSCA design. For completeness, we also report the percentage of observations where some default occurred.

4.2. Statistical data analysis

We focus our formal statistical analysis in this section on the two main results: (1) higher takeup rates, and (2) higher repayment rates under the RoSCA design. In Table 5, we report the results of estimating a logit model for the choice whether to opt out (column 1), as well as a conditional logit for the choice to defect conditional on takeup (column 2).[27]

The estimation produces a number of interesting results, which we will explain later under the simple assumption that each pair draws a value of q from some distribution. If this q is sufficiently high (greater than $1 + i$, which was EGP 12 in the experiments), our model predicts that we should observe the good equilibrium (takeup and no defects) under both designs. In the RoSCA design, if q is low, the frequency of defects should decline with p as it brings $p + q$ above the threshold of 1 (EGP

[27] Results are robust to the inclusion of variables such as household income, food intake, as well as other demographics variables. All of which were not significant for either regression and therefore are not reported for parsimony.

Table 6
Observed Opt Out frequencies for Grameen model.

	Penalty		
	Low	Medium	High
Beheira	5/11	4/10	2/6
Fayoum	3/14	1/7	0/7

Table 7
Observed Opt Out frequencies for RoSCA model.

	Penalty		
	Low	Medium	High
Beheira	3/14	1/15	1/12
Fayoum	3/14	1/21	0/21

10 in the experiments). The first major result in our estimation supports this theoretical prediction: The decision whether to opt out or continue depends significantly on the design (higher chance for takeup under RoSCA), but not on the penalty, and the decision whether or not to default conditional on takeup depends on penalty (lower chance of defection under higher penalty) but not on the design. For example, for our low-p design, the percentage of opting out in Beheira under the Grameen design (45%) was more than double the same rate for the RoSCA design (21%). Then, conditional on takeup, the percentage of defects in Beheira under low-p design is nearly half, and drops precipitously for higher-p designs.

One unambiguously positive result is that the literacy of at least one of the two players reduces the chances of opting out as well as the chances of defection given takeup. We found little evidence that both players being literate would improve the chances of takeup and good-equilibrium play over and above the effect of at least one being literate.

Finally, there is a significant governorate effect, with more opting out and defaults conditional on takeup in the governorate of Beheira compared to Fayoum. Our data suggest that values of q for pairs in Beheira may have been lower than values of q for pairs in Fayoum.[28] Using only the opt-out frequencies, shown in Tables 6 and 7, we can construct likelihood functions for q using the relationships $q < (1 + i)$ under Grameen and $q < 1 - p$ under RoSCA. This analysis is shown in Appendix B. It confirms that we detect both a model and a governorate effect in the distribution of q, but also confirms that for each model (Grameen and RoSCA), the estimated distribution of q in Fayoum first-order stochastically dominates the estimated distribution of q in Beheira.

Differences in q distributions, as well as the design concentrations in each governorate, thus account, at least partially, for the significant governorate effect in our statistical analysis. Pursuing this analysis of q distribution at higher degrees of granularity would tax our sample sizes and is unlikely to yield useful insights. Modeling social capital through social penalty for defection measured with a single parameter q is admittedly an oversimplification.[29] However, this simple model has produced clean theoretical results that were supported by our experiments in the field.

5. Conclusions

We introduce a new model of micro-lending based on the well known RoSCA structure. This model is Islamically permissible and solves the potential coordination failure of standard RoSCAs. We contrast the performance of this model with a standard Grameen interest-based model and find that the RoSCA model leads to greater take-up and higher rates of repayment. This serves as a "proof of concept" for the viability of the new model.

We focus on takeup rates and default rates under the two models – credit infusion from the bank on the one hand and leveraging the community's savings to finance investment or consumption smoothing on the other. We aim not to mimic exactly the institutional structures observed in the field. For instance, whereas Grameen Bank and others have shifted from sequential to simultaneous lending, we use sequential lending in our model. We use sequential structure because we found in the pilot that subjects understood it better. In this regard, we were willing to sacrifice similarity to field operations in order to ensure that subjects understand the game structure fully. Yet precisely because the experiment does not mimic the reality of field operations, we do not wish to push the policy implications too far.

We put forward four main simplifications and limitations of our paper. First, we abstract from the randomness of returns on investment – which could even be negative in reality. This meant that any default was clearly caused by moral hazard.

[28] We are grateful to Chinhui Juhn for the suggestion that our governorate effect may be simply due to different q values for the two governorates. We are also grateful to participants at the ESA Conference in Chicago, 2011, for suggesting that q may also vary with design and payoffs, including p.

[29] There is a vast literature on how social capital can reduce economic failure by enhancing contract enforcement. To be considered as capital, social capital needs to be accessed by individuals in order to draw benefits from it (Yang, 2007). However, measuring social capital has always been a controversial issue, since it is a collective property, but is usually measured at the individual level. Experiments have attempted to measure social capital through proxies of trust, reciprocity, cooperation, and reputation preservation. In this regard, Carpenter (2005) provided common proxies of social capital, and Karlan (2005) used trust games in a microfinance setup.

Table A1
Manova tests.

	F value	*p* value
Experimenter		
Opt Out	0.71	.746
Equilibrium	0.52	.789
Defect	0.69	.655
Penalty		
Opt Out	2.90	.036
Equilibrium	9.15	.000
Defect	10.77	.000

This makes social punishment easier to justify and hence the cost of default would be higher in the game than in the field, which may be a source of bias. Second, the bank fee in the RoSCA model is assumed to be small, which implicitly assumes infrequent defaults, as observations in microfinance more generally have shown. The true feasibility of this new model, and its profitability/sustainability, is in need of field testing. Third, we have no data about the sample's prior familiarity with different forms of financing. Despite suggestive evidence that the sample is no more familiar with one type of financing over the other, if it were the case that individuals in the sample were more familiar with the penalties associated with the Grameen model, and not fully appreciative of the outcomes in the case of default in the RoSCA model, this alone would explain our results. Finally, there is no comparison of the guaranteed RoSCA with a traditional RoSCA, which would have provided an alternative set of benchmarks for analysis, and contributed to our understanding of coordination failures for RoSCA's.

For-profit microfinance institutions and non-profit NGOs have been actively pursuing different models to solve the problem of low microfinance acceptance rates in many Arab countries. Some degree of borrower ownership and democratic governance – mainstays of contemporary credit unions – have been implemented in Grameen and other renowned models of microfinance. Credit unions might be more successful conduits of microfinance in societies with social and religious stigma against interest-based borrowing. In a nonprofit credit union, "interest" income would be acceptable religiously to cover costs – indeed, microlenders in Egypt often label interest as "cost of loan." However, full-fledged credit unions as microfinance institutions have not, to our knowledge, been advocated widely in this part of the world. A test of these designs would be a fruitful avenue for future research.

Appendix A. Sample and experiment checks

MANOVA tests failed to reject the null hypothesis of no experimenter effect, and rejected the null hypothesis of no effect of the penalty size *p* (Table A1).

We could not conduct a test of significance between the two neighboring villages in Beheira because we only ran experiments with Grameen in one and with RoSCA in the other, confounding village-specific and design effects. However Table A2 shows the resemblance of the main socio-demographic variables between our samples from the two Beheira villages, as well as differences from those in Fayoum. We cannot reject the hypothesis that the demographics of Feesha and Aryamon are statistically equal as expected given the proximity and similarities of the two villages.

Table A2
Comparison of village demographics.

Governorate village	Fayoum	Beheira	
	Disya	Feesha	Aryamon
Mean age	39	37	38
% Female	88	34	51
% Literate	27	70	64
% Employed	32	62	45
% Married	76	78	63
% Head of HH	59	65	60
Mean HH income	283	347	330
% Have savings	7	22	28
% Own TV	69	83	88
% Satellite dish	30	49	56
% Own cell phone	27	53	43
Villages equal?		*p* value	.0752
Governates equal?		*p* value	.0000

Appendix B. Construction of the likelihood function to estimate distributions of q

Assuming that pairs in Fayoum draw values of q i.i.d. from the distribution $\chi^2_{n_F}$, and that each pair in Beheira draw values i.i.d. from $\chi^2_{n_B}$, we can easily construct likelihood functions for the two samples as functions of the (degrees of freedom) parameters n_F and n_B, as well as the error rates ϵ_F and ϵ_B and the counts in Tables 6 and 7.

Under our model, we should observe an opt out in the Grameen design, assuming no errors, if and only if $q < (1+i) =$ EGP 12. Under the RoSCA design, again assuming no errors, we should observe opting out only if $q + p < 1 =$ EGP 10. Excluding the zero-penalty rounds, for the low penalty design ($p =$ EGP 6), we should observe opting out only if $q <$ EGP 4, and for our medium and high penalty designs ($p =$ EGP 11, 13, respectively), we should never observe opting out. To the extent that we did observe a few opts out for medium and high values of p, we need to allow for erroneous opts out. We will allow for such errors by assuming that every pair have a fixed probability ϵ of opting out when they should not or continuing when they should opt out.

We have assumed that every pair in governorate G, $G \in \{B, F\}$, draws $q \overset{i.i.d.}{\sim} \chi^2_{n_G}$. Based on our model in Section 2, the decision whether to opt out or continue should depend on whether q is below or above some threshold, respectively. In addition, we are allowing for a trembling-hand probability ϵ_G that would result in the pair choosing opt out when they should continue or vice versa (the need to add such an error term is to avoid the zero-likelihood problem, as discussed, for example, in Boylan and El-Gamal (1993)). The log likelihood function for governorate G (as a function of (n_G, ϵ_G)) can be decomposed into four terms based on counts of opts out and takeups:

- For the Grameen model, for all values of p, if we observe $\#k$ opts out and $\#t$ takeups, the contribution to the log likelihood function is:

$$\#k\left[\log\left(\overbrace{(1-\epsilon_G)F_{\chi^2_{n_G}}(12)}^{\text{no error, } q<12} + \overbrace{\epsilon_G(1-F_{\chi^2_{n_G}}(12))}^{\text{error, } q\geq 12}\right)\right] +$$

$$\#t\left[\log\left(\underbrace{(1-\epsilon_G)(1-F_{\chi^2_{n_G}}(12))}_{\text{no error, } q\geq 12} + \underbrace{\epsilon_G F_{\chi^2_{n_G}}(12)}_{\text{error, } q<12}\right)\right]$$

- For the RoSCA model, for each governorate G, for penalty level $p = 6$, if we observe $\#k$ and $\#t$ takeups, the contribution to the log likelihood function is

$$\#k[\log((1-\epsilon_G)F_{\chi^2_{n_G}}(4) + \epsilon_G(1-F_{\chi^2_{n_G}}(4)))] +$$

$$\#t[\log((1-\epsilon_G)(1-F_{\chi^2_{n_G}}(4)) + \epsilon_G F_{\chi^2_{n_G}}(4))]$$

- Finally, for the RoSCA model, for each governorate G, for penalty levels $p = 11$ and $p = 13$, if we observe $\#k$ and $\#t$ takeups, the contribution to the log likelihood function is simply:

$$\underbrace{\#k\log(\epsilon_G)}_{\text{all errors}} + \underbrace{\#t\log(1-\epsilon_G)}_{\text{all no errors}}$$

Summing up all these terms, we obtain the log likelihood function for each governorate.

Fig. B1 shows the contours of the loglikelihood function, broken down by governorate and design. Our regression analysis result is reproduced in the top two figures in this panel, wherein we can see that the distribution of q in Beheira puts more mass on lower values relative to Fayoum; i.e. the population in Fayoum appears to have higher social capital than the

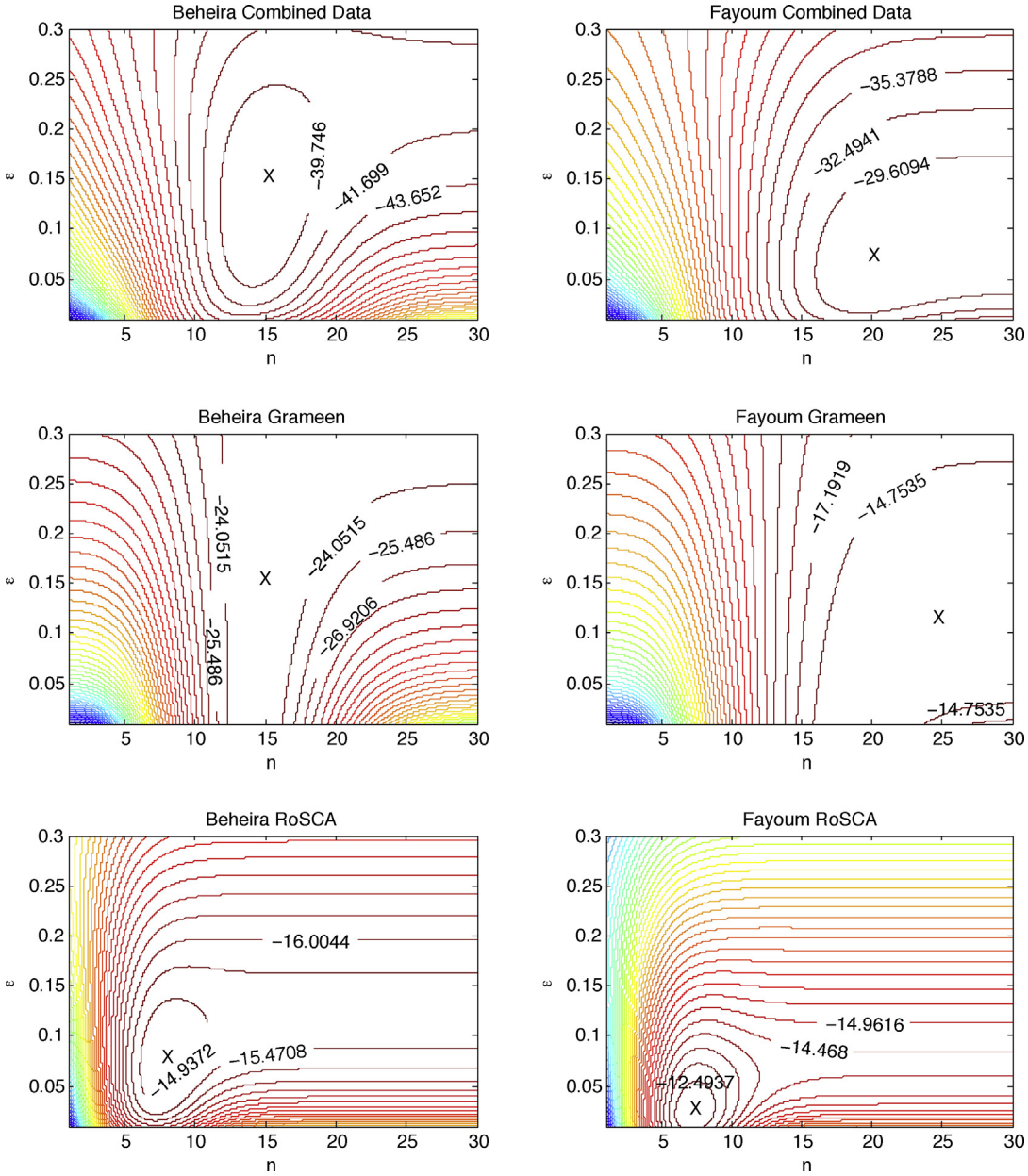

Fig. B1. Log likelihood contours for various subsamples.

population in Beheira. The estimated densities of q are χ^2_{20} for Fayoum and χ^2_{15} for Beheira, and the error rates are 7.5% for Fayoum and 15% for Beheira. The estimated densities of q for the two governorates are shown in Fig. B2.

However, this does not tell the entire story. The four lower plots in Fig. B1, show that the distribution of q is generally similar for the RoSCA design across governorates. Also, the estimated distributions of q suggest higher levels of estimated social punishment under the Grameen model. This result is shown in Fig. B3 for aggregated data under each model. The corresponding estimated densities of q for the two models are shown in Fig. B4. Therefore, as we tried to investigate differences in densities of q – our parameter that measures the importance of social punishment – across governorates, our results have strongly suggested that this difference between governorates is manifest only under the Grameen design (with hindsight, this is clear in Tables 6 and 7). In other words, even if q is model dependent, our results suggest that the RoSCA design should perform equally well in villages with low or high q draws, as predicted by our model for reasonable values of p.

To check the estimation results for distributions of q, we also estimated the parameters of lognormal distributions, which are more difficult to portray graphically because we have three parameters – (μ, σ) for the lognormal and ϵ for the errors – and the results were qualitatively identical, as shown in Table B1 (where "max" means that the parameter estimates for

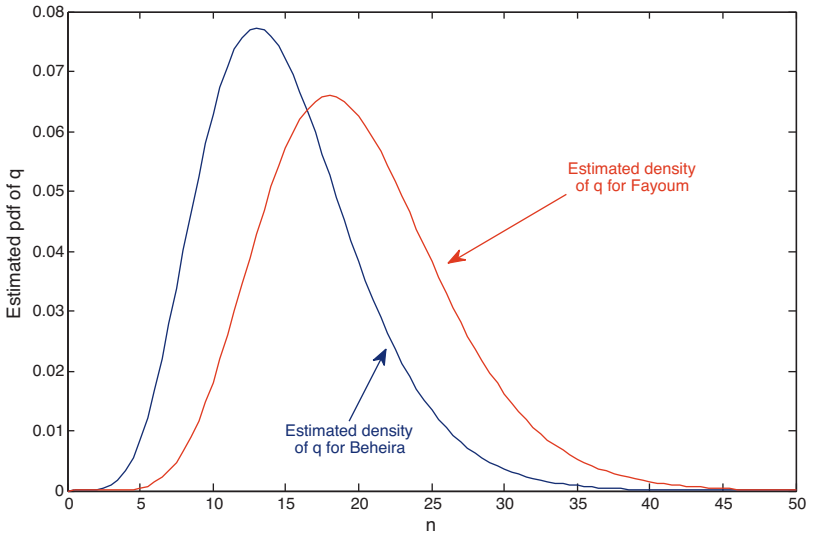

Fig. B2. Estimated densities of q for Beheira and Fayoum.

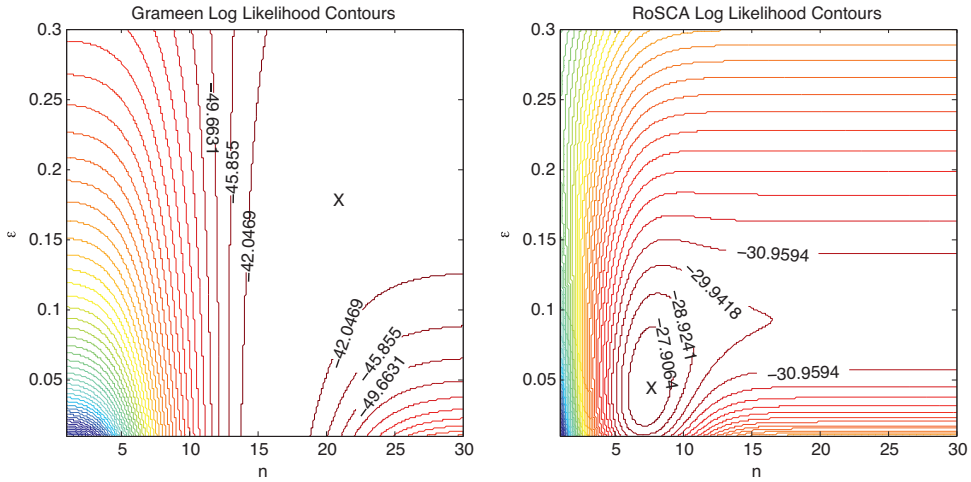

Fig. B3. Log-likelihood contours for all data under Grameen and RoSCA designs.

Table B1
Maximum likelihood estimates (std errors in parentheses).

Sample	$\hat{\mu}$	$\hat{\sigma}^2$	$\hat{\epsilon}$
Beheira (all)	3.1088	1.7653	0.0741
	(3.0441)	(6.5483)	(0.4261)
Beheira (Grameen)	5.8842	4.2846	0.2945
	(3.0581)	(4.4275)	(0.2766)
Beheira (RoSCA)	5.6384	4.3578	0.0741
	(14.040)	(5.2544)	(0.1649)
Fayoum (all)	max	max	0.0238
			(0.0257)
Fayoum (Grameen)	6.8286	2.1233	0.1014
	(25.443)	(14.993)	(0.1881)
Fayoum (RoSCA)	5.3387	4.6962	0.0238
	(253.30)	(297.64)	(0.2472)
Grameen (all)	6.5515	3.0650	0.1934
	(2.9433)	(2.1329)	(0.0919)
RoSCA (all)	4.4077	0.1561	max
	max	max	

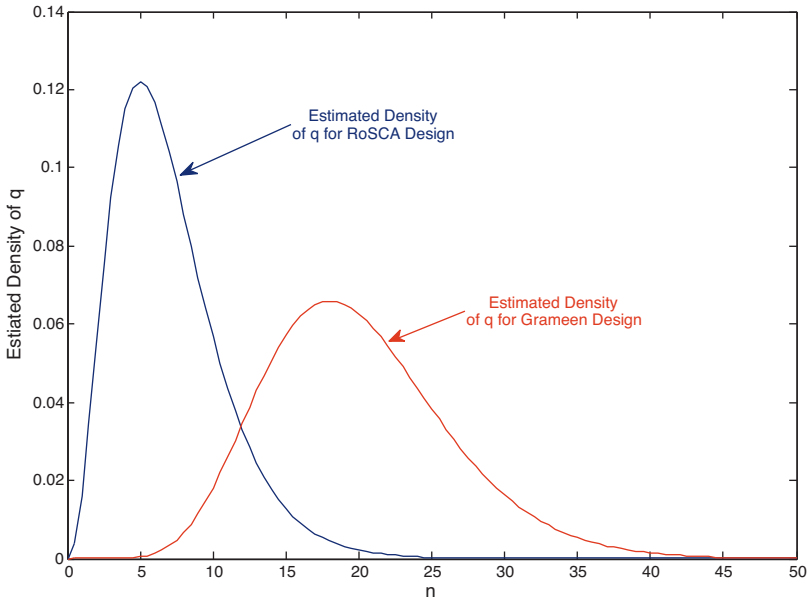

Fig. B4. Estimated densities of q under Grameen and RoSCA designs.

the subsample always were at the upper boundary of allowed parameter values in `fmincon`, the optimization routine used in matlab to minimize the negative of log likelihood, and `fminunc` produced unrealistically high estimates, suggesting that the graphical approach to estimation with a single-parameter family shown in Figs. B1 and B3 is more fruitful, especially given the flatness of the log likelihood functions as shown in the contour graphs). Qualitatively, the results still show higher levels of social capital in Fayoum and higher levels under the Grameen design.

Appendix C. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jebo.2014.02.025.

References

Abdul, R., Rahim, A., 2007. Islamic microfinance: a missing component in Islamic banking. Kyoto Bull. Islamic Area Stud., 38–53.
Ahmed, H., 2002. Financing microenterprises: an analytical study of Islamic microfinance institutions. Islamic Econ. Stud. 9. (2).
Ambec, S., Treich, N., 2007. Roscas as financial agreements to cope with self-control problems. J. Dev. Econ. 82 (January (1)), 120–137.
Anderson, S., Baland, J.-M., 2002. The economics of roscas and intrahousehold resource allocation. Quart. J. Econ. 117 (3), 963–995.
Angelucci, M., Karlan, D., Zinman, J., 2013. Win some lose some? Evidence from a randomized microcredit program placement experiment by Compartamos Banco.
Ashraf, N., Karlan, D., Yin, W., 2006. Tying Odysseus to the mast: evidence from a commitment savings product in the Philippines. Quart. J. Econ. 121 (2), 635–672.
Attanasio, O., Augsburg, B., De Haas, R., Fitzsimons, E., Harmgart, H., 2011. Group lending or individual lending? Evidence from a randomised field experiment in Mongolia.
Augsburg, B., De Haas, R., Harmgart, H., Meghir, C., 2012. Microfinance at the margin: experimental evidence from Bosnia and Herzegovina, Available at SSRN 2021005.
Banerjee, A., Duflo, E., Glennerster, R., Kinnan, C., 2013. The miracle of microfinance? Evidence from a randomized evaluation.
Banerjee, A.V., Duflo, E., August 2004. Do Firms Want to Borrow More? Testing Credit Constraints Using a Directed Lending Program. Center for Economic Policy Research Working Paper.
Banerjee, A.V., Duflo, E., 2011. Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty. Public Affairs.
Besley, T., Coate, S., Loury, G., 1992. On the Allocative Performance of Rotating Savings and Credit Associations. Woodrow Wilson School – Development Studies, Princeton, Working Papers.
Besley, T., Coate, S., Loury, G., 1993. The economics of rotating savings and credit associations. Am. Econ. Rev. 83 (October (4)), 792–810.
Besley, T., Coate, S., Loury, G., 1994. Rotating savings and credit associations, credit markets and efficiency. Rev. Lit. Arts Am. 61 (4), 701–719.
Boylan, R., El-Gamal, M., 1993. Fictitious play: a statistical study of multiple economic experiments. Games Econ. Behav. 5 (2).
Carpenter, J., 2002. Measuring Social Capital: Adding Field Experimental Methods to the Analytical Toolbox. In: Sunder, R., Jonathan, I., Thomas, K. (Eds.), Social Capital, Economic Development and the Environment. Edward Elgar (Fall 2002).
CGAP, 2008. Islamic Microfinance: An Emerging Market Niche. World Bank, Washington, DC.
CGAP, 2009. Measuring Access to Financial Services Around the World. World Bank, Washington, DC.
Crépon, B., Devoto, F., Duflo, E., Parienté, W., 2011. Impact of Microcredit in Rural Areas of Morocco: Evidence from a Randomized Evaluation. Massachusetts Institute of Technology, Cambridge, MA.
de Aghion, B.A., Morduch, J., 2005. The Economics of Microfinance. MIT Press, Cambridge, MA.
Dhumale, R., Sapcanin, A., 1998. An Application of Islamic Banking Principles to Microfinance. UN Development Programme Technical Note.
Dowla, A., Barua, D., 2006. The Poor Always Pay Back: The Grameen II Story, 1st ed. Kumarian Press, Inc., West Hartford, CT.

El-Gamal, M., 2003. 'Interest' and the paradox of contemporary Islamic law and finance. Fordham Int. Law J. 27 (1), 108–149.
El-Gamal, M., 2006. Islamic Finance: Law, Economics, and Practice. Cambridge University Press, Cambridge, UK.
El-Gamal, M., 2007. A simple fiqh-and-economics rationale for mutualization in islamic financial intermediation. In: Nazim, A. (Ed.), Integrating Islamic Finance into the Mainstream: Regulation, Standardization, and Transparency, Cambridge: Islamic Finance Project, Islamic Legal Studies Program. Harvard University, Cambridge, MA.
Gine, X., Karlan, D., 2013. Group versus individual liability: short and long term evidence from Philippine microcredit lending groups. J. Dev. Econ..
Karlan, D., 2007. Social connections and group banking. Econ. J. 117 (517), F52–F84.
Karlan, D.S., 2005. Using experimental economics to measure social capital and predict financial decisions. Am. Econ. Rev. 95 (5), 1688–1699.
Karlan, D., Zinman, J., 2010. Expanding credit access: using randomized supply decisions to estimate the impacts. Rev. Financ. Stud. 23 (1), 433–464.
Karlan, D., Zinman, J., 2011. Microcredit in theory and practice: using randomized credit scoring for impact evaluation. Science 332 (6035), 1278–1284.
Obaidullah, M., Khan, T., 2008. Islamic microfinance development: challenges and initiatives. Islamic Res. Train. Inst., Policy Dialogue Paper No. 2, (PDF of 98 Pages).
Ray, D., 1998. Development Economics. Princeton University Press, Princeton, NJ.
Sinn, M., 2013. Sequential lending: a mechanism to raise repayment rates in group lending? Economica 80 (318).
UNDP, 2008. UNDP Egypt Human Development Report 2008.
Yang, K., 2007. Individual social capital and its measurement in social surveys. Surv. Res. Methods 1 (1), 19–27.