



Enforcement in informal saving groups

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ABSTRACT

Informal groups cannot rely on external enforcement to insure that members abide by their obligations. It is generally assumed that these problems are solved by ‘social sanctions’ and reputational effects. The present paper focuses on roscas, one of the most commonly found informal financial institutions in the developing world. We first show that, in the absence of an external (social) sanctioning mechanism, roscas are never sustainable, even if the defecting member is excluded from all future roscas. We then argue that the organizational structure of the roscas itself can be designed so as to address enforcement issues. The implications of our analysis are consistent with first-hand evidence from roscas in a Kenyan slum.

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1. Introduction

A substantial number of economic activities in developing countries are carried out by informal groups. Their success has attracted much public attention and knowledge of these groups is of particular importance if we want to understand the potential role for more formal institutions. While these groups may differ significantly in their organizational structures and functions (insurance, savings, mutual credit, work cooperatives...), they all share in common that (i) participation in these groups is voluntary, and (ii) they do not and cannot rely on external enforcements. However, very little is known about the mechanisms used by these groups to ensure that members

abide by their obligations. In this paper we aim to explore enforcement issues that arise in informal saving groups by considering the role played by the institutional design of these groups. More specifically, we shall highlight the possible trade-offs between the social desirability of particular organizational structures and their impact on the enforceability of the underlying arrangements. There is very little literature pertaining directly to this issue. The paper closest in spirit to ours is the one by Banerjee et al. (1994) who study the organizational design of credit cooperatives.

We focus on rotating savings and credit associations (roscas) which constitute one of the most commonly found informal financial institutions in the developing world.¹ Recent studies reveal exceptionally high participation rates in these associations.² For instance, from an original field survey we carried out in a Kenyan slum, we find that 57.2% of households have at least one individual who belongs to a roscas. The average monthly contribution into roscas groups is equal to 20.3% of individual income and 13.6% of total household income (Anderson and Baland, 2002). Although roscas are most common in very poor areas of the world, there are examples where they exist along side more formal financial institutions and are sometimes

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¹ See Bouman (1977), for a list of countries in parts of Africa, Asia, the Americas, Caribbean, Middle East, and early Europe where roscas have appeared. The origins of roscas are unclear; records show that they have existed since pre-modern times in China (Tsai, 2000), 9th century in Japan (Miyanaga, 1995), 1663 in Korea (Light and Deng, 1995), and early 19th century in many parts of Africa (Ardener, 1964).

² There is a large anthropological literature on roscas beginning with the work of Ardener (1964) and Geertz (1962).

preferred (see, for example, Levenson and Besley (1996) for Taiwan, Eckhout and Munshi (2003) for India). Roscas are also popular amongst immigrant groups in both the United States and Britain.³

More specifically, a rosca is a group of individuals who gather for a series of regular meetings. At each meeting, each person contributes a predetermined amount into a collective ‘pot’ which is then given to a single member. The latter is subsequently excluded from receiving the pot in future meetings, while still being obliged to contribute to the pot. The meeting process repeats itself until all members have had a turn at receiving the pot. Essentially, members take turns in benefitting from collected savings. At the start of the scheme, the order of such turns must be decided either by a lottery draw (henceforth referred to as a *random rosca*), or according to a predetermined pattern (*a fixed rosca*) or by a bidding process. In the Kenyan context we studied, 71% of the rosca are *fixed* while 29% are *random* (there are no bidding rosca).

In spite of their organizational simplicity, rosca do suffer from incentive problems. Because of the rotational structure of rosca, the incentive for members who receive the pot earlier in the cycle to default on their later contributions is high. Moreover, the incentives of the member who receives the pot last to contribute to the pot are not at all clear. Although the issue of default is acknowledged in almost any study of rosca, enforcement problems have not been directly addressed in the previous literature.⁴

Since rosca are typically formed by a relatively small group of individuals who live in the same area, it is generally assumed that the prospect of participating in future cycles of the rosca as well as the threat of social sanctions by the other members of the group are enough to deter opportunistic defection. Thus, Besley et al. (1993) note that rosca “use pre-existing social connections between individuals to help circumvent problems of imperfect information and enforceability” (p. 805). Similarly, Handa and Kirton (1999) point out that “crucial to the success of rosca is the social collateral that ensures sustainability” (p. 177). It has been discussed that defaulters would not only be sanctioned socially but also prevented from further rosca participation. Ardener (1964) explains that “the member who defaults in one association may suffer to such an extent that he may not be accepted as a member of any other. In some communities, the rotating credit institution has become so rooted in the economic and social system that exclusion would be a serious deprivation” (p. 216).

While we will show that such social sanctions certainly have a role to play, we first demonstrate that exclusion from all future rosca is not a sufficient deterrent to avoid default. We then argue that, when social sanctions are weak, the institutional structure of rosca can be designed so as to minimize enforcement problems. In particular, we shall focus on the way ranks are allocated across members. It will be demonstrated that, while *random* rosca are preferred by a majority of members, the enforcement problems are lower in *fixed* rosca.

The paper is organized as follows. The next section presents a model of rosca participation and discusses the preferred allocation of ranks. We investigate the issue of enforcement in Section 3, and explore how the institutional design of rosca can be modified to address enforcement problems. In Section 4, we illustrate some of the implications of our theoretical analysis in the context of the Kenyan slum we surveyed. Section 5 concludes.

2. A model of random versus fixed rosca

In this section, we develop a simple model of rosca participation. We consider two main motives for rosca participation discussed in the

³ See, for example, Light and Deng (1995), Bonnett (1981), Kurtz (1973), Srinivasan (1995), Bouman (1995), Summerfield (1995), and Besson (1995). There is also some evidence that rosca formed the basis of U.S. savings and loans associations, see Besley (1995) for references.

⁴ See, for example, van den Brink and Chavas (1997), Ardener (1964), and Kurtz (1973). Handa and Kirton (1999) do provide an in-depth study of the role of the rosca leader in explaining the sustainability of the group.

literature. In their seminal contribution, Besley et al. (1993) argued that, on average, rosca allowed members to enjoy the benefits of the pot earlier than if they were saving at home, since the allocation of pots begins at the first meetings. We shall refer to this as the *early pot motive*. In Anderson and Baland (2002), we proposed another motive where members join rosca to save at a higher savings rate than they would at home. We justified this by focusing on the conflict over joint consumption and savings patterns between husbands and wives, and explained that women join rosca to bind themselves to a particular saving pattern that is different from their husbands. We shall refer to this as the *household conflict motive*.

Our aim here is to focus on enforcement issues. To this end, we shall investigate two main questions. First, to what extent does the threat of exclusion from all future rosca help to discipline rosca members? Second, how can the institutional design of the rosca be used to deter default? In order to address these questions, we shall extend the work of Besley et al. (1993) to incorporate multiple rosca cycles.⁵ With regards to institutional features, we focus on the allocation of ranks across members. There are essentially three possibilities: fixed order, random order and bidding for ranks. Although the latter two have been the focus of previous literature, we focus on the former two in the present analysis.⁶ This is justified by our data, where no bidding rosca are observed.⁷ Below we develop a model which simply compares these two observed rosca. We should emphasize that we are not investigating a mechanism design problem.

2.1. The basic setting

As we are concerned with the possibility of future sanctions, we assume that individuals are infinitely lived. Time is discrete, and the lifetime utility of an individual i is represented by:

$$U^i(\mathbf{c}, \mathbf{D}) = \sum_{t=1}^{\infty} \delta^t u^i(c_t, D_t) \quad (1)$$

where \mathbf{D} is the vector of all consumption flows of the indivisible good and D_t represents the consumption at time t of one unit of the indivisible good which, once acquired, lasts for one unit of time: D_t is equal to one if the good is purchased at time t and zero otherwise.⁸ Similarly, \mathbf{c} is the vector of all consumption expenditures on other goods, c_t represents those expenditures at time t , and $\delta < 1$ is the discount factor.

The budget constraint in each period can be expressed as:

$$y = c_t + s_t \quad (2)$$

where y is the constant income per period and s_t is savings. Income is held constant so that the only motive to save is to purchase the indivisible good, the cost of which is equal to P . If the indivisible good is bought successively at times k and $k+\tau$, then we have: $P = \sum_{t=k+1}^{k+\tau} s_t$. We assume that individuals have no access to credit markets so that $s_t \geq 0$.

As discussed above, we allow for two different motives to join a rosca, the *household conflict motive* and the *early pot motive*. The difference between these two motives can be simply modeled as different reservation utilities when saving outside of the rosca. We

⁵ Although it is not their focus, Besley, Coate, and Loury (1993) do discuss the issue of default and assume an exogenous cost of defaulting which is large enough for members to continue contributing after receiving the pot. The central difference here is that we explicitly consider the costs of default and model them in terms of exclusion from future rosca cycles.

⁶ See Besley, Coate, and Loury (1993, 1994), Kovsted and Lyk-Jensen (1999) who contrast random and bidding rosca, Klonner (2003) and Eckhout and Munshi (2003) for analyses of bidding rosca.

⁷ It must however be emphasized that the enforcement problem of the first member to receive the pot in a bidding rosca is very similar to the one we discuss below.

⁸ This is a useful simplifying assumption in a repeated framework, since then current decisions are unaffected by the past.

first examine the optimal saving plan under both of these motives in the absence of rosca participation.

Consider the early pot motive. Let $(\mathbf{c}^*, \mathbf{D}^*)$ represent the optimal consumption flow which maximizes $U^i(\mathbf{c}, \mathbf{D})$, under the budget constraint (2), so that $U^i(\mathbf{c}^*, \mathbf{D}^*)$ denotes lifetime optimal utility. We assume that there is a saving motive so that $c_t^* < y$ for all t .⁹

Now consider the household conflict motive. On its own, the household maximizes $U^H(\mathbf{c}, \mathbf{D})$ which is a weighted sum of the lifetime utility of the husband m , $U^m(\mathbf{c}, \mathbf{D})$ and his wife f , $U^f(\mathbf{c}, \mathbf{D})$:

$$\begin{aligned} U^H(\mathbf{c}, \mathbf{D}) &= \beta U^m(\mathbf{c}, \mathbf{D}) + (1 - \beta) U^f(\mathbf{c}, \mathbf{D}) \\ &= \sum_{t=1}^{\infty} \delta^t (\beta u^m(c_t, D_t) + (1 - \beta) u^f(c_t, D_t)) \end{aligned} \quad (3)$$

$$= \sum_{t=1}^{\infty} \delta^t U^H(c_t, D_t) \quad (4)$$

where $U^H(c_t, D_t) = \beta u^m(c_t, D_t) + (1 - \beta) u^f(c_t, D_t)$, c_t represents joint consumption expenditures on other goods, and β the relative bargaining power of the husband in household decision-making. The budget constraint of the household is similar to the budget constraint (2) above (where γ represents household income). Let $U^H(\mathbf{c}^*, \mathbf{D}^*)$ stand for the household lifetime optimal utility. As in [Anderson and Baland \(2002\)](#), we assume that the wife has a larger preference for the indivisible good, in contrast to her husband who prefers immediate consumption. In consequence, the saving rate optimally chosen in each period by the household, s_t^{H*} , is always smaller than her own optimal saving rate, s_t^{f*} .

2.2. Individual preferences over the allocation of the pot

In a rosca, n members contribute a predetermined amount P/n to the common pot at each meeting. The pot, P , is given to one of them who then acquires one unit of the indivisible good. There is only one meeting per period, and the time space between two meetings lasts one unit of time. As a consequence, the duration of a full cycle is equal to the number of members, n .

Rosca contributions are constant and denoted $s_R = P/n$. As a result, a rosca member's expenditures on other goods are $c_t = c_R = y - s_R$ for all t . Potentially, roscas can choose whether they last only one cycle, or are repeated. However, given the structure of preferences assumed above, there is always a motive to save, and hence, it is always worthwhile to repeat the rosca.¹⁰ This is particularly true for the household conflict motive. In the following, we therefore consider that roscas are always repeated.

There are two main ways in which the pot is allocated among members. On the one hand, there are *random* roscas, where ranks are allocated with equal probabilities at the beginning of each cycle. In each cycle, every member has a probability $1/n$ of receiving a particular rank. The expected utility for an individual, or for a couple, of joining a random rosca is:

$$E(U_r^k(\mathbf{c}, \mathbf{D})) = \sum_{t=1}^{\infty} \delta^t u^k(c_R, 0) + \frac{1}{n} \sum_{t=1}^{\infty} \delta^t u^k(c_R, 1) - u^k(c_R, 0)$$

which can be rewritten as:

$$E(U_r^k(\mathbf{c}, \mathbf{D})) = \frac{\delta}{1 - \delta} u^k(c_R, 0) + \frac{\delta}{1 - \delta n} (u^k(c_R, 1) - u^k(c_R, 0)) \quad (5)$$

On the other hand, there are *fixed* roscas where the allocation of ranks remains unchanged across cycles. This implies that each mem-

ber receives the pot at regular intervals of n units of time. In this situation, the utility of a member with rank g is given by¹¹:

$$\begin{aligned} U_{gf}^k(\mathbf{c}, \mathbf{D}) &= \sum_{t=1}^{\infty} \delta^t u^k(c_R, 0) \\ &\quad + (\delta^g + \delta^{g+n} + \delta^{g+2n} \dots) (u^k(c_R, 1) - u^k(c_R, 0)) \\ &= \frac{\delta}{1 - \delta} u^k(c_R, 0) + \frac{\delta^g}{1 - \delta^n} (u^k(c_R, 1) - u^k(c_R, 0)) \end{aligned} \quad (6)$$

We now compare those two methods of allocating the ranks. From an individual perspective, whenever an individual or a household has a motive to save, so that $c_t^* < y$, she can always find a random rosca such that she is better off. This follows because an individual can choose a rosca with s_R equal to her minimum optimal savings and accumulate additional savings on her own, thereby at least replicating her optimal consumption pattern under autarky, \mathbf{c}^* . By doing this, an individual enjoys the potential benefit of an early rank in the allocation of the pot in some cycle. Note that the latter argument requires that individuals supplement their saving in the rosca with some extra saving on their own. This implies that, once they receive the pot, they may not be in a position to buy the indivisible good but have to wait to accumulate enough extra savings. In a slightly different framework, [Besley et al. \(1994\)](#) show that, if instantaneous utility is separable in (c_t, D_t) , the constant saving rate implemented by the rosca may correspond to the optimal saving pattern under autarky. As it greatly simplifies our discussion, in this paper, we also assume that individuals do not supplement the pot with extra individual savings, so that the pot covers the total cost of the indivisible good.¹²

For fixed order roscas, the above argument holds if the individual is given an early rank. With a later rank, rosca participation may not yield positive benefits. Thus, if a member is last to receive the pot, he is worse off than under autarky since the rosca implies a sub-optimal saving pattern. Under the household conflict motive, rosca participation is also a tool that is used by wives to bring the household saving pattern closer to a level she prefers. Once her husband realizes that she has committed to a particular rosca, it is too late. (In the next section, we shall examine more precisely what this notion of commitment implies.). Thus, under this motive, a woman always has an interest in joining a rosca, as long as it involves a contribution that is higher than the average saving rate in the household and closer to her preferred one.¹³

Clearly, members who know that they will be given a low rank in fixed rosca would prefer to join a random rosca. Ex ante, however, if the initial allocation of ranks in the fixed rosca is drawn randomly, so that each member has a probability $1/n$ to obtain a fixed rank that he keeps throughout the cycles, individuals are indifferent between the two types of roscas. Using Eqs. (5) and (6), one can easily show that, under this situation, the expected utility from joining a fixed or a random rosca are identical.¹⁴ If the allocation of initial ranks for the fixed rosca is not uniformly random, members who are more likely to be given a favorable rank prefer a fixed order rosca while those given a less favorable lottery prefer the random rosca.

¹¹ The initial allocation of ranks is discussed later in more detail.

¹² In their model, each unit of the indivisible good provides a constant and infinite flow of services, which allows [Besley et al. \(1994\)](#) to assume away discounting while still preserving the desire to consume the indivisible good earlier. In the present model, assuming away discounting would imply that no preference is given for earlier consumption of the indivisible good, which would be unsatisfactory.

¹³ More generally, roscas are preferred under a forced saving motive, where individuals bind themselves to a particular saving pattern that they cannot achieve under autarky (see [Gugerty \(2007\)](#) and [Ambec and Treich \(2007\)](#)).

¹⁴ Note also that a simple lottery whereby each member has a probability $\frac{1}{n}$ of receiving the pot at each period brings the same level of ex ante utility. We do not explicitly analyze this alternative arrangement as (i) we do not observe this in our data set, and (ii) in a more general setting where individuals need a certain amount of cumulated savings at regular intervals, risk aversion reduces its attractiveness (see Section 3).

⁹ Note that $s_t^* = y - c_t^*$ is such that $u'(c_t^*) = \delta u'(c_{t+1}^*)$ when saving for one unit of the indivisible good.

¹⁰ A formal proof would follow directly, though for rosca repetition to dominate joining a new rosca, one needs to introduce some frictions, such as search or set-up costs.

2.3. Collective preferences over the allocation of the pot

We now investigate collective preferences over the allocation of the ranks. Consider the following repeated stages

- Before the cycle starts, the group holds a meeting and, by majority rule, it decides whether to have a random or a fixed rosca.
- The cycle starts and the pot is allocated to each member according to the rule.
- The cycle ends, and the group holds a meeting again and decides the allocation of ranks in the subsequent cycle. In other words, it decides whether to maintain the ranks that were given in the previous cycle or to reallocate them randomly across all members.
- A new cycle starts and so on.

There are conflicting interests in the allocation of the ranks as members with an early rank prefer to keep their ranks in future cycles, while members with a late rank would prefer ranks to be redrawn. We have:

Proposition 1. *At the beginning of each cycle, a majority of members strictly prefers the random to the fixed allocation of ranks.*

Proof. At the beginning of a cycle, the expected utility over the cycle for member k of a random allocation, where each member has exactly $1/n$ chances of getting a particular rank, is given by:

$$W_r^k = \sum_{t=1}^n \delta^t u^k(c_R, 0) + \frac{1}{n} \sum_{t=1}^n \delta^t (u^k(c_R, 1) - u^k(c_R, 0)),$$

while the utility for the same member with fixed rank g is given by

$$W_{gf}^k = \sum_{t=1}^n \delta^t u^k(c_R, 0) + \delta^g (u^k(c_R, 1) - u^k(c_R, 0)).$$

Comparing these two expressions, one gets:

$$\begin{aligned} W_{gf}^k < W_r^k &\Leftrightarrow \delta^g (u^k(c_R, 1) - u^k(c_R, 0)) < \frac{1}{n} \sum_{t=1}^n \delta^t (u^k(c_R, 1) - u^k(c_R, 0)) \\ &\Leftrightarrow \delta^g < \frac{1}{n} \sum_{t=1}^n \delta^t \end{aligned}$$

which, with $\delta < 1$ and $n \geq 2$, holds true for all $g \geq \frac{n+1}{2}$. This is due to the fact that δ^t is a convex function of t , and implies that a majority of members strictly prefer a uniformly random allocation of ranks to any given fixed allocation. \square

This result follows directly from the way multiplicative discounting operates, that is, the discounted value gets smaller at a decreasing rate with time. The corresponding discounted utility levels associated with various ranks are illustrated in Fig. 1 below. As can be seen, the average of the discounted values at different points in time, point A in the figure, is always greater than the discounted value at the average of these points in time (i.e., median rank), point B. As a result, the member with the median rank strictly prefers the random to the fixed order rosca.

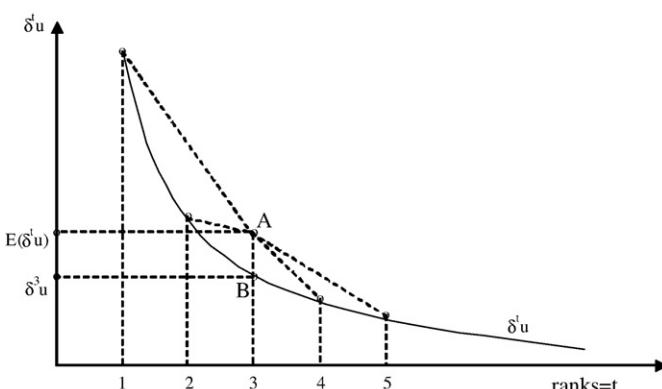


Fig. 1. Expected utility from a random or a median rank.

Our emphasis on discount rates is reasonable in a context of destitution and poverty. Indeed, from the field survey we carried out on informal groups in Kenya (see Section 4), the median monthly interest rate paid on fully collateralized loans is as high as 20%. Consider a hypothetical rosca of 17 members who gather every two weeks (these figures correspond to the average characteristics of the roscas we surveyed). Assuming that the discount rate over two weeks is equal to 10% and that the value of the pot for the first member is 1, it is easy to show that the discounted value of the pot for the last member, after 34 weeks, is as low as 0.185. Comparing roscas, we find that 10 members strictly prefer the random while 7 members prefer the fixed rosca. If the pot is randomly allocated, its expected value for each member is equal to 0.491. In comparison, the value of the pot for the median ranked member is equal to 0.430. On average, the present value of the pot for those who prefer the random rosca is as low as 0.310, much below that of the 7 members who benefit from an early rank (the average value for them is equal to 0.749). For the disadvantaged members, the switch to a random allocation of ranks thus increase expected benefits by 58% on average. In comparison, if we considered a discount rate of 5% every two weeks, the gain for those members from changing the allocation of ranks would be equal to 26% (from 0.540, the average discounted value of the pot for these members in the fixed rosca, to 0.683, the expected value of a random allocation of ranks).

While not modeled here, the preference for random over fixed roscas should also hold (and perhaps be even stronger) with hyperbolic discounting, while it is independent of the degree of risk aversion.¹⁵ The proposition has important implications since fixed roscas, as a collective arrangement, are not time-consistent under the majority rule. At the meeting preceding each cycle, a majority of members prefer randomly drawing new ranks for all members instead of maintaining the allocation of ranks prevailing in the previous cycle. By contrast, random roscas are time-consistent in the sense that a majority of members would always vote in favor of random ranks at the beginning of every cycle.

It is worth noting that the argument also extends within the cycle: among the members who have not yet received the pot, a majority is in favor of randomly drawing the remaining ranks instead of keeping the order determined at the beginning of the cycle. The most time-consistent structure is therefore one in which, at each period within a cycle, the winner of the pot is drawn randomly among those who have not yet received it. In this setting, members only learn their rank when they receive the pot but remain identical before receiving it. Unfortunately, the information we gathered on roscas in Kenya is not precise enough to distinguish between roscas which randomize at the beginning of each cycle and those which randomize at each distribution of the pot, so that we are not able to pursue this line of enquiry in this paper. It is however likely that a random allocation of ranks at every period involves larger organizational costs at the group (e.g. by requiring group meetings at every period or close monitoring of rank revelation within a cycle) and lowers predictability at the individual level (making the planning of expenditures within a cycle more difficult).¹⁶

Finally, it is worth noting that, ex post, the distribution of lifetime utilities is more unequal under a fixed than under a random rosca. Among all possible allocation of ranks across cycles, the fixed allocation is the one leading to the most unequal distribution of welfare, with the first (last) ranked member always being the first (last) to receive the pot in all cycles. In a collective decision process in which the group cares not only about the ex ante but also the ex post distribution of utilities across members, the group should prefer random roscas as leading to a more

¹⁵ The result mainly follows from the assumption of time-separable preferences. In a more general setting, the preference for random over fixed roscas will depend on the inter-temporal elasticity of substitution and the degree of risk aversion, as we have demonstrated in a previous version of this paper.

¹⁶ However, as will be clear from the discussion in the next section, the enforcement properties of those two types of random roscas are identical.

egalitarian ex post outcome.¹⁷ From informal discussions with rosca members, it indeed appeared that a situation in which one member keeps an unfavorable rank across all cycles was perceived as unfair (ex post). Given this, the existence of fixed roscas is hard to justify on the basis of the individual or collective preferences. In the next section, we discuss the extent to which fixed roscas may have a role in disciplining members and solving enforcement problems.

3. Enforcement

As an informal group, a rosca cannot legally enforce agreements between members. As discussed in the introduction, roscas can inflict two types of sanctions on defecting members. First, they can exclude the member from all future roscas and, as we shall assume throughout, from all other rosca groups as well. We refer to this as *exclusion*. Second, roscas can also punish defection via a range of social sanctions such as giving a bad reputation, retaliating at the workplace, or damaging personal property. We refer to this set simply as *social sanction*. Let σ_k represent the cost to individual (or household) of the social sanction that the group can impose on them if they defect. Clearly, σ_k depends on a number of individual (household) characteristics which make one more vulnerable to these sanctions, that we shall discuss in Section 4. We assume that these characteristics are perfectly observable.

In the previous literature, it has been assumed that σ_k is sufficiently large to solve all enforcement problems, so that the role played by the organizational structure of roscas has remained largely ignored. Here, we analyze in more detail the role of social sanctions, and their interrelation with the design of the rosca. As a starting point, we first consider that no social sanctions can be inflicted on their members, i.e. $\sigma_k = 0$, so that only exclusion can be employed against defecting members. The first institutional feature we examine is the repeated structure of roscas. Thereafter, we consider the allocation of ranks.

3.1. Enforcement through exclusion

Under the household conflict motive, it is precisely the strength of social sanctions that allows the wife to commit her household to a rosca. In the absence of social sanctions, the household would in fact refuse to pay the first contribution, as it does not correspond to its optimal saving. As a result, the wife's desire to join the rosca would be jeopardized, as the other members would realize that her intentions are futile. Typically, exclusion from all future roscas cannot be used as a threat since the household would be better off not participating at all. Thus, in the absence of social sanctions, the household always leaves the rosca.¹⁸

We now turn to the early pot motive. Although it is not their focus, Besley et al. (1993) discuss the issue of default when considering the possibility that, having received the pot, a member stops contributing. In their one-cycle framework, they assume an exogenous cost of defaulting which is large enough to induce members to remain in the rosca.¹⁹ As they note, in repeated roscas, there is the possibility of punishing a member by excluding him from all future cycles. The question that naturally arises is to what extent such a threat is in itself sufficient to guarantee that members obey their obligations. Consider a member who obtains the pot in the first meeting. When receiving the pot, she

compares what she would gain by leaving the rosca and being excluded from all future cycles, and saving on her own forever, to what she would gain from staying in the group and fulfilling her obligations. We show in the proposition below that, for both random and fixed roscas, the net gain from leaving the rosca is always strictly positive.

Proposition 2. *In the absence of social sanctions, roscas are not sustainable. The member who is the first to receive the pot is always tempted to leave and defect, even if she is excluded from all future cycles (Proof in Appendix A).*

In the absence of social sanctions, when a member is the first to receive the pot, she can always do better by leaving the group and saving on her own in order to acquire additional units of the indivisible good, compared to remaining in the rosca. The intuition for this result follows from the fact that the first receiver is at least always able to replicate the best she can hope for in a rosca by saving on her own. Therefore, exclusion from all future roscas groups is not a sufficient deterrent of defection.²⁰

3.2. Enforcement through the allocation of ranks

In the preceding discussion, we have focused on a particular enforcement problem where a rosca member, upon receiving the pot, is tempted to leave the rosca and cease paying contributions before the end of the cycle. Roscas, however, may also suffer from a second enforcement problem: the temptation of those members who receive an unfavorable rank to leave the rosca before undertaking any payment at all to the common pot. Clearly, the first enforcement problem is most severe for the member who receives the first rank, while this second enforcement problem is more likely to arise for the member with the last rank.

The first part of Proposition 3 states that incentives in fixed roscas are identical among all members: indeed, after receiving the pot, the first ranked member is in the exact same position as the last ranked member as he has to wait a full cycle before receiving a new pot. By contrast, in a random roscas, the enforcement problem for the first member to receive the pot is more severe, as future ranks are identical across all members. This explains why we focus on the enforcement problem of the first individual. Comparing his enforcement constraint across the two types of roscas, we find that the first member to receive the pot has a lower incentive to default in a fixed than in a random rosca:

Proposition 3. *In a random rosca, the enforcement problems of the first member to receive the pot are always more severe than those of the last member. In a fixed rosca, the enforcement problems are identical across members of different ranks. Moreover, enforcement problems are more severe in a random than in a fixed rosca (Proof in Appendix A).*

To address the enforcement problem, rosca members can therefore choose to adopt a fixed allocation of ranks. Fixed order roscas are indeed more favorable to the member who received the first rank in the initial cycle, as she is then assured to retain her favorable position in all subsequent cycles. In a random rosca, the first ranked member in a given cycle is uncertain about his rank in the next cycle: in particular, the probability that he receives the pot in the first period of that cycle is only $1/n$. The non-randomness of fixed roscas therefore reduces the enforcement problem for the first ranked member, who is then less tempted to leave and save on her own. By contrast, the adoption of a fixed allocation of ranks hurts the last ranked member, whereas a random allocation enables her to anticipate a better rank in the future.

¹⁷ We are grateful to one of the editors for pointing that out to us. This argument is directly related to the literature on ex post considerations in welfare economics of uncertainty (see, e.g., Hammond, 1998; Meyer and Mookherjee, 1987; Ray and Ueda, 1996).

¹⁸ It must be noted here that, while we focus on the household conflict motive in the exposition, all of the arguments made also apply to any forced saving motive, where a rosca is used as a means to save more than one would on their own (see in particular Gugerty, 2007; Anderson and Baland, 2002).

¹⁹ "This cost might represent the discomfort, loss of face, and other social costs associated with having to confront the other Rosca members each day or, in the extreme, the costs of finding a new job or place to live. In a more general setting, it might also represent the loss from being excluded from Rosca participation in the future" (Besley et al. 1993, p. 806).

²⁰ The argument a fortiori holds when roscas have a limited, possibly uncertain, lifetime, as this only reduces the future benefits from staying in the rosca. This result is reminiscent of a finding in a very different literature on sovereign debt, where Bulow and Rogoff (1989) find that future exclusion from borrowing is not a sufficient threat to sustain lending to small countries.

However, as we have seen above, the enforcement problem is less severe for those members.

Three points need to be made here. First, the immediate payment of a first contribution before ranks are announced reduces the enforcement issue of the last ranked member, as a payment has already been made and would be lost in case of defection. By contrast it leaves the incentives of the first ranked member unaffected. Such a possibility therefore increases the enforcement problem of the first member compared to the last one, so that they are no longer equivalent in a fixed rosca. Second, the enforcement issue of the last ranked individual can also be reduced if only one rank is drawn at each allocation of the pot, so that a member knows her rank only when she receives the pot and the members who have not yet received it do not know when they will obtain it in the remaining cycle. Such a scheme however leaves once again the incentive problem of the first ranked member unchanged. Finally, there are two other possible ways to reduce the enforcement problem. The first one is to drop the strict sequentially of the rosca and instead resort to a lottery system at each period, so that the first player has a positive probability of receiving the pot before all members received it. While such a lottery system certainly improves the enforcement problem of the first ranked individual, it also affects the expected benefits from joining such a lottery, as the probability that one member never receives the pot over a finite period of time is now positive. Risk aversion may render this unacceptable to some members.²¹ An alternative system would be to allow the pot to grow across periods, so that the first member is now promised a larger pot in the next cycle. However, given the enforcement conditions expressed above, such a system would involve a non-stationary pot size, and a contribution amount would exceed a member's income after a finite number of cycles. Backward reasoning implies this possibility cannot credibly solve the enforcement issue.

3.3. Enforcement through membership fee

If roscas are not, by themselves, sustainable, one may wonder whether a monetary entry fee could solve the problem. Consider that, upon joining a rosca, members must pay a membership fee that would be lost if they fail to fulfill their obligations. We now argue that such a fee cannot solve the enforcement problems in fixed roscas. Indeed, in such roscas, the enforcement problem is identical for all members and keeps repeating itself at each allocation of the pot. As a result, the same fee must be retained by the rosca throughout the cycle, so as to avoid defection by the member who receives the pot. As roscas have repeated cycles, the fee must be kept by the rosca throughout its lifetime to avoid defection also in future cycles.²² This implies that, from the perspective of rosca members, this fee would essentially be a sunk cost that would never be refunded, whether the member leaves or stays in the roscas. It would therefore fail to deter defection.

In a random rosca, the fee paid in the first period could be progressively reimbursed throughout the cycle, since enforcement problems are less severe for later ranked members. In particular, since the last member, after receiving the pot, is in the same situation as when joining a rosca *ex ante* (since her ranks in later cycles are unknown), no sanctions are necessary for her to remain in the rosca in that period. As a result, in a random rosca, the fee can be completely reimbursed at the end of the cycle, so that the sunk cost argument discussed in the case of fixed roscas no longer applies. However, even in this case a fee cannot resolve the enforcement problem. Intuitively, the maximum entry fee a group can impose on a member cannot exceed her expected gains from joining the group. Such a fee is just

high enough to prevent defection from a member who received an average rank in the cycle, and corresponds to the incentive of this 'average' member to stop contributing. The member who is first to receive the pot becomes an 'average member', in expected terms, only after the first cycle is completed. By leaving immediately, she gains the contributions, net of the reimbursed fee, that would remain to be paid over the rest of the first cycle.

Proposition 4. *The enforcement problem cannot be solved by a membership fee (Proof in Appendix A).*

Additionally, it is worth emphasizing that a major factor behind the success of roscas as an informal financial institution is that they avoid all problems associated with the accumulation of savings within a group. That advantage would be lost if the rosca had to manage membership fees.

Finally, it may be argued that other characteristics of the rosca may be chosen to address the enforcement issue, such as the size of the pot, the length of the cycle or the number of members. Under our modelling assumptions, the size of the pot (which represents the price of one unit of the indivisible good) is exogenously given. Additionally, as roscas meet once per unit of time, the length of a cycle is identically equal to the number of members. Ethnographic evidence (from informal interviews) and the data support this assumption: as rosca members typically receive their income at regular points in time, they usually contribute to the roscas then to avoid the accumulation of liquidities at home. This explains why most roscas are organized on a weekly or a monthly basis.²³ Given this, since $s_R = \frac{p}{n}$, there is only one variable left to be chosen by rosca members, which is either the contribution, s_R , or the number of members, n . This number may be chosen by the rosca so as to further reduce enforcement problems. To do so, membership should be set at a level which increases $U_{1,r}^k(\mathbf{c}, \mathbf{D})$ or $U_{n,r}^k(\mathbf{c}, \mathbf{D})$ in a fixed rosca, or $U_{1,r}^k(\mathbf{c}, \mathbf{D})$ in a random rosca. We are unable to obtain clear predictions, however, as much depends on whether the indivisible good is a complement or a substitute to expenditures on other goods. Additionally, if we relax the assumption that the number of members is proportional to the length of a cycle, so that the number of members can be fixed independently, as in Besley et al. (1993), the expected utility of a joining member is strictly increasing in membership: more members indeed imply that each member's expected rank diminishes with n and becomes closer to one half.²⁴ Intuitively, an increase in the number of participating individuals makes the 'average' situations more likely compared to the 'extreme' (first or last ranks), and thus reduces the expected waiting time. Therefore, enforcement problems can also be reduced in random roscas by increasing the number of members.

4. An empirical illustration

Our interest on enforcement problems in roscas comes from an intensive field survey we carried out in 1997 in the slum of Kibera in Nairobi. The survey combined a household survey, a group survey as well as open interviews with the heads of the groups. A slum like the one we analyze is one of the best places to study the behavior of informal groups. The inhabitants of the slum are very poor, with no access to formal insurance or credit institutions. In the absence of state intervention, they have created a host of informal groups dealing mostly with health insurance, funeral assistance and saving and credit. Thus, out of the 620 groups we surveyed, 374 are roscas (for more details, see Anderson and Baland 2002).

Enforcement is a serious concern in roscas, as emphasized by a respondent: "the usual form of cheating is for a new member to come to a merry-go-round (the local name for a rosca), and ask for number 1 or 2

²¹ The possibility of a lottery system would be more relevant in an extended mechanism design problem.

²² If the rosca has just one cycle, to deter the first member to defect, the fee should correspond to the net gain that he would obtain by defecting. As a result, the fee should be almost equal to a pot (deduction made of one contribution), so that, in the first period, all members should pay an amount equal to a pot (fee + contribution). As it would have to be paid up-front, it would destroy all incentives to join a rosca.

²³ In our sample, 29.4% of roscas meet weekly, 41.2% meet monthly, and 19.2% meet bi-weekly.

²⁴ To properly address this issue, a continuous time approach is required. This however complicates considerably the model, without adding much in content.

because they have an emergency... And then, they stop contributing. (...) There are many cheaters like that, about half of the population! Some of them are well-known! Still some groups fail due to cheating, but more often because members lack money to contribute." Rosca members invest time and resources in addressing enforcement problems. When a member fails to contribute regularly, groups generally resort to a system of progressive sanctions, usually preceded by an attempt to establish the reasons for his defaulting. They visit the member at his home, or send warning letters. In the absence of a satisfactory reaction, many rosca also attempt to retrieve the amounts due. For instance, when one member left with the pot, one group went to the home of the person and appropriated a radio set to compensate for the loss. (In all groups, the acceptance of new members is subject to them being well-known by the group: "The group knows where everybody has his house. So, if someone cheats us, group members go to his house and take away things to repay themselves.") Ultimately, defecting members may be expelled.²⁵ Groups sometimes complain to the local police station, with no much effect, but also resort to more diffuse social threats and pressures. Thus, the chairman of a rosca threatened a defecting member by writing: "So, you have been given ample time and you have yourself to blame if all goes worse. The ball is in your pocket!", and in a later meeting, he reminded members of a deadly Kikuyu curse, known as 'kikumi', which could be used if one squanders others' money.

More interesting from our perspective is that groups use their organizational design to address enforcement problem. Thus a group reported the following: "at the beginning, numbers were drawn by lottery (i.e. random allocation of ranks), to decide who will host the group in her house and get the pot (...). We dropped the lottery, and the executive committee decides the order. If attendance was found to be no good, then you will be given a late number."

Looking to the characteristics of the rosca, we find that the average rosca in our sample is composed of 16 members and has experienced roughly 9.5 full cycles, which is consistent with our theoretical assumption of repeated rosca cycles. More interestingly, 71% are fixed rosca and only 29% are random. Comparing these two rosca, we find that random rosca are more likely to be organized around a single ethnicity and to have been started with friends. In contrast, fixed order rosca are more heterogeneous and are more often started with people from the same neighborhood. It is possible that social sanctions can more easily be applied on friends and members of the same tribe, thereby allowing the group to choose a random allocation of the pot. It should be emphasized that, in accord with our theoretical analysis, a minority of rosca groups have a membership fee. On average, this up-front fee is only equal to approximately 25% of the monthly contribution, which is by far too low to deter defection in a random rosca, but is used to cover administrative costs.

As we argued, fixed rosca are better able to solve enforcement problems than random ones. We therefore expect that individuals who are more vulnerable to social sanctions to be more likely to belong to random rather than fixed rosca. Vulnerability to social sanctions should be higher for individuals who are less mobile, have longer standing social networks in the slum and have more visible wealth and objects of value. Such individuals are indeed more likely to suffer from retaliation and reputational effects from the group.

By looking at the characteristics of the 374 members we surveyed, we find systematic differences between participants to random versus fixed rosca. We can probably relate these to vulnerability to social sanctions. Members of random rosca are more likely to be: (i) employed as a permanent worker in the formal sector, have larger households, and own their own dwelling (they are less mobile); (ii) lived longer in the slum, belong to the Kikuyu tribe (the dominant tribe around Nairobi), participate to other informal groups and have previously participated to other rosca (they belong to larger social networks); and (iii) have higher incomes and own more objects of value such as TV, camera,

Table 1
Individual and household characteristics.

	No rosca	All rosca	Fixed order	Random order	Equivalence of means fixed versus random
Female	0.40 (0.49)	0.86 (0.35)	0.86 (0.34)	0.84 (0.37)	0.03 (0.04)
Married	0.56 (0.50)	0.66 (0.47)	0.67 (0.47)	0.64 (0.48)	0.03 (0.05)
Age	29.65 (9.34)	32.86 (8.33)	32.28 (8.38)	34.24 (8.08)	-1.95** (0.94)
At least primary school	0.62 (0.49)	0.48 (0.50)	0.47 (0.50)	0.48 (0.50)	-0.01 (0.06)
Permanent Work	0.37 (0.48)	0.60 (0.49)	0.53 (0.50)	0.75 (0.43)	-0.22*** (0.05)
Formal sector	0.28 (0.45)	0.19 (0.39)	0.11 (0.31)	0.38 (0.49)	-0.27*** (0.04)
Years in slum	7.43 (6.37)	8.15 (5.93)	7.86 (5.69)	8.84 (6.45)	-1.00 (0.67)
Household income	8028.84 (7482.10)	9188.81 (9762.93)	7977.69 (9272.73)	12067.55 (10330.35)	-4089.86*** (1089.56)
Household size	4.98 (2.13)	4.86 (2.08)	4.67 (2.05)	5.33 (2.11)	-0.66*** (0.23)
Own room	0.19 (0.39)	0.21 (0.41)	0.10 (0.30)	0.47 (0.50)	-0.37*** (0.04)
No. objects of value	4.11 (2.83)	4.43 (2.86)	4.01 (2.43)	5.44 (3.52)	-1.44*** (0.32)
Kikuyu	0.21 (0.41)	0.24 (0.43)	0.12 (0.33)	0.52 (0.50)	-0.39*** (0.04)
Luhya	0.19 (0.39)	0.18 (0.38)	0.22 (0.41)	0.08 (0.27)	0.14*** (0.04)
Luo	0.41 (0.49)	0.38 (0.49)	0.46 (0.50)	0.18 (0.39)	0.28*** (0.05)
Previous rosca	0 (0)	0.50 (0.50)	0.39 (0.49)	0.77 (0.42)	-0.52*** (0.10)
Other group membership	0.66 (0.47)	0.60 (0.49)	0.56 (0.50)	0.72 (0.45)	-0.16*** (0.06)
Number of observations	848	374	264	110	374

Standard deviations are in brackets except for the final column where standard errors are reported. All income variables are calculated by month and measured in Kenyan shillings. P-values for the equivalence of means test across random and fixed rosca are presented in the fifth column.

stereo, radio, clock, etc. (they have more visible wealth). This information is summarized in Table 1 below.²⁶

With the exception of the number of years spent in the slum, all the differences in the characteristics are statistically significant in an equivalence of means test across random and fixed rosca. We also estimated the probability that an individual participates in a random rosca compared to a fixed rosca as a function of those characteristics. The results, reported in Appendix B, fully support the differences highlighted in the descriptive statistics.

It must be noted, before concluding, that the relationship between some of those characteristics and individual vulnerability can be ambiguous. It is possible that individuals who have a permanent job in the formal sector are less mobile and more susceptible to retaliation in their work place. But they are also likely to enjoy better alternative opportunities, so that defection from the group would be virtually costless. Similarly, to own a house makes the resident less mobile but also less susceptible to pressure from landlords or neighbors. Or, participation in previous rosca can be interpreted as a measure of social networks and larger social sanctions. This interpretation relies on the idea that most of the individuals who have already been members of rosca were not expelled from those previous groups. Rather the group dissolved voluntarily, for instance because the amount of regular contributions could no longer be agreed upon. These ambiguities explain why we were not able to provide more of a proper test of our theoretical results.

²⁶ It should be noted that our empirical results remain robust if we exclude rosca in their first cycle (8% of our sample).

²⁵ In our sample of 374 rosca, 10% have explicitly expelled members.

5. Conclusion

A key feature of informal groups is that they cannot rely on external enforcement. It is typically assumed that these groups, such as roscas, rely instead on social sanctions to solve their enforcement problems. In this paper we examine these notions carefully. By their nature, these groups are set up beyond the direct reach of the usual instruments of coercion, both political and legal. They are thus a relatively pure example of self-enforcing informal groups where serious concerns regarding the possibility of default prevail.

Social sanctions certainly have a role to play. We first demonstrate however that expulsion from the group is in itself never a sufficient deterrent to default. We then ask whether institutional features of these groups are chosen in some part to prevent members from defaulting on their responsibilities. We focus on the allocation of ranks, and we show that a random allocation of ranks, though preferred by a majority of members, tends to exacerbate enforcement problems. They are therefore sustainable only if the costs of social sanctions on their members are sufficiently high. On the basis of a field survey carried out in Kenya, we then illustrate some of the key differences in the organizational features of the roscas.

Appendix A. Proof of the Propositions

Proof of Proposition 2. First note that, for the first ranked individual, the enforcement problem occurs once she has received the first pot. Consider a random rosca. If she stays in the rosca, her expected utility after receiving the pot, $E(U_{1,r}^k(\mathbf{c}, \mathbf{D}))$ is equal to:

$$E(U_{1,r}^k(\mathbf{c}, \mathbf{D})) = \sum_{t=1}^{n-1} \delta^t u^k(c_R, 0) + \sum_{t=n}^{\infty} \delta^t u^k(c_R, 0) + \frac{1}{n} \sum_{t=n}^{\infty} \delta^t (u^k(c_R, 1) - u^k(c_R, 0)) \quad (7)$$

where the first term on the right hand side represents her utility in the rest of the first cycle, while the two other terms represent her expected utility from all future cycles. The above can be re-written as:

$$E(U_{1,r}^k(\mathbf{c}, \mathbf{D})) = \frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta^n} \frac{1}{n} (u^k(c_R, 1) - u^k(c_R, 0)) \quad (8)$$

The utility an individual k receives if she defects from the rosca and saves on her own is equal to $U^k(\mathbf{c}^*, \mathbf{D}^*) - \sigma_k$. We denote the utility of an individual if she saves s_R on her own, without participating in a rosca by $U_{np}^k(\mathbf{c}, \mathbf{D})$, where:

$$U_{np}^k(\mathbf{c}, \mathbf{D}) = \frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta^n} (u^k(c_R, 1) - u^k(c_R, 0)). \quad (9)$$

Let the net benefit to staying in a random rosca for the first ranked individual be denoted by $\Delta_{1,r}^k$. Using Eqs. (7)–(9), we have:

$$\begin{aligned} \Delta_{1,r}^k &= E(U_{1,r}^k(\mathbf{c}, \mathbf{D})) - (U^k(\mathbf{c}^*, \mathbf{D}^*) - \sigma_k) \\ &= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta^n} \frac{1}{n} (u^k(c_R, 1) - u^k(c_R, 0)) \right) - U_{np}^k(\mathbf{c}, \mathbf{D}) \\ &\quad + U_{np}^k(\mathbf{c}, \mathbf{D}) - U^k(\mathbf{c}^*, \mathbf{D}^*) + \sigma_k = \left[\frac{\delta^n}{1-\delta^n} \frac{1}{n} - \frac{\delta^n}{1-\delta^n} \right] (u^k(c_R, 1) - u^k(c_R, 0)) \\ &\quad + [U_{np}^k(\mathbf{c}, \mathbf{D}) - U^k(\mathbf{c}^*, \mathbf{D}^*)] + \sigma_k < 0, \text{ if } \sigma_k = 0 \end{aligned} \quad (10)$$

The first bracketed term is negative as long as $\frac{1}{1-\delta} < n \frac{1}{1-\delta^n}$, which is always the case for $n > 1$. This term represents the net discounted value from consuming the indivisible good earlier by saving on her own rather than in a rosca. It is negative because the individual must wait at least until the beginning of a new cycle before having a chance at receiving the pot and buying an additional

unit of the indivisible good. In contrast, by saving the same amount on her own, she is guaranteed to receive the indivisible good at the beginning of each new cycle. The second term in Eq. (10) represents the difference in utility between saving in a rosca and saving optimally at home. This term is negative because optimal savings, with discounting, are typically non-constant, whereas roscas impose a constant saving rate.

Consider now the net benefit from staying in a fixed rosca for the first ranked individual, $\Delta_{1,f}^k$. Let $U_{1,f}^k(\mathbf{c}, \mathbf{D})$ denote the utility of the first ranked member of saving in a fixed rosca, after receiving the pot:

$$\begin{aligned} U_{1,f}^k(\mathbf{c}, \mathbf{D}) &= \sum_{t=1}^{n-1} \delta^t u^k(c_R, 0) + \sum_{t=n}^{\infty} \delta^t u^k(c_R, 0) \\ &\quad + \sum_{t=n}^{\infty} \delta^{kn} (u^k(c_R, 1) - u^k(c_R, 0)) \\ &= \left(\frac{\delta^n}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta^n} (u^k(c_R, 1) - u^k(c_R, 0)) \right) \end{aligned} \quad (11)$$

Using Eq. (11), we have:

$$\begin{aligned} \Delta_{1,f}^k &= U_{1,f}^k(\mathbf{c}, \mathbf{D}) - (U^k(\mathbf{c}^*, \mathbf{D}^*) - \sigma_k) \\ &= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta^n} (u^k(c_R, 1) - u^k(c_R, 0)) \right) \\ &\quad - U_{np}^k(\mathbf{c}, \mathbf{D}) + U_{np}^k(\mathbf{c}, \mathbf{D}) - U^k(\mathbf{c}^*, \mathbf{D}^*) + \sigma_k \\ &= U_{np}^k(\mathbf{c}, \mathbf{D}) - U^k(\mathbf{c}^*, \mathbf{D}^*) < 0, \sigma_k = 0 \end{aligned} \quad (12)$$

In the absence of social sanctions, the difference in utility between staying in a fixed rosca or saving on one's own is that the rosca imposes a sub-optimal constant saving pattern, c_R , instead of c^* . Otherwise, in a fixed rosca, the first ranked member is assured to receive the pot first in all future cycles. Hence, by saving the same amount on her own, she receives additional units of the indivisible good at the same time. \square

Proof of Proposition 3. Consider first fixed roscas and let the utility of the last ranked member be denoted by $U_{n,f}^k(\mathbf{c}, \mathbf{D})$. Her net benefit to staying in a fixed rosca, $\Delta_{n,f}^{ku}$ is equal to:

$$\begin{aligned} \Delta_{n,f}^k &= U_{n,f}^k(\mathbf{c}, \mathbf{D}) - (U^k(\mathbf{c}^*, \mathbf{D}^*) - \sigma_k) \\ &= \left(\sum_{t=1}^{\infty} \delta^t u^k(c_R, 0) + \sum_{v=1}^{\infty} \delta^{vn} (u^k(c_R, 1) - u^k(c_R, 0)) \right) - U^k(\mathbf{c}^*, \mathbf{D}^*) + \sigma_k \\ &= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta^n} (u^k(c_R, 1) - u^k(c_R, 0)) \right) - U^k(\mathbf{c}^*, \mathbf{D}^*) + \sigma_k = \Delta_{1,f}^k \end{aligned} \quad (13)$$

where $k = i, H$. This follows because, after receiving the pot in a fixed rosca, all members must wait exactly one full cycle before receiving their next pot. In other words, the enforcement problem is the same for all ranked members with similar vulnerability to social sanctions, σ_k .

This is not so for random roscas. Indeed, in this case, the member who receives the last rank in the first cycle can expect an earlier rank in the future. More formally, her expected utility if she stays in the rosca, $E(U_{n,r}^k(\mathbf{c}, \mathbf{D}))$, is equal to:

$$\begin{aligned} E(U_{n,r}^k(\mathbf{c}, \mathbf{D})) &= \left(\sum_{t=1}^n \delta^t u^k(c_R, 0) + \delta^n (u^k(c_R, 1) - u^k(c_R, 0)) \right) \\ &\quad + \left(\sum_{t=n+1}^{\infty} \delta^t u^k(c_R, 0) \right. \\ &\quad \left. + \frac{1}{n} \sum_{t=n+1}^{\infty} \delta^t (u^k(c_R, 1) - u^k(c_R, 0)) \right) \end{aligned} \quad (14)$$

Table 2

Estimations of whether individual select into random or fixed order rosca.

	Random (1)	Random (2)	Random (3)	Random (4)
Age	−0.014 (0.008)	−0.011 (0.01)	−0.006 (0.01)	−0.016 (0.011)
At least primary	−0.22 (0.15)	−0.34 (0.17)**	0.05 (0.16)	−0.14 (0.18)
Household income	1.4e−5 (8.6e−6)*	1.6e−5 (6.5e−6)**	1.4e−5 (6.9e−6)**	1.6e−5 (8.3e−6)
Household size	0.045 (0.038)	0.066 (0.038)*	0.11 (0.04)***	0.12 (0.04)***
≤1 year in Kibera			−0.24 (0.31)	−0.15 (0.32)
Kikuyu			1.07 (0.17)***	0.74 (0.19)***
Permanent employment		0.38 (0.16)**		0.28 (0.17)*
Formal sector		0.77 (0.21)***		0.65 (0.22)***
Own room		1.10 (0.18)***		0.70 (0.21)***
No. objects of value	0.08 (0.03)***			−0.03 (0.04)
Previous rosca			0.95 (0.16)***	0.85 (0.16)***
Group membership			0.27 (0.17)**	0.19 (0.17)
Constant	−2.79 (0.65)***	−1.39 (0.40)***	−2.26 (0.43)***	−2.05 (0.45)***
Log likelihood	−733.47	−700.62	−691.39	−679.03
No. of observations	373	373	373	373

The results are from a maximum-likelihood probit estimation with sample selection. Robust standard errors are in parentheses. A single asterisk denotes significance at the 10% level, double for 5%, and a triple for 1%.

where the first term in brackets represents her utility in the first cycle and the second term is her expected utility in all future cycles. Using Eq. (14), the net benefit to staying in a random rosca, $\Delta_{n,r}^k$ is:

$$\begin{aligned} \Delta_{n,r}^k &= E(U_{n,r}^k(c, D)) - (U^k(c^*, D^*) - \sigma_k) \\ &= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \left(\delta^n + \frac{\delta^{n+1}}{1-\delta} \right) (u^k(c_R, 1) - u^k(c_R, 0)) \right) \\ &\quad - U^k(c^*, D^*) + \sigma_k \end{aligned} \quad (15)$$

In contrast to the first ranked member, the expected net benefit for the last ranked member in a random rosca may be positive. In particular, if her utility function is such that the optimal savings pattern is almost identical to that in the rosca, then, using Eq. (15), $\Delta_{n,r}^k$ becomes:

$$\begin{aligned} \Delta_{n,r}^k &= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \left(\delta^n + \frac{\delta^{n+1}}{1-\delta} \right) (u^k(c_R, 1) - u^k(c_R, 0)) \right) \\ &\quad - \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta} (u^k(c_R, 1) - u^k(c_R, 0)) \right) + \sigma_k \\ &= \left(\delta^n + \frac{\delta^{n+1}}{1-\delta} - \frac{\delta^n}{1-\delta} \right) (u^k(c_R, 1) - u^k(c_R, 0)) \\ &\quad + \sigma_k > 0 \text{ even for } \sigma_k = 0. \end{aligned} \quad (16)$$

This expression is positive since staying in the rosca allows the member to receive the indivisible good earlier in future cycles, where she is likely to receive more favorable ranks.

Using Eqs. (10) and (16), we also have:

$$\begin{aligned} \Delta_{n,r}^k &= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \left(\delta^n + \frac{\delta^{n+1}}{1-\delta} \right) (u^k(c_R, 1) - u^k(c_R, 0)) \right) \\ &\quad - U^k(c^*, D^*) + \sigma_k \\ &= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \left(\frac{(n-1)}{n} \delta^n + \frac{\delta^n}{1-\delta} \right) (u^k(c_R, 1) - u^k(c_R, 0)) \right) \\ &\quad - U^k(c^*, D^*) + \sigma_k = \frac{(n-1)}{n} \delta^n (u^k(c_R, 1) - u^k(c_R, 0)) + \Delta_{1,r}^k \end{aligned}$$

Comparing Eqs. (10) and (16), we get for the random rosca that the benefits to stay in the rosca are higher for the last rank member than for the first ranked member:

$$\Delta_{n,r}^k > \Delta_{1,r}^k$$

For the fixed rosca, using Eqs. (12) and (13), we obtain that the benefits to stay are the same across ranks:

$$\Delta_{n,f}^k = \Delta_{1,f}^k = \Delta_{l,f}^k \quad \forall l$$

To compare the two types of rosca, we can therefore restrict our attention to the incentives for the first ranked individual to remain in the rosca. Comparing Eqs. (10) and (12), we get:

$$\Delta_{1,f}^k > \Delta_{1,r}^k$$

Hence, the results stated under Proposition 3. \square

Proof of Proposition 4. We show here that no fee exists that can solve the enforcement problem in a random rosca. We focus on the first ranked individual, and consider a situation under which a fee is paid in the first period of each cycle, and reimbursed afterwards within the cycle so as to maximize the incentives of the first ranked individual to stay in the rosca. If fees have also to be paid in later periods within the cycle, this can only increase her incentives to leave. Moreover, as we have already argued in the case of fixed order rosca, the fee should be completely reimbursed at the end of the cycle. Otherwise, it is analogous to a sunk cost that is never reimbursed, so that it has no impact on the enforcement constraint.

We let f_1 stand for the fee paid in the first period, and f_t for the amount reimbursed to a member in period t . The budget constraint implies that: $\sum_{t=1}^n f_t = 0$. The expected utility of a member joining a rosca with a fee can be written as:

$$E(U^k(\text{Fee})) = \left(\sum_{t=1}^n \delta^t u^k(c_R + f_t, 0) + \frac{1}{n} \delta^n (u^k(c_R + f_t, 1) - u^k(c_R + f_t, 0)) \right) + \delta^{n+1} E(U^k(\text{Fee}))$$

where the first bracketed term is the explicit expression of the expected utility of a member in the first cycle. We first note that, to offer to the first ranked members the best incentives to stay, it must be true that $f_1 < 0$ and $f_t \geq 0$ for $t = 2, \dots, n$. To maximize this incentive, we are looking for the highest fee that can be imposed while still preserving members' incentives to join the rosca. As such a fee reduces the expected utility of members, we therefore require that the rosca, with this maximal membership fee, yields an ex ante utility which is equal to the utility a member enjoys by saving on his own. We therefore have:

$$E(U^k(\text{Fee})) = U^k(c^*, D^*) \quad (17)$$

Note that for the above equality to hold, then it must be true the fee is strictly smaller than the pot, since otherwise, there are no net gains that can be expected from the rosca (as the pot is then bought by everyone in the first period): $f_1 < P$.

Let us now turn to the utility the first ranked individual obtains by leaving once she receives the pot. If she leaves, she saves on her own, and therefore her expected future utility in period 1 is equal to $U^k(\mathbf{c}^*, \mathbf{D}^*)$. Optimality implies:

$$U^k(\mathbf{c}^*, \mathbf{D}^*) > \sum_{t=1}^{n-1} \delta^t u^k(y, 0) + \delta^n U^k(\mathbf{c}^*, \mathbf{D}^*). \quad (18)$$

Using Eq. (17), we obtain:

$$U^k(\mathbf{c}^*, \mathbf{D}^*) > \sum_{t=1}^{n-1} \delta^t u^k(y, 0) + \delta^n E(U^k(\text{Fee})). \quad (19)$$

If a member stays in the rosca, she must still save in net over the periods 2 to n , since the fee is strictly smaller than the pot. Moreover, the reimbursement is made so as to maximize their utility from period 2 onwards (to increase the incentive to stay for the first member), so that savings will be positive (and increasing) over the remaining cycle: $c_R + f_t < y$ for $t = 2, \dots, n$. As a result,

$$\sum_{t=1}^{n-1} \delta^t u^k(y, 0) + \delta^n E(U^k(\text{Fee})) > \sum_{t=1}^{n-1} \delta^t u^k(c_R + f_t, 0) + \delta^n E(U^k(\text{Fee})) \quad (20)$$

Inequalities (19) and (20) imply that, in the absence of social sanctions, the first member is always better off by leaving once she receives the pot, even at the cost of loosing her membership fee. \square

Appendix B. Two-step estimation of individual participation

We estimate the probability that an individual participates in a random rosca compared to a fixed rosca as a function of his characteristics, using a Heckman two-step estimation procedure. In the first stage, we follow Anderson and Baland (2002) and estimate the probability that an individual joins a rosca as a function of individual characteristics, using gender, marital status, and female household bargaining power as instruments. In the second stage, we estimate the probability an individual selects into a random rosca, as a function of characteristics related to their vulnerability to social sanctions. Alternative estimations, one where we instead employ a simultaneous estimation procedure and another which does not account for the selection issue, and simply conditions on rosca participation generate similar results. Table 2 summarizes our second stage results from estimating the probability of joining a random rosca compared to a fixed rosca.

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