Enforcement and Organizational Design 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 rosca itself can be designed so as to address enforcement issues. The implications of our analysis are tested against first-hand evidence from rosca groups 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 these issues of enforcement and consider the role played by the institutional design of these informal groups. There is very little literature pertaining directly to this issue. The paper closest in spirit to ours is the one by Banerjee, Besley, and Guinnane (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] Bouman (1995) cites studies which report membership rates between 50 to 95 percent of the adult population in the Republic of Congo, Liberia, Ivory Coast, Togo, Nigeria, Gambia, and Cameroon. In many rural areas, these associations are the sole saving and credit institution. It has been estimated that the annual sums mobilized in these associations amount to 8 to 10 percent of GDP in Ethiopia, one half of the national savings in Cameroon, and double that of the organized banking sector in Kerala, India (see Bouman 1995).[3] 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 preferred (see, for example, Levenson and Besley (1996) for Taiwan, Eeckhout and Munshi (2003) for India). Roscas are also popular amongst immigrant groups in both the United States and Britain.[4]

[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).

[3] In our sample from a slum in Nairobi, Kenya, 57.2% of households have at least one individual who belongs to a rosca. The average monthly contribution into rosca groups is equal to 20.3% of individual income, and average contributions form 13.6% of total household income.Within the entire sample of households (including rosca and non-rosca participants), 5.4% of income is saved through roscas.

[4] See, for example, Light and Deng (1995), Bonnett (1981), Kurtz (1973), Srinivasan (1995), Summerfield (1995),

More specifically, a rosca is a group of individuals who gather for a series of regular meetings. At each meeting, each person contributes a pre-determined 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, by a lottery draw, a bidding process, or according to a predetermined pattern. [5]

However, in spite of their organizational simplicity, roscas do suffer from incentive problems. Because of the rotational structure of roscas, 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 roscas, enforcement problems have not been directly addressed in the previous literature.[6] From an extensive field study we carried out in Kenya, it appears that enforcement is a serious concern: a respondent emphasized: "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 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."

Since roscas 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, Coate, and Loury (1993) note that roscas "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 roscas 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.

and Besson (1995). There is also some evidence that roscas formed the basis of U.S. savings and loans associations, see Besley (1995) for references.

[5]See, Ardener (1964) for a detailed discussion of the various ways to allocate the pot.

[6]See, for example, van den Brink and Chavas (1997), Ardener (1964), Cope and Kurtz (1980), and Kurtz (1973). Handa and Kirton (1999) do provide and in depth study of the role of the rosca leader in explaining the sustainability of the group.

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).

In the Kenyan context, groups certainly 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, they discuss the matter at a general meeting with all the members. Fines are also regularly imposed. More importantly, many roscas also attempt to retrieve the amounts due. For instance, when one member left with the pot, the Arahuka 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 his being well-known in 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.[7] In such circumstances, the group may also complain to the police station or the KANU (the dominant political party) local office. More frequently, social pressure may take the form of giving the defaulting member a 'bad name', to reduce his chances in becoming a member of another group. This reputational effect may especially be important in groups organized along clan lines, where the failure of a member will also be known in the village of origin.[8] But groups also resort to more diffuse social threats and pressures. Thus, in a letter to a member "refusing to take the appropriate action", the chairman of the Kibera Kianda Self Help Group writes: "So, you have been given ample time and you have yourself to blame if all goes worse. The ball is in your pocket!" Even more explicitly, in a meeting of the same group, "the chairman cautioned committee against irregularities and misuse of money. He reminded members of a deadly Kikuyu curse, known as 'kirumi', which could be used if one squanders others' money. He gave example of what has befallen some members of (another group)."

While we will show that such social sanctions certainly have a role to play, we first demonstrate

[7] In our sample of 374 roscas, 10% have explicitly expelled members.

[8] Relatedly, to help a member in distress, one rosca group organized a harambee, which is a traditional meeting during which members voluntarily contribute to support this member. To ensure substantial contributions, the group, whose members all came from the same village, announced that the contributions made would be read in public during the meeting, but also later in the village.

that exclusion from all future roscas is not a sufficient deterrent to avoid default. We then argue that, when social sanctions are weak, the institutional structure of roscas can be designed so as to minimize enforcement problems. In the Kenyan slum, rosca groups do use their organizational design to address enforcement problem. For example, in the Kibera Nyakwageria group "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." In this paper, we shall focus in particular on the way ranks are allocated across members. It will be demonstrated that enforcement problems are lower in 'fixed order' roscas, where turns are not redrawn between cycles

The paper is organized as follows. The next section presents a model of rosca participation. We investigate the issue of enforcement in Section 3, and explore how the institutional design of roscas can be modified to address enforcement problems. We then discuss the empirical predictions from our analysis. The main implications of our theoretical analysis are tested using household level data that we collected in a Kenyan slum. The data are summarized in Section 5 and the results from our empirical analysis are subsequently provided. Section 7 discusses some of the empirical findings in the context of an extended version of the model. Section 8 concludes.

2. The model

In this section, we develop a simple model of rosca participation. We consider two main motives for rosca participation discussed in the literature. In their seminal contribution, Besley, Coate and Loury (1993) argued that, on average, roscas 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*. Following an extensive field study in Kenya, we proposed in Anderson and Baland (2002) another motive where members join roscas 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 roscas to bind themselves to a particular saving pattern that is different from their husbands. In this perspective, roscas are viewed as a way for women to commit their households to a particular saving pattern. 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 roscas 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 seminal work of Besley, Coate, and Loury (1993) to incorporate multiple rosca cycles.[9] 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.[10] This is justified by our data, where no bidding roscas are observed.[11]

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:

$$U^i(c_t) = \sum_{t=1}^{\infty} \delta^t u^i(c_t, D_t) \tag{2.1}$$

where c_t represents expenditures on other goods at time $t, \delta < 1$ is the discount factor and D_t represents consumption of one unit of the indivisible good which, once acquired, lasts for one unit of time.[12] As a result, D_t is equal to one if the good is purchased at time t and zero otherwise.

The budget constraint in each period can be expressed as:

$$y = c_t + s_t \tag{2.2}$$

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

[9] 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.

[10] See Besley, Coate, and Loury (1993 and 1994), Kovsted and Lyk-Jensen (1999) who contrast random and bidding roscas, Klonner (2002) and Eeckhout and Munshi (2003) for an analysis of bidding roscas.

[11] 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.

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

durable good is bought successively at times k and $k+\tau$, then we have: $P=\sum_{t=k}^{k+\tau} s_t$. 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 modelled as different reservation utilities when saving outside of the rosca. We first examine the optimal saving plan under both of these motives in the absence of rosca participation. In the following, we use the index H to refer to a household, while i and j are used to refer to individual agents.

Consider the early pot motive. Let c_t^* represent the optimal consumption flow which maximizes $U^i(c_t)$, under the budget constraint (2.2), so that $U^i(c_t^*)$ denotes lifetime optimal utility. We assume that there is a saving motive so that $c_t^* < y$ [13].

Now consider the household conflict motive. On its own, the household maximizes $U^H(c_t)$ which is a weighted sum of the lifetime utility of the husband i, $U^i(c_t)$, and his wife j, $U^j(c_t)$:

$$
\begin{aligned}
U^H(c_t) &= \beta U^i(c_t) + (1-\beta) U^j(c_t) \\
&= \sum_{t=1}^{\infty} \delta^t (\beta u^i(c_t, D_t) + (1-\beta)\, u^j(c_t, D_t)) && (2.3) \\
&= \sum_{t=1}^{\infty} \delta^t u^H(c_t, D_t) && (2.4)
\end{aligned}
$$

where $u^H(c_t, D_t) = \beta u^i(c_t, D_t) + (1-\beta)\, u^j(c_t, D_t)$, 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 (2.2) above (where y represents household income). Let $U^H(c_t^*)$ 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 by the household, s_t^{H*}, is always smaller than her own optimal saving rate, s_t^{j*}.

2.2. Rosca Participation

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

[13] 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.

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 represented by $s_R = \frac{P}{n}$. As a result, a rosca member's expenditure on other goods is $c_t = c_R = y - s_R$ for all t. There are two main ways in which the pot is allocated among members in a rosca. On the one hand, there are *random* roscas, where ranks are reallocated randomly at the beginning of each cycle. The allocation of ranks is uniform across members, so that, at each cycle, each member has a probability $\frac{1}{n}$ of receiving a particular rank. The expected utility for an individual, or for a couple, of joining a random rosca is:

$$
\begin{aligned}
E(U_r^k(c_R)) &= \sum_{t=1}^{\infty} \delta^t u^k(c_R, 0) + \frac{1}{n}(\delta^1 + \delta^2 + ... + \delta^n)\left(u^k(c_R, 1) - u^k(c_R, 0)\right) \\
&\quad + \frac{1}{n}(\delta^{n+1} + \delta^{n+2} + ... + \delta^{2n})\left(u^k(c_R, 1) - u^k(c_R, 0)\right) + ... \\
&= \sum_{t=1}^{\infty} \delta^t u^k(c_R, 0) + \frac{1}{n}\sum_{t=1}^{\infty} \delta^t u^k(c_R, 1) - u^k(c_R, 0)) \qquad \textit{with } k = i, H.
\end{aligned}
$$

which can be rewritten as:

$$
E(U_r^k(c_R)) = \frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta}{1-\delta}\frac{1}{n}\left(u^k(c_R, 1) - u^k(c_R, 0)\right) \tag{2.5}
$$

On the other hand, there are *fixed* roscas where the allocation of ranks remains unchanged after the first cycle. This implies that each member receives the pot at regular intervals of n units of time. In this situation, the utility of a member with rank l in a fixed rosca is given by:[14]

$$
\begin{aligned}
U_{l,f}^k(c_R) &= \sum_{t=1}^{\infty} \delta^t u^k(c_R, 0) + (\delta^l + \delta^{l+n} + \delta^{l+2n} ...)\left(u^k(c_R, 1) - u^k(c_R, 0)\right) \\
&= \frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^l}{1-\delta^n}\left(u^k(c_R, 1) - u^k(c_R, 0)\right)
\end{aligned} \tag{2.6}
$$

Note that when an individual or a household has a motive to save, so that $c_t^* < y$, she can always find a 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 savings pattern, c_t^*. By doing this, an individual enjoys the potential benefit of an early rank in the allocation of the pot in some cycle. It is only in a

[14] The initial allocation of ranks is discussed later in more detail.

fixed rosca in which a member receives the last rank that rosca participation does not yield strictly positive benefits.

As we argued in our earlier paper (Anderson and Baland (2002)), rosca participation is 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 the household conflict 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.

2.3. Institutional design in roscas

In this section, we examine the benefits to rosca members of alternative institutional arrangements in the absence of enforcement problems. We focus here on two dimensions: the repetition of the rosca cycle, and the allocation of ranks.

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.[15] This is particularly true for the household conflict motive.

We now compare the two methods of allocating ranks: random versus fixed. It is clear, given their rank in the fixed rosca, members with a early rank prefer the fixed rosca, while members with a late rank prefer a random allocation of ranks. We therefore focus on the member who obtains the median rank, $\frac{n+1}{2}$, as this median member plays a pivotal role if the system of rank allocation is decided by a majority rule. Comparing the expected utility of this member under both settings, we obtain the following result:

Proposition 1. *The median member strictly prefers the random to the fixed allocation of ranks.*

Proof:

Comparing equations (2.6) and (2.5), one obtains for a member k with rank l in the fixed rosca:

$$U^k_{l,f}(c_R) \quad < \quad E(U^k_r(c_R)) \Longleftrightarrow \frac{\delta^l}{1-\delta^n}\left(u^k(c_R,1)-u^k(c_R,0)\right) < \frac{\delta}{1-\delta}\frac{1}{n}\left(u^k(c_R,1)-u^k(c_R,0)\right)$$

[15] 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.

$$\iff \quad \frac{\delta^l}{1-\delta^n} < \frac{\delta}{1-\delta}\frac{1}{n} \tag{2.7}$$

which, with $\delta < 1$ and $n \geq 2$, holds true for all $l \geq \frac{n+1}{2}$.[16] ■

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 Figure 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, for the member with the median rank, the random rosca strictly dominates the fixed order rosca.

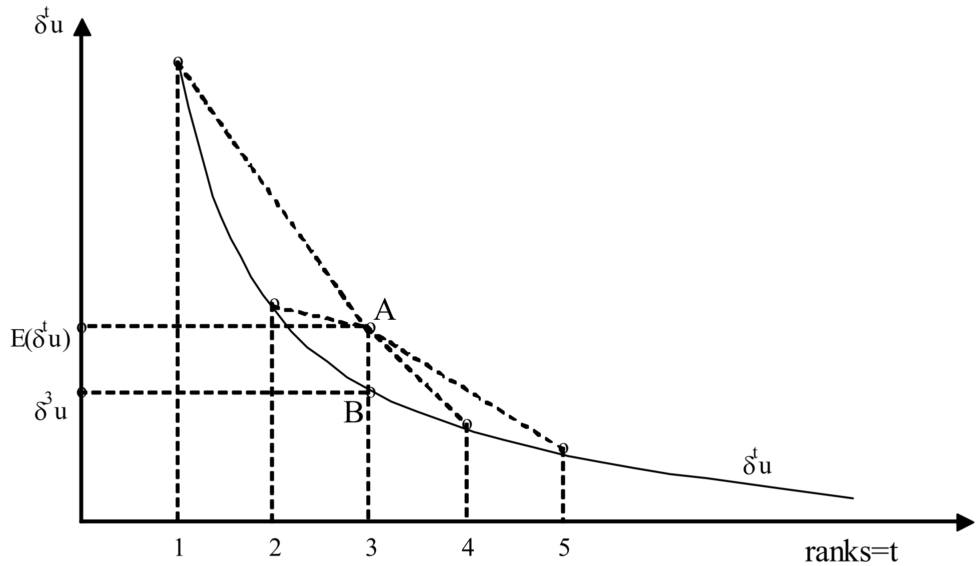

Figure 1 - Expected utility from a random or a median rank

The proposition is important, it implies that, given a fixed allocation of ranks, the median member and, hence, a majority of members will always prefer a (uniform) random allocation. This provides a strong rationale for random roscas.[17] In particular, given any initial allocation of ranks

[16] This result can be extended to non-fixed allocation of ranks (and a symmetric distribution function), as long as the probability of receiving an early rank is lower than under the uniform random allocation. More formally, the uniform random allocation of ranks will always be preferred to another allocation of ranks if, under this new allocation rule, for all $m \leq \frac{n+1}{2}$, the probability that a member's rank is equal to m, $P(l \leq m)$, is smaller than $\frac{m}{n}$.

[17] The result rests upon multiplicative discounting. While it is hard to properly model other types of discounting, it must also be noted that the preferences above are time-separable. 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 showed in a previous version of this paper.

in the first cycle, in each subsequent cycle, there is always a majority of members who prefer ranks to be re-drawn randomly at the beginning of each cycle. In particular, consider a situation under which, in the fixed rosca, ranks have been allocated randomly in the initial allocation, each member having a probability $\frac{1}{n}$ to obtain a particular rank in the fixed rosca. In this case, ex ante, the expected utility from joining a fixed rosca is equal to the corresponding expected utility in a random rosca. Ex post, however, after a first cycle, Proposition 1 implies that a majority of members will opt against the fixed allocation of ranks.

Finally, at another level, one may argue that random roscas are more desirable because they give each member an equal chance of receiving an early rank in each cycle. 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 Proposition 1, one would expect to observe only random roscas. However, this is not the case. In our sample of 374 roscas, 71% are fixed and only 29% are random. We cannot therefore explain the existence of fixed roscas from the perspective of individual motives to participate. Instead, we examine the role of institutional design in explaining their existence. In particular, we will argue that fixed roscas area better able to discipline their members.

3. Enforcement in roscas

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 inter-relation 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. Exclusion and sustainability

Under the household conflict motive, it is precisely the strength of social sanctions that allow 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, Coate and Loury (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*

[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 Gugherty (2000) and 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, Coate and Loury (1993), p. 806).

is the first to receive the pot is always tempted to leave and defect, even if she is excluded from all future cycles.

Proof:

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, $E(U^i_{1,r}(c_R))$, is equal to:

$$E(U^i_{1,r}(c_R)) = \sum_{t=1}^{n-1} \delta^t u^i(c_R, 0) + \sum_{t=n}^{\infty} \delta^t u^i(c_R, 0) + \frac{1}{n} \sum_{t=n}^{\infty} \delta^t \left(u^i(c_R, 1) - u^i(c_R, 0)\right) \tag{3.1}$$

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 rewritten as:

$$E(U^i_{1,r}(c_R)) = \frac{\delta}{1-\delta} u^i(c_R, 0) + \frac{\delta^n}{1-\delta} \frac{1}{n} \left(u^i(c_R, 1) - u^i(c_R, 0)\right) \tag{3.2}$$

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

$$U^i_{np}(c_R) = \frac{\delta}{1-\delta} u^i(c_R, 0) + \frac{\delta^n}{1-\delta^n} \left(u^i(c_R, 1) - u^i(c_R, 0)\right). \tag{3.3}$$

Let the net benefit to staying in a random rosca for the first ranked individual be denoted by $\Delta^i_{1,r}$. Using equations (3.1) to (3.3), we have:

$$\begin{aligned}
\Delta^i_{1,r} &= E(U^i_{1,r}(c_R)) - (U^i(c^*_t) - \sigma_i) \\
&= \left(\frac{\delta}{1-\delta} u^i(c_R, 0) + \frac{\delta^n}{1-\delta} \frac{1}{n} \left(u^i(c_R, 1) - u^i(c_R, 0)\right)\right) - U^i_{np}(c_R) + U^i_{np}(c_R) - U^i(c^*_t) + \sigma_i \\
&= \left[\frac{\delta^n}{1-\delta} \frac{1}{n} - \frac{\delta^n}{1-\delta^n}\right] \left(u^i(c_R, 1) - u^i(c_R, 0)\right) + \left[U^i_{np}(c_R) - U^i(c^*_t)\right] + \sigma_i \qquad (3.4) \\
&< 0, \;\; if \; \sigma_i = 0
\end{aligned}$$

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 (3.4) 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, $\Delta^i_{1,f}$. Let $U^i_{1,f}(c_R)$ denote the utility of the first ranked member of saving in a fixed rosca, after receiving the pot:

$$\begin{aligned} U^i_{1,f}(c_R) &= \sum_{t=1}^{n-1} \delta^t u^i(c_R, 0) + \sum_{t=n}^{\infty} \delta^t u^i(c_R, 0) + \sum_{k=1}^{\infty} \delta^{kn} \left(u^i(c_R, 1) - u^i(c_R, 0) \right) \\ &= \left(\frac{\delta}{1-\delta} u^i(c_R, 0) + \frac{\delta^n}{1-\delta^n} \left(u^i(c_R, 1) - u^i(c_R, 0) \right) \right) \end{aligned} \tag{3.5}$$

Using (3.5), we have:

$$\begin{aligned} \Delta^i_{1,f} &= U^i_{1,f}(c_R) - \left(U^i(c^*_t) - \sigma_i \right) \\ &= \left(\frac{\delta}{1-\delta} u^i(c_R, 0) + \frac{\delta^n}{1-\delta^n} \left(u^i(c_R, 1) - u^i(c_R, 0) \right) \right) - U^i_{np}(c_R) + U^i_{np}(c_R) - U^i(c^*_t) + \sigma_i \\ &= U^i_{np}(c_R) - U^i(c^*_t) < 0, \quad if\ \sigma_i = 0 \end{aligned} \tag{3.6}$$

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^*_t. 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. ■

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]

[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.

3.2. The two enforcement problems

In the discussion above, 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. We argue in this section that the first problem is always more severe than the second, which explains why the former is a key determinant of rosca institutional design.

The second enforcement issue refers to the incentives for the member (or household) who received an unfavourable rank, say the last one, to remain in the rosca. Consider first fixed roscas and let the utility of the last-ranked member be denoted by $U^k_{n,f}(c_R)$. Her net benefit to staying in a fixed rosca, $\Delta^k_{n,f}$, is equal to:

$$\begin{aligned}
\Delta^k_{n,f} &= U^k_{n,f}(c_R) - \Big(U^k(c^*_t) - \sigma_k\Big) \\
&= \left(\sum_{t=1}^{\infty} \delta^t u^k(c_R, 0) + \sum_{v=1}^{\infty} \delta^{vn} \Big(u^k(c_R, 1) - u^k(c_R, 0)\Big)\right) - U^k(c^*_t) + \sigma_k \\
&= \left(\frac{\delta}{1-\delta} u^k(c_R, 0) + \frac{\delta^n}{1-\delta^n} \Big(u^k(c_R, 1) - u^k(c_R, 0)\Big)\right) - U^k(c^*_t) + \sigma_k \qquad (3.7) \\
&= \Delta^k_{1,f}
\end{aligned}$$

where $k = i, H$. The above result 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. As a result, after receiving the pot, the first ranked member is in the exact same position as the last ranked member.

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, $E(U^k_{n,r}(c_R))$, is equal to:

$$E(U^k_{n,r}(c_R)) = \left(\sum_{t=1}^{n} \delta^t u^k(c_R, 0) + \delta^n \Big(u^k(c_R, 1) - u^k(c_R, 0)\Big)\right)$$

$$+\left(\sum_{t=n+1}^{\infty}\delta^t u^k(c_R,0)+\frac{1}{n}\sum_{t=n+1}^{\infty}\delta^t\left(u^k(c_R,1)-u^k(c_R,0)\right)\right) \tag{3.8}$$

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 (3.8), the net benefit to staying in a random rosca, $\Delta_{n,r}^k$ is:

$$\begin{aligned}\Delta_{n,r}^k &= E(U_{n,r}^k(c_R))-(U^k(c_t^*)-\sigma_k)\\ &= \left(\frac{\delta}{1-\delta}u^k(c_R,0)+\left(\delta^n+\frac{\delta^{n+1}}{1-\delta}\frac{1}{n}\right)\left(u^k(c_R,1)-u^k(c_R,0)\right)\right)-U^k(c_t^*)+\sigma_k\end{aligned} \tag{3.9}$$

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 (3.9), $\Delta_{n,r}^k$ becomes:

$$\begin{aligned}\Delta_{n,r}^k &\simeq \left(\frac{\delta}{1-\delta}u^k(c_R,0)+(\delta^n+\frac{\delta^{n+1}}{1-\delta}\frac{1}{n})\left(u^k(c_R,1)-u^k(c_R,0)\right)\right)\\ &\quad -\left(\frac{\delta}{1-\delta}u^k(c_R,0)+\frac{\delta^n}{1-\delta^n}\left(u^k(c_R,1)-u^k(c_R,0)\right)\right)+\sigma_k\\ &\simeq \left(\delta^n+\frac{\delta^{n+1}}{1-\delta}\frac{1}{n}-\frac{\delta^n}{1-\delta^n}\right)\left(u^k(c_R,1)-u^k(c_R,0)\right)+\sigma_k>0 \text{ even for } \sigma_k=0.\end{aligned} \tag{3.10}$$

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 (3.10) and (3.4), we also have:

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

Combining this with the above discussion for fixed roscas, we obtain:

Proposition 3. *The enforcement problems of the last ranked member are always less severe than those of the first member.*

3.3. The allocation of ranks and enforcement

In this section, we turn to the allocation of ranks, and its role in countering the incentives to default. Comparing the incentives to default across these two types of roscas, one obtains:

Proposition 4. *For a given σ_k, enforcement problems are less severe in a fixed than in a random rosca.*

Proof: Comparing equations (3.4),(3.6),(3.7) and (3.10):

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

■

Proposition 4 highlights how the enforcement problem is the most serious for the first ranked member in a random rosca. To address this 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. Non-randomness 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. However, as we have seen above, the enforcement problem then is identical for all members.

Two 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.[21]

[21] There are potentially two other ways to reduce the enforcement problem. The first one is to drop the strict sequentiality 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. 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

3.4. Other institutional features

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 also avoid defection 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 5. *The enforcement problem cannot be solved by a membership fee.*

This result is demonstrated in Appendix A.

member's income after a finite number of cycles. Backward reasoning implies this possibility cannot credibly solve the enforcement issue.

[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.

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. 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 $U_{1,f}(c_R)$ or $U_{n,f}(c_R)$ in a fixed rosca, or $U_{1,r}(c_R)$ 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. Empirical implications

We now turn to deriving empirical predictions from our theoretical analysis presented above. Our main testable hypothesis, is that fixed roscas are better able to solve enforcement problems than random ones. One way to identify an enforcement effect would be to have data with an exogenous

[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.

change in the ability of roscas to enforce compliance. However, such data are not available to us. Rather the data we have at hand is how participants to different types of roscas vary by individual characteristics. We will argue in this section, how our theoretical analysis yields predictions to test our main hypothesis with this data. Given Proposition 1, a majority of members, irrelevant of their type, prefer random roscas to fixed. As a result, if different roscas do systematically vary by the characteristics of their members, Proposition 4 suggests that individuals in fixed roscas should be less vulnerable to social sanctions, i.e., less likely to adhere to their obligations. It is in this sense that we can exploit the variation in individual characteristics to identify the enforcement effect.

To test our empirical predictions we use the varying vulnerability to social sanctions across individuals as some individuals have more to lose when indulging in opportunistic behavior. We thus expect that individuals who are less mobile are more likely to suffer from retaliation and reputational effects from the group. Typically, less mobility is associated with ownership of their dwelling, or having set up their entire family in the slum. Similarly, individuals who have longer standing social networks in the slum will suffer more: thus, those who have spent more years in the slum are more susceptible to reputational effects. Also, individuals who have succeeded in obtaining permanent employment, particularly if it is in the formal sector, are more vulnerable, all the more so that retaliation in their place of work is also possible. Finally, the same holds for individuals with visible wealth that can be confiscated by the group. We define individuals who are more vulnerable to social sanctions (high σ_k) as follows:

Definition 1. *Vulnerability to social sanctions, σ_k, is high when individuals are less mobile (own their dwellings, live in a large family), have greater social networks (spent more years in the slum), have permanent employment (possibly in the formal sector), and have more visible wealth and objects of value.*

Given Proposition 4, we expect that individuals with a higher σ_k to belong to roscas with less stringent enforcement mechanisms. The direct implication is as follows:

Conjecture 1. *Individuals who are more (less) vulnerable to social sanctions are more (less) likely to belong to random rather than fixed roscas.*

5. Description of the Data

The data used in the estimation were collected in 1996-1997 in the slum of Kibera which is situated on the outskirts of Nairobi and is the largest in Kenya. It extends over 225 hectares of land and houses a population 600 000 people. The inhabitants are very poor. They live with enormous risks to their health and income, with no access to formal insurance or credit institutions. There is little intervention by the State to improve the well-being of the slum population. As a result, individuals are left to their own devices to satisfy their most basic needs. These circumstances have given rise to the formation of numerous informal credit groups such as roscas, health insurance groups, funeral groups, saving and credit groups, and collective investment groups.

We interviewed 520 households, all living in the same area of Kibera, namely the village of Kianda. Households, selected through a random process, were interviewed over the course of four months during the spring of 1997.[25] All household members were first surveyed for information on their education, work activity, and income. Household expenditures were carefully recorded over a week, with frequent visits by one of the enumerators. During the second round, each member was asked detailed information on all informal groups which they belong to. From this process, we collected information on 620 groups, of which 375 were roscas.

The table below describes how random and fixed roscas vary by their structural aspects:

[25] Refer to Appendix B for more details on the data collection process.

	All Roscas	Fixed Order	Random Order	Equivalence of Means Fixed versus Random
Fixed	0.71	1	0	
	(0.46)	(0)	(0)	
Random	0.29	0	1	
	(0.46)	(0)	(0)	
Members	16.04	15.61	17.10	-1.49
	(11.44)	(10.58)	(13.27)	(1.30)
Cycle	250.27	209.90	347.18	-137.28***
	(255.86)	(219.12)	(307.81)	(28.19)
Pot	4123.10	3199.91	6338.77	-3138.87***
	(5706.44)	(4121.25)	(7964.47)	(627.71)
Contrib.	321.20	294.97	384.14	-89.16*
	(452.25)	(475.36)	(386.02)	(51.18)
Memb.Fee	0.29	0.32	0.21	0.11**
	(0.45)	(0.47)	(0.41)	(0.05)
Women only	0.67	0.73	0.58	0.05
	(0.47)	(0.45)	(0.49)	(0.06)
Same ethnic	0.37	0.34	0.45	-0.12**
	(0.48)	(0.47)	(0.50)	(0.05)
Friends	0.56	0.48	0.74	-0.25***
	(0.50)	(0.50)	(0.44)	(0.05)
Relatives	0.09	0.10	0.05	0.04
	(0.28)	(0.30)	(0.23)	(0.03)
Neighbors	0.21	0.26	0.10	0.16***
	(0.41)	(0.44)	(0.30)	(0.05)
Profession	0.11	0.12	0.10	0.02
	(0.32)	(0.32)	(0.30)	(0.04)
No.Obs.	374	264	110	374

Table 1: Rosca Characteristics[26]

Roscas with a random order tend to have a larger cycle, contribution, and pot. We will return to these relationships in Section 7. More generally, roscas with larger membership have longer cycles (correlation of 0.64) and larger pots (correlation of 0.33). Conversely, contributions are negatively related to membership (correlation -0.04) and cycle length (correlation -0.14), though the degree of correlation is low.[27]

Random roscas are more likely to be organized around a single ethnicity. Of these single

[26]Standard deviations are in parentheses. Cycle length is in days. Rosca contribution and pot is measured by month and in Kenyan shillings, where one U.S. dollar is approximately equal to 60 Kenyan shillings. A single, double and triple asterix denote significance at the 10%, 5% and 1% levels in the equivalence of means test across random and fixed roscas.

[27]Handa and Kirton (1999) also find a negative relationship between rosca size and contributions.

ethnicity groups, 25% are Kikuyu, 13% Luhya, 33% Luo, 11% Kamba, and 15% Kisii. These proportions do not vary significantly from those in the general household sample. Fixed order roscas are more likely to be started with neighbors, and less likely to be started with friends compared to random roscas.

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. Additionally, it is more likely to be imposed if the rosca has written rules and a governing body. Therefore its purpose is to cover these extra costs rather than solve an enforcement problem.

We now turn to examining the characteristics of individuals who join random and fixed roscas. The 520 households interviewed represent approximately 2300 individuals. After omitting all individuals aged less than 18 years, we are left with a sample of 1220. The following table describes the individual and household characteristics of participants by type of rosca:

	No Rosca	All Roscas	Fixed Order	Random Order	Equivalence of Means Fixed versus Random
Female	0.40	0.86	0.86	0.84	0.03
	(0.49)	(0.35)	(0.34)	(0.37)	(0.04)
Married	0.56	0.66	0.67	0.64	0.03
	(0.50)	(0.47)	(0.47)	(0.48)	(0.05)
Age	29.65	32.86	32.28	34.24	-1.95**
	(9.34)	(8.33)	(8.38)	(8.08)	(0.94)
At least Primary School	0.62	0.48	0.47	0.48	-0.01
	(0.49)	(0.50)	(0.50)	(0.50)	(0.06)
Permanent. work	0.37	0.60	0.53	0.75	-0.22***
	(0.48)	(0.49)	(0.50)	(0.43)	(0.05)
Formal sector	0.28	0.19	0.11	0.38	-0.27***
	(0.45)	(0.39)	(0.31)	(0.49)	(0.04)
years in slum	7.43	8.15	7.86	8.84	-1.00
	(6.37)	(5.93)	(5.69)	(6.45)	(0.67)
Hhold Inc.	8028.84	9188.81	7977.69	12067.55	-4089.86***
	(7482.10)	(9762.93)	(9272.73)	(10330.35)	(1089.56)
Hhold Size	4.98	4.86	4.67	5.33	-0.66***
	(2.13)	(2.08)	(2.05)	(2.11)	(0.23)
Own room	0.19	0.21	0.10	0.47	-0.37***
	(0.39)	(0.41)	(0.30)	(0.50)	(0.04)
Kikuyu	0.21	0.24	0.12	0.52	-0.39***
	(0.41)	(0.43)	(0.33)	(0.50)	(0.04)
Luhya	0.19	0.18	0.22	0.08	0.14***
	(0.39)	(0.38)	(0.41)	(0.27)	(0.04)
Luo	0.41	0.38	0.46	0.18	0.28***
	(0.49)	(0.49)	(0.50)	(0.39)	(0.05)
Kamba	0.05	0.07	0.06	0.09	-0.03
	(0.23)	(0.26)	(0.25)	(0.29)	(0.03)
Kisii	0.10	0.10	0.09	0.11	-0.02
	(0.30)	(0.30)	(0.29)	(0.31)	(0.03)
No. Obs	848	374	264	110	374

Table 2: Individual and Household Characteristics[28]

The most noteworthy differences between the first two columns are the proportion of individuals who are female and permanent workers among rosca participants compared to non-participants. Rosca participants are also more likely to be married, less educated, working in the informal sector, have higher incomes, and lived in Kibera longer.

The general pattern that seems to emerge from the last three columns of Table 2 is that

[28] All income variables are caculated by month and measured in Kenyan shillings. P-values for the equivalence of means test across random and fixed roscas are presented in the fifth column.

individuals with a high σ_k, according to Definition 1, belong to random roscas compared to fixed roscas: they are more likely to be employed as a permanent worker in the formal sector, have higher incomes, and lived longer in Kibera.

In general, rosca participants and non-participants do not vary significantly by household characteristics, though households with rosca members tend to be slightly wealthier. By contrast, household characteristics do vary by rosca type where a similar pattern to what we found for individual characteristics emerges. Individuals from wealthier households, and who own property are more likely to belong to random roscas.[29] These individuals also come from slightly larger households.

The distribution of rosca participants by ethnicity follows almost exactly that across rosca non-participants. There are significant differences however by type of rosca. In particular, the Kikuyu are more likely to be a member of random order roscas (63%). In contrast, more than 85% of Luhya and Luo rosca participants are in fixed order roscas. The Kamba and Kisii fall in between, where approximately 65% belong to fixed order roscas.

From the raw data, it would seem that individuals who are more vulnerable to social sanctions participate in random roscas. This finding is in accord with our predictions from Section 4. We now turn to the empirical analysis.

6. Empirical Estimates

This section aims to directly test Conjecture 1. To do this we estimate the probability that an individual participates in a random rosca compared to a fixed rosca as a function of their vulnerability to social sanctions, σ_i.

We employ a two-step estimation procedure. In the first stage, we estimate the probability that an individual joins a rosca as a function of individual characteristics. This probability is represented by the following:

$$R = \beta_R X_R + \epsilon_R \tag{6.1}$$

[29] Household income is equal to the sum of individual income from any income generating activity (includes both formal and informal sector labor and self-employment) across all working household members. Alternative measures of income were also considered which included net transfers and rental income, as well as proxies such as food expenditure and total expenditure. However, none of the main results are altered when these alternative measures are used in the estimations.

where R is equal to one if an individual joins a rosca and equal to zero otherwise and $\epsilon_R \sim N[0,1]$. The vector X_R is comprised of individual characteristics which determine rosca participation.

In the second stage, we estimate the probability an individual selects into a random rosca, represented by:

$$Y = \beta_Y X_Y + \epsilon_Y \tag{6.2}$$

where $\epsilon_R \sim N[0,1]$. The vector X_Y is comprised of individual characteristics which determine their vulnerability to social sanctions (according to Definition 1). We assume that the variable Y is observed only if $R = 1$.

There are two main facets of rosca participation that determine the variables in X_R. On the one hand, individuals belong to roscas because they have a willingness to save, on the other hand, they participate because they are accepted into a rosca group. All of the variables included in X_R via this latter facet clearly also determine individuals' vulnerability to social sanctions and are hence included in X_Y. Therefore, to identify rosca participation, represented by (6.1), we need variables which determine only individuals' motive to save and not their vulnerability. In our previous work using these data (Anderson and Baland 2002), the main determinants of rosca participation were gender and marital status. We use similar variables to identify the sample selection equation (6.1) in the estimations.[30] However, there is not a single variable that can a priori distinguish between individual's vulnerability to social sanctions and their likelihood of joining a rosca. Given this, we also present estimations which do not account for the selection issue, and simply condition on rosca participation (which may introduce a bias). However, rosca members should presumably be more vulnerable to social sanctions. As a result, though estimations which exploit the variation in their vulnerability may present a bias, this bias should go against our empirical conjectures. Therefore, conclusions can still be drawn a fortiori in support of these conjectures.

The results from our first stage estimation of (6.1) are listed in the first column of Table 6 in Appendix D. The tables below summarize our second stage results from estimating (6.2). Alternative estimations which ignore the sample selection issue are presented in Appendix D.[31]

[30] Arguably women are more likely to be vulnerable to social sanctions. Given that households are typically extended, it is less likely that marital status is related to vulnerability.

[31] Refer also to Appendix D for estimations of rosca characteristics which include the instruments of the sample selection equation.

	Random	Random	Random	Random	Random	Random
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.002 (0.01)	-0.015 (0.01)	-0.01 (0.01)	-0.009 (0.01)	-0.005 (0.01)	-0.01 (0.01)
At least Primary	-0.01 (0.16)	-0.06 (0.16)	-0.07 (0.16)	-0.20 (0.18)	-0.20 (0.18)	0.22 (0.18)
Permanent worker		0.57 (0.16)***	0.43 (0.16)***			0.28 (0.17)*
Formal sector				0.88 (0.20)***	0.77 (0.21)***	0.69 (0.21)***
Household Income	0.14 (0.04)***		0.10 (0.05)**		0.10 (0.05)**	0.08 (0.05)
Own room	0.76 (0.21)***	0.69 (0.20)***	0.73 (0.21)***	0.69 (0.21)***	0.73 (0.21)***	0.72 (0.21)***
Hhold size	0.07 (0.04)**	0.09 (0.04)**	0.08 (0.04)**	0.10 (0.04)**	0.09 (0.04)**	0.09 (0.04)**
≤ 2 yrs in kibera	-0.002 (0.31)	0.002 (0.30)	-0.04 (0.30)	0.10 (0.31)	0.04 (0.31)	0.01 (0.31)
Kikuyu	1.08 (0.22)***	1.03 (0.21)***	1.02 (0.22)***	0.94 (0.22)***	0.94 (0.22)***	0.92 (0.22)***
Luhya	-0.09 (0.24)	-0.08 (0.24)	-0.10 (0.24)	-0.20 (0.25)	-0.20 (0.25)	-0.20 (0.25)
Other	0.08 (0.46)	0.15 (0.45)	0.07 (0.45)	0.28 (0.47)	0.18 (0.47)	0.17 (0.46)
Kamba	0.73 (0.30)**	0.78 (0.30)***	0.76 (0.29)***	0.68 (0.31)**	0.68 (0.30)**	0.71 (0.30)**
Kisii	0.46 (0.29)	0.43 (0.28)	0.40 (0.28)	0.36 (0.30)	0.34 (0.29)	0.32 (0.29)
Constant	-2.79 (0.65)***	-1.66 (0.42)***	-2.53 (0.61)***	-1.42 (0.46)***	-2.37 (0.67)***	-2.25 (0.64)
Log likelihood	-685.97	-685.62	-683.44	-681.65	-679.53	-678.58
No. Obs	373	373	373	373	373	373

Table 3 - Estimations of whether individual select into random or fixed order roscas[32]

The above table compares random to fixed roscas under various empirical specifications. From specification (1) we see that household income is an important determinant of whether individuals join random roscas. Specifications (2) and (3) include employment as a permanent worker, whereas specifications (4) and (5) consider employment in the formal sector. Both characteristics of employment enter in positively and significantly. Random rosca participants are also from larger households and own their living quarters. These results are consistent with Conjecture 1, which states that individuals who are more vulnerable to social sanctions (those with a high σ_i) are more likely to belong to random roscas. A final result is that members of the Kikuyu and Kamba tribes are more likely to be in random roscas.[33]

[32] The results are from a maximum-likelihood probit estimation with sample selection. The log of household income is used in the estimations. Robust standard errors, using the Huber/White/sandwich estimator of variance, are in parentheses. A single asterix denotes significance at the 10% level, double for 5%, and a triple for 1%.

[33] One can argue that roscas choose a fixed allocation of ranks in order to punish members who do not regularly pay their contributions by giving them the last rank. This can be understood as a moral hazard problem, where the punishment expected induces agents to regularly pay, even if they suffer a bad income shock. One may expect such a problem to be more prevalent with less wealthy individuals. However, this line of interpretation leaves open the issue as to why, given that the last ranks are given to irregular contributors, the subset of those who have paid regularly do not choose a random allocation amongst themselves.

7. Pot size and the allocation of ranks

The empirical estimates from the previous section demonstrate that individuals who are more vulnerable to social sanctions and have more to lose from defaulting in a rosca are more likely to belong to random roscas where the benefits to rosca participation are higher. What also emerges from the data (see Table 1) is that random roscas have larger pots. This is illustrated in the table below:

Pot size	(0,900)	[900,2100)	[2100,5000)	[5000,40000)
Proportion with random order	0.22	0.22	0.31	0.42
No. observations	92	94	88	100

Table 4 - Pot size and random allocation of ranks

As can be seen from the above table, there is a positive relationship between the size of the pot and a random allocation of ranks. Moreover, if we run similar estimations to those in Table 3, where the dependent variable is the size of pot, similar results ensue; individuals with a high σ_k (according to Definition 1) are more likely to participate in roscas with larger pots (see Appendix C).[34]

Although we did not explicitly model the size of the pot, the incentives to default are higher the larger the pot. Given the superior enforcing property of fixed roscas, for a given σ_k, we should then expect roscas with larger pots to resort more to a fixed order of ranks. This seemingly inconsistency in the data is, however, consistent with our framework. This can be demonstrated by extending the model of Sections 2 and 3 to incorporate individuals who vary by their desired pot size and their vulnerability to sanctions. The purpose of this section is to develop the model along these lines. The exposition here relies on the early pot motive, however, by following the reasoning below, it is straightforward to develop a model with similar conclusions based on the household conflict motive.

Consider two types of agents, h and l. Each type of agent is characterized by an instantaneous income y_i, and a vulnerability to social sanctions, σ_i, with $i = h, l$, where $y_h > y_l$. There are three types of goods in this economy: a current consumption good, c, and two types of indivisible goods, h and l, the price of which is equal to P_h and P_l respectively. For the ease of exposition, we assume

[34] This evidence that similar individual characateristics predict participation into roscas with larger pots and into random roscas is further evidence of a strong correlation between these two institutional features. Given this, it is important to note that the results of Table 3 are robust to including pot size in the estimations. However, clearly such estimates are biased by potential endogeneity problems.

here that the preferences of agents are such that they always desire to save in order to consume one unit of the indivisible good every two periods. The lifetime utility of agent i is given by:

$$U_i = \sum_{t=1}^{\infty}(\delta^t u(c_{i,t}, d_m) - \delta^t x_t \sigma_i)$$

where d_m is a dummy variable equal to D_m if one unit of the indivisible good $m = l, h$ is purchased at time t and zero otherwise; and x_t is a dummy variable equal to one when social sanctions, σ_i, are imposed on the agent, and zero otherwise.

When agent i does not participate in a rosca, she optimally chooses $c^*_{i,t}$ such that she consumes one unit of the corresponding durable good i every two periods. If she purchases the good at time $t+1$, then the first-order condition for savings yields: $u'(c^*_{i,t}, 0) = \delta u'(c^*_{i,t+1}, D_i)$, $c^*_{i,t} \leq y_i$ and $\left(y_i - c^*_{i,t}\right) + \left(y_i - c^*_{i,t+1}\right) = P_i$, with $i = h, l$. Her optimal lifetime utility is then given by:

$$U^*_i = \sum_{t=1}^{\infty}(\delta^t u(c^*_{i,t}, 0)) + (\delta^2 + \delta^4 + \delta^6 + ...) \left(u(c^*_{i,t}, D_i) - u(c^*_{i,t+1}, 0)\right) \tag{7.1}$$

Given the agents' preferences, the amount of the contribution to the rosca is just equal to the price of the corresponding indivisible good, P_i, divided by two. Roscas, when they exist, are thus composed of exactly two members. We assume that agents prefer their optimal pot size in a rosca. For an agent of type h we have:

$$\begin{aligned} & \sum_{t=1}^{\infty}(\delta^t u(c_h, 0)) + (\delta^2 + \delta^4 + \delta^6 + ...) \left(u(c_h, D_h) - u(c_h, 0)\right) \\ > \; & \sum_{t=1}^{\infty}(\delta^t u(y_h - \frac{P_l}{2}, 0)) + (\delta^1 + \delta^3 + \delta^5 + ...) \left(u(y_h - \frac{P_l}{2}, D_l) - u(y_h - \frac{P_l}{2}, 0)\right), \end{aligned} \tag{7.2}$$

where $c_h = y_h - \frac{P_h}{2}$. Similarly for an agent of type l:

$$\begin{aligned} & \sum_{t=1}^{\infty}(\delta^t u(c_l, 0)) + (\delta^2 + \delta^4 + \delta^6 + ...) \left(u(c_l, D_l) - u(c_h, 0)\right) \\ > \; & \sum_{t=1}^{\infty}(\delta^t u(y_l - \frac{P_h}{2}, 0)) + (\delta^1 + \delta^3 + \delta^5 + ...) \left(u(y_l - \frac{P_h}{2}, D_h) - u(y_l - \frac{P_h}{2}, 0)\right) \end{aligned} \tag{7.3}$$

with $c_l = y_l - \frac{P_l}{2}$. These inequalities are the sufficient (incentive compatibility) conditions such that an agent of type h (l) prefers to participate in a rosca with a pot P_h (P_l) rather than in a rosca with pot size P_l (P_h). These are sufficient conditions since they ensure this holds even if a type h (l) agent is allocated the worst position (last in a fixed rosca), in the rosca with a pot P_h (P_l), and the best position (first in a fixed rosca), in the rosca with pot P_l (P_h). These two conditions also ensure that no rosca consists of two agents of different types. Roscas with a small pot are composed of lower income individuals (type l), and likewise, large pot roscas are composed of high income individuals (type h).

We now explore the impact of social sanctions, σ_i, on the system of rank allocation that can be adopted by roscas. There are potentially four types of roscas that are available for agent i: fixed or random, with a large or a small pot. Using equations (3.4) and (3.6) from Section 3, we can set out the enforcement constraints which characterize which types of roscas are sustainable, given σ_i. Below lists the relevant constraints for large pot roscas. Similar conditions can easily be derived for small pot roscas.

Roscas with large pots adopt a random allocation of ranks iff the following enforcement constraint is satisfied:

$$\sum_{t=1}^{\infty}(\delta^t u(c_h, 0)) + \frac{1}{2}(\delta^2 + \delta^3 + \delta^4 + ...)\,(u(c_h, D_h) - u(c_h, 0)) \geq U_h^* - \sigma_h. \tag{7.4}$$

A fixed order rosca is adopted iff. (7.4) does not hold and:

$$\sum_{t=1}^{\infty}(\delta^t u(c_h, 0)) + (\delta^2 + \delta^4 + \delta^6 + ...)\,(u(c_h, D_h) - u(c_h, 0)) \geq U_h^* - \sigma_h. \tag{7.5}$$

Finally, roscas with large pots are not sustainable iff, (7.5) is not satisfied.

Conditions (7.4) and (7.5) are mutually exclusive, and the value of σ_h plays a critical role in determining which constraint is satisfied. Large values of σ_h satisfy condition (7.4), medium values of σ_h satisfy condition (7.5), and low values of σ_h do not satisfy either. Random roscas with large pots are therefore sustainable only if σ_h is large enough, while no large pot rosca is sustainable if σ_h is very low. (Note that, when σ_h is very low, the agent does not enter a rosca with a different pot size either, since her benefits to remaining in that rosca are even lower, so that the enforcement constraint there is a fortiori violated.)

Many different types of equilibria can possibly emerge, depending on the value of social sanctions, σ_i, and the pattern of optimal saving. To enable us to directly compare the enforcement constraints across types, we now consider a simple example, where the instantaneous utility function of the agents is represented by:

$$u(c_{i,t}, d_k) = -\left(c_t - \bar{c}\right)^2 + d_k$$

so that agents optimally consume $\bar{c}$ and save the surplus $y_i - \bar{c}$. This assumption ensures that the optimal savings remain constant across periods, which then allows us to directly compare the different enforcement conditions across agents. To keep the notation simple, assume further that $P_i = 2(y_i - \bar{c})$, so that one unit of the indivisible good i costs exactly two periods of savings for agent i. Using condition (7.4) above, large pot roscas adopt random ranks iff. $\sigma_h \geq \frac{\delta^2}{2(1+\delta)} D_h$. Following condition (7.5), they adopt a fixed allocation of ranks iff: $0 \leq \sigma_h < \frac{\delta^2}{2(1+\delta)} D_h$. Whereas they are not sustainable if $\sigma_h < 0$ (i.e., both (7.4) and (7.5) are violated). Analogous conditions follow for small pot roscas. Note, however, that the enforcement condition for a random allocation of ranks is more difficult to satisfy for high income agents in large pot roscas than for low income agents in small pot roscas. This follows since $\frac{\delta^2}{2(1+\delta)} D_l < \frac{\delta^2}{2(1+\delta)} D_h$. We then obtain the following types of equilibria as a function of the value of the parameters:

Interval of σ_i, $i = h, l$	agent l	agent h
below 0	no rosca	no rosca
$\left(0, \frac{\delta^2}{2(1+\delta)} D_l\right)$	fixed rosca with pot P_l	fixed rosca with pot P_h
$\left(\frac{\delta^2}{2(1+\delta)} D_l, \frac{\delta^2}{2(1+\delta)} D_h\right)$	random rosca with pot P_l	fixed rosca with pot P_h
above $\frac{\delta^2}{2(1+\delta)} D_h$	random rosca with pot P_l	random rosca with pot P_h

The above table lists the different types of roscas that emerge in equilibrium as a function of (σ_l, σ_h). In particular, if $\sigma_h > \frac{\delta^2}{2(1+\delta)} D_h > \frac{\delta^2}{2(1+\delta)} D_l > \sigma_l > 0$, so that high income agents are more vulnerable to social sanctions than low income ones, one obtains an equilibrium under which high income agents select into roscas with large pots and a random allocation of ranks, while low income agents select in roscas with small pots and a fixed allocation of ranks. In this situation, high income individuals select into large pot roscas, where the cost of social sanctions is high enough to sustain a random allocation of ranks. By contrast, small pot roscas can only be fixed order because low income agents are much less vulnerable. The crucial factor behind the relative importance of the enforcement constraint between roscas with varying pot size is therefore the correlation between one's vulnerability to social sanctions and income.

8. Conclusion

It is typically assumed that informal groups, such as roscas, rely on social sanctions to solve their enforcement problems. In this paper we examine this notion more carefully and distinguish between expulsion from future roscas cycles and extraneous social sanctions. We first demonstrate that theoretically expulsion in itself is never a sufficient deterrent. 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 the incentives to default. They are therefore sustainable only if the costs of social sanctions on their members are sufficiently high. We provide some evidence in favour of our hypothesis, since individuals who are more vulnerable to those sanctions tend to participate in roscas where the order of ranks is randomly drawn at each cycle.

9. Appendix A: Proof of Proposition 5

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 roscas, 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:

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

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 $t = 2, ...n$. 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:

$$E(U^k(Fee)) = U^k(c_t^*) \tag{9.1}$$

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 $U^k(c_t^*)$. Optimality implies:

$$U^k(c_t^*) > \sum_{t=1}^{n-1} \delta^t u^k(y, 0) + \delta^n U^k(c_t^*). \tag{9.2}$$

Using (9.1), we obtain:

$$U^k(c_t^*) > \sum_{t=1}^{n-1} \delta^t u^k(y, 0) + \delta^n E(U^k(Fee). \tag{9.3}$$

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 $t = 2, ...n$. As a result,

$$\sum_{t=1}^{n-1} \delta^t u^k(y,0) + \delta^n E(U^k(Fee) > \sum_{t=1}^{n-1} \delta^t u^k(c_R + f_i, 0) + \delta^n E(U^k(Fee)) \tag{9.4}$$

Inequalities (9.3) and (9.4) 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.

10. Appendix B: Data methodology

The household level questionnaire was administered in three parts. The first part covered the household composition, education, employment non-recurrent expenditures and housing sections. The second part was administered over the subsequent week, where the household member in charge of daily expenses was asked to report on those expenses following a detailed list of items. They were assisted in this task by frequent visits by the enumerators. At the end of the week, we collected this information and administered the third part, which covered the participation of adult household members to informal groups. An interview typically lasted two hours for the first part, and one hour for the third part. The households were selected using a pseudo-random procedure, by which, every ten questionnaires, each enumerator would be randomly given a new starting point in the village of Kianda (by using a map), and would start from there following a pre-specified geographical itinerary (fifth house on your left, take the first street on the right, third house on the right, seventh house on the left,...). While people never seemed to refuse answering the questionnaire (they were indeed compensated for their time by a bag of maize flour), empty households were re-checked at night, and were skipped if they were not at home during the enumeration in the selected location. The supervisors of the enumerators frequently paid visits to the interviewed households to check the accuracy of the responses, and each questionnaire was re-checked in the presence of the enumerator for incoherent or missing responses and consistency across the information collected and casual discussion about the household concerned. Enumerators were regularly sent back to the households until the questionnaire was approved. It should also be emphasized that 8 out of the 10 enumerators who collaborated to the study were living in Kibera itself, which greatly facilitated access to the households. Parallel to this, we also conducted semi-open interviews of representatives of informal groups, to get a better understanding of the inner functioning of the groups. The main findings of those interviews were discussed with all the persons interviewed during a day long seminar we organized in the slum.

11. Appendix C: Additional Estimations

The table below lists similar estimations to those in Section 6 where the dependent variable is the rosca pot and contribution.

	Pot (1)	Pot (2)	Contribution (1)	Contribution (2)
Age	0.02 (0.008)*	0.014 (0.008)*	0.003 (0.008)	0.002 (0.01)
At least Primary	0.24 (0.13)*	0.26 (0.13)**	0.36 (0.13)***	0.38 (0.13)***
Permanent worker	0.52 (0.15)***	0.38 (0.15)***	0.50 (014)***	0.41 (0.14)***
Formal sector	0.06 (0.18)	0.14 (0.18)	0.15 (0.17)	0.21 (0.17)
Hhold. income	0.05 (0.03)*	0.035 (0.029)	0.03 (0.03)	0.02 (0.03)
Own room	0.50 (0.19)***	0.50 (0.20)**	0.40 (0.21)**	0.40 (0.21)*
Hhold size	0.03 (0.03)	0.03 (0.03)	-0.001 (0.03)	-0.004 (0.04)
≤ 2 yrs in kibera	-0.23 (0.26)	-0.07 (0.25)	-0.30 (0.20)	-0.23 (0.23)
Kikuyu	0.54 (0.19)***	0.52 (0.19)***	0.36 (0.19)*	0.35 (0.19)*
Luhya	0.31 (0.20)	0.32 (0.20)*	0.36 (0.19)*	0.37 (0.20)*
Other	-0.29 (0.43)	-0.22 (0.43)	-0.06 (0.38)	-0.01 (0.38)
Kamba	0.27 (0.23)	0.22 (0.23)	0.35 (0.21)*	0.32 (0.21)
Kisii	0.60 (0.21)***	0.64 (0.22)***	0.37 (0.24)	0.40 (0.24)
Constant	5.52 (0.46)***	6.07 (0.41)***	3.81 (0.43)***	4.16 (0.38)***
λ	0.35 (0.12)		0.23 (0.11)	
Log likelihood	-1096.12		-1086.85	
R^2		0.20		0.15
No. Obs	373	373	373	373

Table 5 - Estimations of on rosca pot and contribution[35]

[35]The dependent variables are in logs. The Heckman two stage approach is used in the estimations of the first and third columns. The estimations in the second and fourth columns do not account for sample selection, robust standard errors are in parentheses.

12. Appendix D: Alternative Estimations

The table below lists similar estimations to those in Section 6 but ignoring the first stage estimation of the probability an individual joins a rosca. We see that this sample selection rule is in fact not playing a large role and that the main results are unchanged. The first column reports the results from the estimation of the sample selection rule.

	Rosca Participation	Random (1)	Random (2)
Female	0.26 (0.04)***	-0.11 (0.12)	
Married	-0.16 (0.06)***	-0.16 (0.14)	
Female*Married	0.34 (0.08)***	-0.01 (0.16)	
Female inc. share	0.67 (0.24)***	0.28 (0.38)	
(Female inc. share)^2	-0.80 (0.28)***	-0.52 (0.43)	
Age	0.01 (0.002)***	-0.006 (0.004)	-0.004 (0.004)
Primary	-0.003 (0.03)	-0.06 (0.06)	-0.06 (0.06)
Permanent	0.25 (0.04)***	0.04 (0.06)	0.05 (0.06)
Formal	-0.08 (0.04)**	0.25 (0.08)***	0.28 (0.08)***
Hhold. inc	0.01 (0.01)	0.03 (0.02)*	0.023 (0.017)
Own room	-0.06 (0.04)	0.31 (0.08)***	0.26 (0.08)***
Hhold size	-0.02 (0.01)***	0.04 (0.01)***	0.03 (0.01)**
≤ 2 yrs in kibera	-0.17 (0.03)***	0.09 (0.10)	-0.05 (0.10)
Kikuyu	0.03 (0.04)	0.33 (0.08)***	0.33 (0.08)**
Luhya	0.06 (0.04)	-0.07 (0.08)	-0.06 (0.08)
Other	-0.11 (0.05)*	0.05 (0.16)	0.08 (0.18)
Kamba	0.27 (0.08)***	0.22 (0.12)**	0.25 (0.12)**
Kisii	0.05 (0.06)	0.11 (0.11)	0.13 (0.11)
Log likelihood	-511.58	-164.29	-168.34
$\overline{R}^2$	0.32	0.27	0.26
No. Obs	1220	373	373

Table 6 - Estimations without sample selection[36]

The estimation in the second column includes the instruments used to identify the first stage estimation of rosca participation. Comparing the second and third columns in the above table, we see that the main results of Section 6 are generally robust to the inclusion of these additional variables.

[36] The coefficients reported are the derivatives of the probit function evaluated at the sample means.

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