MEMORANDUM

No 17/2003

Sustainability and organizational design in informal groups, with some evidence from Kenyan Roscas

By
Siwan Anderson, Jean-Marie Baland and Karl Ove Moene

ISSN: 0801-1117

Department of Economics
University of Oslo

This series is published by the
University of Oslo
Department of Economics

P. O.Box 1095 Blindern
N-0317 OSLO Norway
Telephone: + 47 22855127
Fax: + 47 22855035
Internet: http://www.oekonomi.uio.no/
e-mail: econdep@econ.uio.no

In co-operation with
The Frisch Centre for Economic Research

Gaustadalleén 21
N-0371 OSLO Norway
Telephone: +47 22 95 88 20
Fax: +47 22 95 88 25
Internet: http://www.frisch.uio.no/
e-mail: frisch@frisch.uio.no

List of the last 10 Memoranda:

No 16	Halvor Mehlum, Karl Ove Moene and Ragnat Torvik Parasites 19 pp.
No 15	Michael Wallerstein and Karl Ove Moene Does the Logic of Collective Action Explain the Logic of Corporatism?. 42 pp.
No 14	Sheetal K. Chand Stabilizing Poverty In The Context Of The IMF’s Monetary Model. 31 pp.
No 13	Knut Røed and Oddbjørn Raaum The Effect of Programme Participation on the Transition Rate from Unemployment to Employment. 42 pp.
No 12	Hilde C. Bjørnland A stable demand for money despite financial crisis: The case of Venezuela. 19 pp.
No 11	John K. Dagsvik and Steinar Strøm Analyzing labor supply behavior with latent job opportunity sets and institutional choice constraints. 44 pp.
No 10	Ugo Colombino, Erik Hernæs, Zhyiang Jia and Steinar Strøm Retirement in Italy and Norway. 51pp.
No 09	Simen Gaure and Knut Røed How Tight is the Labour Market? A Micro-Based Macro Indicator. 34 pp.
No 08	Finn R. Førsund and Nikias Sarafoglou The Tale of two Research Communities: The Diffusion of Research on Productive Efficiency. 43 pp.
No 07	Taryn Ann Galloway and Rolf Aaberge Assimilation Effects on Poverty Among Immigrants in Norway. 26 pp.

A complete list of this memo-series is available in a PDF® format at:
http://www.oekonomi.uio.no/memo/

Sustainability and organizational design in informal groups, with some evidence from Kenyan Roscas*

Siwan Anderson
Department of Economics, University of British Columbia, Canada

Jean-Marie Baland
CRED, University of Namur, Belgium

Karl Ove Moene
Department of Economics, University of Oslo, Norway

March 2003

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 reduce the severity of enforcement issues. The implications of our analysis are tested against first-hand evidence from rosca groups in a Kenyan slum.

*This paper has benefited from comments and discussions with Patrick Francois, Simon Grant, David Green, John Hoddinott, Dean Karlan, Robert Townsend and seminar participants at the University of Copenhagen, DELTA (Paris), University of Toulouse, CSAE at Oxford, University of Namur, and BREAD annual conference (Washigton). We are grateful to the CRED (Namur) and to the MacArthur Foundation for financial support, particularly for the collection of field data. We thank Jean-Philippe Platteau and Anita Abraham, both from CRED, for their participation in the group interviews and the numerous discussions that helped launch the project, and the two leading enumerators, Jane Murutu and Daniel Waweru, both from Kibera, for their enthusiasm and dedication. This work is part of the Belgian Program on Interuniversity Poles of Attraction initiated by the Belgian State, Prime Minister's Office, Science Policy Programming.

1. Introduction

A substantial number of economic activities in developing countries are carried out by informal groups. Their success has attracted much 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 their study in Taiwan). 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, usually by a lottery draw, but occasionally on the basis of other criteria (seniority, recognized need, auction,...).[5]

As is apparent from the rotational structure of roscas, the incentive for members who receive the pot earlier on in the cycle to default on their later contributions is high. Although this risk of default is acknowledged in almost any study of roscas, enforcement problems have not been directly addressed in the previous literature. From an extensive field study we carried out in Kenya, it appears that rosca groups encounter two main problems: (1) there are members who do not regularly pay their contributions, and (2) there are members who stop contributing when receiving the pot. 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, and still, some groups fail due to cheating."

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. 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

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.

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 'social sanctions' certainly have a role to play, we argue that sanctions leading to the defecting member's exclusion from rosca participation are not a sufficient deterrent to avoid default. We then examine how the institutional structure of roscas can be designed so as to minimize enforcement problems. In particular, we focus on the way ranks are allocated across members. We shall thus argue that enforcement problems are lower if turns are not redrawn between cycles, and are also affected if the rosca allows for the possibility to change ranks out of necessity. While the main argument will be explored using a model similar to the one proposed by Besley, Coate and Loury (1993), we will show that the same argument can be developed using a household conflict approach, where roscas are viewed as a way for women to commit thier households to a particular saving pattern, (see our companion paper, Anderson and Baland (2002)). Under these motives, social sanctions are also necessary to deter default and the institutional characteristics of the roscas play a similar role in reinforcing the strength of these incentives constraints, in a way parallel to that of the main model.

We test the main implications of our theoretical analysis using household level data that we collected in a Kenyan slum. Although, the issue of enforcement has not been formally addressed before, several case studies mention mechanisms to minimize default such as: accepting only trustworthy members, placing the most unreliable members at the end of the rotation, and nominating a leader to oversee activities of the group.[6] We will also consider these alternative mechanisms in our empirical investigation using household level data that we collected in a Kenyan slum as well as informal interviews that we carried out on a smaller sample of informal groups.

The paper is organized as follows. The next section presents a model to explore how the institutional design of roscas affects enforcement problems. We then discuss the empirical predictions from our analysis. Section 4 provides ethnographic evidence from the Kenyan slum to highlight the importance of enforcement problems in rosca groups, as well as the solutions they adopt. The data are summarized in Section 5 and the results from our empirical analysis are subsequently provided. Section 7 concludes.

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

2. The model

In this section, we develop a simple model which builds upon the framework provided in the seminal work of Besley, Coate, and Loury (1993), where the purpose of joining a rosca is to save in order to purchase an indivisible good. Our aim here is to focus directly on enforcement issues. To this end, we extend their model to incorporate multiple rosca cycles, since the threat of exclusion from all future roscas is presumed to be a key instrument in disciplining roscas members.

We then investigate how the institutional design of a rosca affects default. Three major features include the allocation of ranks, the possibility of changing one's rank in case of necessity and the imposition of a membership fee. With regards to the allocation of ranks, 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.[7] This is purely justified by our data, where no bidding roscas are observed.

There are five other features that rosca members decide upon: the number of members, size of pot, cycle length, frequency of meetings and the amount of the contribution. However, among these five, there are only three degrees of freedom. That is, individual contributions are simply determined by dividing the size of the pot by the number of members, or the frequency of meetings is obtained by dividing the cycle length by the number of members. As in Besley, Coate and Loury (1993), we assume that the size of the pot is exogenously given. This assumption is supported by the notion that individuals have a predetermined motive to save for a specific indivisible good, the price of which is exogenous. Rosca membership is thus instrumental to this decision. Additionally, we assume that membership size is equal to the length of a cycle. The ethnographic evidence and the data presented in later sections 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.[8] As a result, increased membership typically leads to longer rosca cycles.[9] Under

[7]The seminal work is that of Besley, Coate, and Loury (1993 and 1994). See also Kovsted and Lyk-Jensen (1999) who contrast random and bidding roscas, and Klonner (2002) for an analysis of bidding roscas.

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

[9]It could be argued, however, that roscas can always double their membership and organize two sub-roscas, so that the frequency with which members receive their income is not necessarily a determinant of group size. In our sample, 42 out of 374 roscas, divided the pot in two to be given to two separate members at each meeting. However, those roscas often had a secondary role which might also require enlarged membership to successfully function.

these assumptions, there is therefore only one choice variable remaining. We will return to the implications of this below.

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. While the model is kept simple and rests on the motive for rosca participation proposed by Besley et al (1993), we discuss in the final subsection alternative motives and how these affect our main results.

2.1. The basic setting

In a rosca, n members contribute a predetermined amount P/n to the common pot at each meeting. The pot is given to one of them who then acquires one unit of the indivisible good, the cost of which is equal to P. Once acquired, the indivisible good lasts for one unit of time.[10] Time is discrete and the time space between two meetings represents one unit of time. As a result, the duration of a full cycle is equal to the number of members, n.

To introduce the possibility of future sanctions, we assume that individuals are infinitely lived. The lifetime utility of an individual is represented by:

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

where c_t represents expenditures on other goods at time $t, \delta < 1$ is the discount factor, and D_t represents consumption of the indivisible good which is equal to one if the good is purchased at time t and zero otherwise.

An individuals' budget constraint is:

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

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. If the durable good is bought successively

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

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 $s_t \geq 0$.

Let c_t^* represent the optimal consumption flow which maximizes $U(c_t)$. Assume that there is a saving motive so that $c_t^* < y$.[11] 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. Note that when an individual has a motive to save, she can always find a rosca such that she is better off. This follows because she 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, she enjoys the potential benefit of an early rank in the allocation of the pot.

We consider two ways in which to allocate ranks within a rosca. On the one hand, there are *random* roscas, where ranks are re-allocated at the beginning of each cycle. Without loss of generality, we assume that 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 of an individual who joins a random rosca is:

$$\begin{aligned} E(U(c_R)) &= \sum_{t=1}^{\infty} \delta^t u(c_R, 0) + \frac{1}{n}(\delta^1 + \delta^2 + ... + \delta^n)\left(u(c_R, 1) - u(c_R, 0)\right) \\ &\quad + \frac{1}{n}(\delta^{n+1} + \delta^{n+2} + ... + \delta^{2n})\left(u(c_R, 1) - u(c_R, 0)\right) + ... \\ &= \sum_{t=1}^{\infty} \delta^t u(c_R, 0) + \frac{1}{n}\sum_{t=1}^{\infty} \delta^t \left(u(c_R, 1) - u(c_R, 0)\right) \end{aligned}$$

which can be rewritten as:

$$E(U(c_R)) = \frac{\delta}{1-\delta} u(c_R, 0) + \frac{\delta}{1-\delta}\frac{1}{n}\left(u(c_R, 1) - u(c_R, 0)\right). \tag{2.3}$$

On the other hand, there are *fixed* roscas where the allocation of ranks remains unchanged after the first cycle. We assume that, at the beginning of the first cycle, the allocation of ranks is random and uniform across members. Given this assumption, it is easily demonstrated that the expected utility of an individual who joins a fixed rosca is also equal to (2.3). Hence, the expected utility in each type of rosca is identical. This is an issue that we address in detail below.

[11] 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.

2.2. Rosca sustainability

As an informal group, a rosca cannot legally enforce agreements between members. The question that naturally arises is to what extent the threat of exclusion from the group is sufficient to guarantee that members obey their obligations. More precisely, there are two types of enforcement problems faced by roscas. First, there is the temptation, upon receiving the pot, to leave the rosca and cease paying contributions before the end of the cycle. Second, there is 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 the second enforcement problem is more likely to arise for the member with the last rank. We address these two enforcement problems in turn.

As discussed above, 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 roscas of other groups as well. Second, roscas can also punish defection vai 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 s_i represent the cost to individual i of the social sanction that the group can impose on her if she defects. Clearly, s_i depends on a number of individual characteristics which make the individual more vulnerable to those sanctions, that we shall discuss in Section 3. We also assume that types are perfectly observable.

Consider the enforcement problem of the 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 1. *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:

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, $E(U_{1,r}(c_R))$, is equal to:

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

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:

$$E(U_{1,r}(c_R)) = \frac{\delta}{1-\delta} u(c_R, 0) + \frac{\delta^n}{1-\delta} \frac{1}{n} \left(u(c_R, 1) - u(c_R, 0)\right) \tag{2.4}$$

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

$$U_{np}(c_R) = \frac{\delta}{1-\delta} u(c_R, 0) + \frac{\delta^n}{1-\delta^n} \left(u(c_R, 1) - u(c_R, 0)\right).$$

Let the net benefit to staying in a random rosca for the first ranked individual be denoted by $\Delta_{1,r}^i$. Using (2.4) we have:

$$\begin{aligned}
\Delta_{1,r}^i &= E(U_{1,r}(c_R)) - (U(c_t^*) - s_i) \\
&= \left(\frac{\delta}{1-\delta} u(c_R, 0) + \frac{\delta^n}{1-\delta} \frac{1}{n} \left(u(c_R, 1) - u(c_R, 0)\right) \right) - U_{np}(c_R) + U_{np}(c_R) - U(c_t^*) + s_i \\
&= \left[\frac{\delta^n}{1-\delta} \frac{1}{n} - \frac{\delta^n}{1-\delta^n} \right] + \left[U_{np}(c_R) - U(c_t^*)\right] + s_i \qquad (2.5) \\
&< 0, \;\; if \; s_i = 0
\end{aligned}$$

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. By 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 (2.5) 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 increasing, 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 $U_{1,f}(c_R)$ denote the utility of the first ranked member of saving in a fixed rosca, after receiving the pot:

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

Using the above, we have:

$$\begin{aligned} \Delta^i_{1,f} &= U_{1,f}(c_R)-(U(c^*_t)-s_i) \\ &= \left(\frac{\delta}{1-\delta}u(c_R,0)+\frac{\delta^n}{1-\delta^n}\left(u(c_R,1)-u(c_R,0)\right)\right)-U_{np}(c_R)+U_{np}(c_R)-U(c^*_t)+s_i \\ &= U_{np}(c_R)-U(c^*_t)<0,\ \ if\ s_i=0 \qquad (2.6) \end{aligned}$$

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 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 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.[12]

Now we turn to the second enforcement problem where we are concerned with the incentives to stay for the last ranked rosca member. Consider first fixed roscas where the utility of this member is denoted by $U_{n,f}(c_R)$. Her net benefit to staying in a fixed rosca, $\Delta^i_{n,f}$, is equal to:

$$\Delta^i_{n,f} = U_{n,f}(c_R)-(U(c^*_t)-s_i)$$

[12]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.

$$
\begin{aligned}
&= \left(\sum_{t=1}^{\infty} \delta^t u(c_R, 0) + \sum_{k=1}^{\infty} \delta^{kn} \left(u(c_R, 1) - u(c_R, 0)\right)\right) - U(c_t^*) + s_i \\
&= \left(\frac{\delta}{1-\delta} u(c_R, 0) + \frac{\delta^n}{1-\delta^n} \left(u(c_R, 1) - u(c_R, 0)\right)\right) - U(c_t^*) + s_i \qquad (2.7) \\
&= \Delta_{1,f}
\end{aligned}
$$

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 individuals with similar vulnerability to social sanctions, s_i. 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, $E(U_{n,r}(c_R))$, is equal to:

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

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. Her net benefit to staying in a random rosca, $\Delta_{n,r}^i$ is therefore:

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

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 $\Delta_{n,r}^i$ becomes:

$$
\begin{aligned}
\Delta_{n,r}^i &\simeq \left(\frac{\delta}{1-\delta} u(c_R, 0) + (\delta^n + \frac{\delta^{n+1}}{1-\delta} \frac{1}{n}) \left(u(c_R, 1) - u(c_R, 0)\right)\right) \\
&\quad - \left(\frac{\delta}{1-\delta} u(c_R, 0) + \frac{\delta^n}{1-\delta^n} \left(u(c_R, 1) - u(c_R, 0)\right)\right) + s_i \qquad (2.8) \\
&\simeq \left(\delta^n + \frac{\delta^{n+1}}{1-\delta} \frac{1}{n} - \frac{\delta^n}{1-\delta^n}\right) \left(u(c_R, 1) - u(c_R, 0)\right) + s_i > 0 \; even \; for \; s_i = 0.
\end{aligned}
$$

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.

Comparing (2.8) to (2.5), we also have:

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

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

Proposition 2. *The enforcement problems of the last ranked member are always less severe than those of the first member.*

2.3. Institutional design and enforcement

In this section, we turn to the institutional design of a rosca, and its role in countering the incentives to default. We first consider the allocation of ranks, comparing fixed and random roscas, as a way to reduce the enforcement problem described above. It follows easily that:

Proposition 3. *For a given s_i, enforcement problems are less severe in a fixed than in a random rosca.*

Proof: Comparing equations (2.5),(2.6),(2.7) and (**??**), we obtain:

$$\Delta^i_{n,r} > \Delta^i_{n,f} = \Delta^i_{1,f} > \Delta^i_{1,r}$$

■

This proposition 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 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 thus 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 the 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 the incentives problem of the first ranked member unchanged.

It is important to note that, in our model, the expected utility of a member is the same, whether ranks are redrawn periodically or not. The expected utility of an individual who joins a random rosca is indeed equal to:

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

In a fixed rosca, expected utility is given by:

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

This result follows from the fact that, with time-separable preferences, drawing all future ranks at time 0, or redrawing these ranks periodically, has the same impact on the ex ante utility of a member. Indeed, in both cases, the probability of receiving the pot at any time t is equal to $\frac{1}{n}$.

Each state of the world has the same probability under both systems of rank allocation. As a result, in our model, the choice of fixed versus random allocation is costless.

One might expect, however, that random roscas are more desirable. From informal discussions with rosca members, it appeared that a situation in which one member receives an unfavorable rank across all cycles was perceived as deeply unfair (ex post). It is thought that every member should be given an equal chance at receiving a favorable rank in the future. Fairness considerations may thus prompt rosca groups to adopt a random allocation of ranks.

Moreover, if we do not assume time-separable utility functions, the two types of roscas are no longer equivalent. While we develop a formal example in Appendix A, we can here briefly state the main intuition.[13] In a random rosca, members receive the same certainty equivalent in each cycle. They face the same uncertainty, and hence attach an identical value to it (though discounted). In contrast, fixed roscas involve a first cycle certainty equivalent, before ranks are drawn, that differs from those of subsequent periods (as people are then sure of their ranks, with a constant consumption flow). As a result, random (fixed) roscas tend to be preferred when the intertemporal elasticity of substitution across cycles is low (high).

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[14], the fee must be kept by the rosca throughout its lifetime to also avoid defection in future cycles. 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

[13]See also Kreps and Porteus (1978), Epstein and Zin (1989), and Grant, Kajii, and Polak (1998).

[14]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.

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 no fee can 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.*

This result is demonstrated in Appendix B.

Finally, one can also argue 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.

Some roscas exhibit more flexibility than others. In particular, although insurance does not play a primary role in our data as there are no bidding roscas (see Besley et al, 1993 and 1994, Klonner, 2003 and Kovsted and Lyk-Jensen, 1999), there are many roscas where it is under exceptional circumstances possible to change the predetermined order. This event only occurs when a member can justify an urgent case of necessity. As we shall see in the ethnographic section, there are various ways through which groups deal with these requests. For example, they may allow the member to postpone contributions, or to opt out of the current cycle and re-enter the rosca later, or even to receive a more favorable rank within the current cycle. These requests however are very infrequent and must be fully justified and approved by the entire group during a plenary meeting. Moreover, there are various other ways to solve such contingencies, such as borrowing from family networks, requesting remittances from the native village or participating in the many other informal groups which, in contrast to roscas, specifically serve an insurance purpose. It should also be emphasized that the insurance gain accruing to the members is essentially in terms of added flexibility in the way roscas payments are made rather than a genuine insurance benefit. Moreover, even though we do not formally address this issue here, this added flexibility also reduces the prospect of involuntary defections, where some members may be temporarily and unexpectedly in a position where they cannot afford their contributions.

This being said, many roscas seem to allow for this possibility of changing ranks in the case of need, and clearly such a feature increases the benefits to joining a rosca. However, it also affects the enforcement problem. Without modelling it explicitly, we shall assume that groups are always able to perfectly screen legitimate requests so that this institutional feature actually increases the expected utility a member obtains upon joining the rosca. Moreover, the aspect which is most relevant to our theoretical framework is the possibility that a member receives a more favorable rank in a given cycle.[15]

First consider this possibility in a random rosca. For all members, the possibility of receiving a more favorable rank in case of necessity increases the benefits of staying in the rosca. Therefore, this change in the institutional structure of the random rosca relaxes the enforcement constraint for both the first and the last ranked members. As a result, in all random roscas, this option dominates:

Proposition 5. *All random roscas should allow for the possibility of changing one's rank.*

This reasoning however does not apply to a fixed rosca. Consider the enforcement issue of the first-ranked member. In this case, allowing the first rank to be given to another member (on justified grounds) in a future cycle reduces the benefits for the first-ranked member of staying in the rosca. Therefore, in contrast to random roscas, the first ranked member necessarily looses from this additional option. As a result, the possibility of changing ranks exacerbates her enforcement problem. As long as the probability of such changes remain low enough, her position remains however more favorable than under a random rosca. For the last ranked member on the contrary, the possibility of obtaining a more favorable rank increases her benefits of staying, so that her enforcement constraint is less binding.

[15]Note also that, in the case where the rosca allows this change in ranks, it has the option of demanding guarantees in support of the request (such as a deposit, e.g. a radio, to the chairman of the group) which, however (as we argued for membership fees) cannot be generalized to all members for all cycles.

In accord with Proposition 2, the enforcement problems of the last ranked individual are not binding in this case as well. Hence, we need only consider the enforcement issues of the first-ranked individual. Let $\Delta^i_{1,r,chrank}$ and $\Delta^i_{1,f,chrank}$ represent her incentives to remain in a rosca where changing rank in case of necessity is possible, while $\Delta^i_{1,r}$ and $\Delta^i_{1,f}$ represent, as before, her incentives to stay in the rosca when this is not possible. The above discussion, combined with Proposition 4, yields the following results[16]:

Proposition 6. *The possibility of changing one's rank in case of necessity exacerbates the enforcement problem in fixed order roscas. Therefore, for a given s_i, the incentives to stay in a rosca satisfy the following ordering:*

$$\Delta^i_{1,f} > \Delta^i_{1,f,chrank} > \Delta^i_{1,r,chrank} > \Delta^i_{1,r}$$

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. Therefore, since the contribution $s_R = \frac{P}{n}$, there is only one variable left to be chosen by rosca members, which is 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[17], 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. 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

[16]Note also that the higher the discount rates, the higher is the incentive to leave for the first ranked member in a random rosca compared to a fixed rosca. As a result, the difference in social sanctions necessary to ensure sustainability in a random versus a fixed rosca increases with the discount rate.

[17]To properly address this issue, a continuous time approach is required. This however complicates considerably the model, without adding much in content. A detailed analysis is available from the authors upon request.

waiting time. Therefore, enforcement problems can also be reduced in random roscas by increasing the number of members.[18]

2.4. Roscas as a commitment to save

In previous work, we proposed (Anderson and Baland (2002)) an alternative explanation to the Besley et al (1993) motive for rosca participation, 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. This is in line with Gugherty (2000) who argues that roscas serve as a mechanism through which individuals bind themselves to a particular saving rate in the presence of time-inconsistent preferences. The sociological literature also stresses the collective norms and regulations in roscas which encourage members to save (see, for example, Bouman (1977), Fernando (1986) and Ardener (1995)). For example, Bouman (1977) points out that "The most effective component and the foremost reason for joining a Rosca is the "forced" saving element. Through the regularity of small deposits, which otherwise might be spent on trivialities, one is able to accumulate more sizeable sums for a worthwhile cause" (p. 184). These alternative approaches suggest that roscas allow members to better follow their objectives than if they save on their own.

We now argue that this alternative motive renders the presence of social sanctions even more necessary to ensure enforcement. We focus here on the household conflict approach. A similar discussion can be held for the argument based on time-inconsistent preferences. For the commitment argument to make sense, the decision to participate in a rosca must necessarily pre-date the payment of the first contribution. Otherwise, the husband can oppose her joining the rosca in the first place, since by making an immediate upfront contribution, she reveals her intention to force the household to save more than it wants to. The timing of the decision can be characterised as follows: at time

[18] One may imagine two alternative ways to solve the enforcement issue. 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 other 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 member's income after a finite number of cycles. Reasoning backwards, this possibility therefore cannot credibly solve the enforcement issue.

0, the wife decides whether to join a rosca; at time 1, ranks are drawn, and she then pays her first contribution, if she decides to stay. (Note that this is also the relevant decision pattern for time-inconsistent preferences.) Clearly, in this setting, once ranks are drawn, the household who received an unfavourable rank is tempted not to pay the first contribution and leave the rosca immediately, since the joint household decision is to not save in a rosca in the first place. Social sanctions are once again necessary to enforce such a household to remain in the rosca. In their absence, the last ranked household will always prefer to leave the rosca when asked to pay its first contribution: the wife cannot commit to continue her participation in the rosca as nothing binds the household to these obligations and the household is free to change her decision.

By contrast, absent sanctions, households with a more favourable rank may decide to contribute, at least until they obtain the pot. The question however is what do they decide once they receive it. Clearly, if the rosca is fixed, the first ranked household is tempted to leave the rosca as it is then in the exact same position as the last ranked one: the social sanctions necessary to discipline both of these ranks, and thus avoid defection, are then identical. In a random rosca, the enforcement problem of the first ranked household is once again more severe than for the last ranked, as the random allocation of ranks in the future reduces the former's benefits to remaining in the rosca, while increasing those of the latter. The allocation of ranks thus once again plays a major role in the enforcement constraint. (A formal proof can easily be obtained by retracing the steps of the propositions above.) Finally, the possibility to request change of rank has the same impact on the enforcement constraints as in the above subsection.

We therefore have:

Proposition 7. *If the household joins the rosca to commit to the saving pattern imposed by the rosca (as in Anderson and Baland (2002)), social sanctions are necessary, and, for a given s_i, the incentives to stay in a rosca satisfy the same ordering as in Proposition 6:*

$$\Delta^i_{1,f} > \Delta^i_{1,f,chrank} > \Delta^i_{1,r,chrank} > \Delta^i_{1,r}$$

Lastly, note that a membership fee to be paid upon joining is once again of little help to solve the enforcement problem. In a fixed rosca, it is a sunk cost that is lost, whether the household stays or leaves the rosca. In a random rosca, where the fee is progressively reimbursed throughout the cycle, a similar argument to the one developed in the previous subsection can be applied: as the fee is smaller than the pot, households who received the pot are always able to replicate the best they can hope for in the rosca, and can actually do better, because the payment of the fee reduces the utility one expects from staying in the rosca.

3. Empirical Predictions

We develop here the empirical implications of our analysis, by comparing the net utility a member gains when defaulting to the maximum social sanction that can be inflicted upon her. The enforcement constraint requires the gains to be smaller than the sanctions. As we argued in section 2, social sanctions are necessary to avoid defection. There are several dimensions in which a particular individual can be punished when defaulting. In this respect, it is useful to distinguish between formal rules of punishments and social pressures.

Roscas often resort to a system of predefined sanctions against defaulting members. Where the strength of social sanctions are lower, we expect the group to resort more rigidly to written rules and sanctions with less sympathy for the subjective appreciation of the circumstances. We therefore expect those groups to be more formalized and more hierarchically organized, by making explicit the rules applicable to defectors, or by trusting an elected member with the role of investigation and punishment. The hypothesis here is that roscas in which members tend to be less reliable will display a higher degree of formalism.

Social pressure depends on at least three measurable variables: group size, social homogeneity and members' personal relationships (neighbors, relatives,...). Group size has an ambiguous relationship with social sanctions, since it increases the capacity of the group to punish the defecting member, while it simultaneously reduces the incentives for the individual members to do so. Similarly, as we discuss in the next section, the impact of social homogeneity or members' closeness is not necessarily straightforward: while groups organized, say, along ethnic or clan lines can impose stronger sanctions on defecting members, it is also harder to inflict a sanction on a close relationship. Moreover, it is possible that social sanctions differ widely across tribes, some tribes being tougher on members who cheated their tribal trust.

Finally, as argued in the previous section, some members are clearly more vulnerable than others, in the sense that they may have more to lose when indulging in opportunistic behavior. Thus, members 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 family in their house. Similarly, members who have longer standing social networks in the slum will suffer more: thus, members who have spent more years in the slum are likely to suffer more from reputational effects. Also, individuals who succeeded in getting a permanent employment, particularly if it is in the formal sector, are much more vulnerable, all the more so that retaliation in their place of work is also possible. Finally, members with visible wealth that can be confiscated by the group are also more vulnerable to group sanctions.

Definition 1. *Individuals are more reliable (s_i is high) if they own their dwellings, live in a large family, have spent more years in the slum, have more visible wealth and objects of value that the group can confiscate, and have a permanent employment, possibly in the formal sector.*

Therefore, we expect more reliable individuals to belong to roscas with less stringent enforcement mechanisms. Our theoretical analysis provides direct implications with how the gains from defection depend on the organizational structure of the rosca. In particular, gains from defection are lower if the rosca does not draw turns after each cycle. We therefore expect that:

Conjecture 1. *Less reliable individuals are more likely to belong to roscas with fixed order.*

Conjecture 2. *Less reliable individuals are more likely to belong to more formalized roscas.*

If we now consider the possibility of changing one's rank, Proposition 5 points out that random roscas should always adopt that feature, as it increases benefits to the members while reducing the enforcement problem. We therefore expect:

Conjecture 3. *Random roscas allow for the possibility of changing one's order in case of necessity.*

The possibility of changing one's rank increases enforcement problems in fixed order roscas. Combined with the above conjecture, this implies:

Conjecture 4. *The least reliable individuals belong to fixed order roscas where changing order in case of necessity is not possible. The most reliable individuals belong to random roscas where changing order is possible. Individuals with intermediate levels of reliability belong to fixed order rosca where changing order is possible.*

It should be stressed here that, since the possibility of changing ranks has conflicting effects on the enforcement constraint depending on the way ranks are initially allocated, one cannot directly test this feature in isolation. Instead we must consider its interaction with random and fixed allocations.

Lastly, the use of a membership fee does not allow roscas to solve their enforcement issues. As a result:

Conjecture 5. *Roscas do not use membership fee to avoid defection.*

As laid out in Section 2, we could not derive direct empirical implications for the other institutional features, such as membership, contribution, or cycle length. The main difficulty with these variables is that they also depend on individual preferences. To this end, we will briefly explore them empirically but have no testable predictions.

Another important point is that our theoretical framework is essentially capturing the notion of incentive compatibility. However, adverse selection is also relevant to enforcement problems. This is a major concern for rosca groups. As will shall see from the ethnographic evidence however, groups usually resort to a variety of screening mechanisms to accept members. As a result, members of the same group usually know each other well, and adverse selection problems are therefore much less likely to have an impact on the organizational design of the rosca.[19]

Additionally, it is interesting to note that the direct empirical implications of adverse selection for Conjecture 1 do not change. Consider two types of individuals, one with a high motive to save and the other with no motive to save. With adverse selection, the enforcement problem is again two-fold; that of an early ranked individual leaving with the pot and that of an individual with an unfavorable rank leaving the group before making any contributions. This later problem is not very serious in that groups members are better off if the individual who does not want to save leaves the group. The enforcement problem of an individual leaving when receiving the pot is more severe. In a fixed rosca, this problem will emerge in the first cycle. In a random rosca there is an added risk since a potential defector may wait a few cycles until he receives a favorable enough rank. Therefore, to reduce the adverse selection problem, rosca groups are better off choosing a

[19]The superior information enjoyed by rosca participants about each other may also explain why other economic actors (traders for indivisible goods, school directors for school fees,...) do not lend credit to individuals, but usually show flexibility as to the time the payment due is made .

fixed order allocation.[20]

Regarding other institutional features, we may expect that optimal membership is smaller when groups are concerned with adverse selection. Indeed, smaller groups tend to comprise individuals who know each other well and are thus better able to successfully select new members. Additionally, we might expect that smaller pots and larger contributions may help to discourage potential defectors by reducing their net expected gain.

4. Enforcement in roscas: ethnographic evidence from Kibera

Before turning to the empirical estimates, we provide some ethnographic evidence based on a series of open interviews. Fifty groups were interviewed with regards to their internal functionings and their historical evolution. For many of these groups, we also examined their books of account, the minutes of their meetings and their constitutions. The evidence below provides an overview of these interviews with regards to enforcement and adverse selection issues. Regarding enforcement, groups encountered the two main problems: (1) members (who presumably receive an unfavorable rank) cease to pay their contributions, and (2) members who stop contributing when receiving the pot. The interviews reveal the various ways through which groups impose sanctions on these defaulting members. We then turn to their concern with regards to adverse selection. The anecdotes reveal the importance of this issue, but also the measures they adopt to circumvent the problem are quite successful.

Consider the first enforcement problem. 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 meeting with all the members. For instance, in the Kujitahidi group, "before expulsion, there is always some discussion with the executive committee to see whether there are valid reasons justifying the absence. But if the member lies, he may not be forgiven". Similarly, the Kibera Nyakwerigeria group rules state that

[20] As will be seen in section 4, some groups explicitly allocate the last rank to new members, as a way to test their reliability. This however does not address the incentive compatibility issue. In the same vein, one may argue that groups should re-draw ranks at each meeting of the rosca (excluding those who have already received the pot in the cycle). The remaining members then do not know their ranks in the current cycle, so that the enforcement problem of the last member is reduced. However, our theory shows that the issue falls not so much upon the last but on the first member, so that such a design would fail to address the main problem. Moreover, it involves organizational costs, which perhaps explain why we do not observe this in our data.

"If a member misses to attend a meeting and without even sending his/her contribution, committee members must establish the cause of his/her absence with immediate effect." If the member cannot provide a good excuse and pay his contribution on the same day, a substantial fine is charged. "If any member misses for three consecutive meetings without any proper reason, he/she will be expelled from the group. (...) Stern action will be taken against any member who may run away with members money." While, in this group, no member was ever formally expelled, 11 out of 36 members left because they could not afford regular contributions. Fines are regularly imposed: for example, in the meeting preceding our interview, 3 out of the 25 current members were sanctioned for late payments and made to pay a fine.

Many roscas also attempt to retrieve the amounts due. When one member left with the pot, the Arahuka group went to the home of the person and appropriated a few possessions to compensate for the loss. In another rosca group, a condition for accepting a new member "is that 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." By contrast, in the same group "when someone cannot contribute for several days, she is out of the present cycle. At the end of the cycle (50 days), she receives back the money she has contributed till she stopped contributing. She may start again as a member at the next cycle." Very interestingly, in light of the argument we present in this paper, the Kibera Nyakwageria group "dropped the lottery, and the executive committee decides the order. When your attendance is not good, you will be given a last number." While most groups genuinely try to help and understand the situation of a member in difficulty, they also insist that, without valid motives, strict rules are necessary to discipline the members. In the Kibera Nyakwageria group, a member states: "You cannot trust people in matters of money. People tend to cheat. This is why you need good rules. They protect and reassure ourselves about the others' behavior".

In most groups, expulsion of a member is usually viewed as the ultimate sanction.[21] In some rare cases, the group also complains 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.[22] But groups also resort to more diffuse social threats and

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

[22]Relatedly, to help a member in distress, one rosca group organized a harambee, which is a traditional meeting

pressures. Thus, in a letter to a member "refusing to take the appropriate action", the chairman of the Kibera Kianda Self Help Group writes: "Failure to do so, a further action will be effected by either committee or entire members without further communication to you. So, you have been given ample time and you have yourself to blame if all goes worse. The ball is in your pocket. Your humble servant,...". 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 the 'Rwathia group"'.

Groups address the adverse selection problem by being very careful when accepting potential members. Thus, in all groups, the selection process is considered crucial, and information is always gathered on would-be members. For instance, Kibera Nyakwageria group members underline : "We are neighbors, and we know each other well". New members must be approved by a consensus at the general assembly. For a new member in the Arahoka Women group, "we check that she accepts the rules and she does not come from the bush. She must be recommended by one of us." Similarly, in the Obwanchani Self-Help group, "we discuss before admitting a new member, who must be recommended by one of us. We require several members to know him personally. Otherwise, he will not be accepted, even if he is a Kisii." Interestingly, in another rosca group we interviewed, new members joining the rosca are given the last number (suggesting that this is a fixed order rosca).

Most groups do not want to be too large. The importance of trust and mutual knowledge is often emphasized as an important factor for the successful functioning of the group. Some groups do not want to expand as this would affect the relationships between the members: 'all members know each other well, and understand each other. More people would destroy this.' (Upendo Women Group). They also stress the organizational difficulties that arise with large groups (time to reach each member, organize meetings,...) and fear that accepting new members increases the length of the cycle. For instance, the Katieno women group declares that they did not want more members, because "you cannot wait two years for the draw. And if we create two subgroups, members will feel as belonging to two different groups."

Some groups stress the importance of ethnic homogeneity to ensure cooperation within the

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.

group, a good knowledge of the members and a fair level of trust within the group. Thus, in the Masogo Progressive group, all members belong to the same clan, "clan solidarity is important, we Luos know each other well, we speak the same language and understand each other." In the same vein, while the Arahoka women group considered mixed tribes as important "to avoid tribalism", although the group is exclusively composed of Kikuyus and Kambas, because "we share the same culture and speak almost the same language. But, Kikuyus and Luos is not OK". In the Konyirkendi group, members feel united, they have activities 'to encourage spirit of friendship', but this is possible because "we share the same language and culture, and we all come from the same area".

Tribal competition raises a number of problems in an organization. Thus, the Acheng Widow group points that, with mixed ethnicities, a chairman will be "under pressure by his kin to favour them. If a chairman eats with members of another tribe, or speaks in their favour, he will be accused of betraying his tribe." Jealousy and rivalries may be more frequent in mixed ethnic groups. Thus the Kujitahidi group has written rules stating that each tribe should be fairly represented in the executive committee. Yet, the Luos, who are dominant in the group, feel under-represented and resent the chairperson, because he is a Kikuyu.

On the other hand, mixed groups may allow stricter rules. A member interviewed noted that "it would be better to be a mixed group, because there is less jealousy when you mix up different tribes, with clear rules." Also, the Kibera Amani group (not a rosca) stressed the importance of ethnic diversity, and the use of the mother tongue is prohibited during the meetings. With a tribal group, "you have more tensions, and people bring in family quarrels". Relatedly, in the Tumaini Women Group, the written rules stipulate that "the official language to be used during the meeting is either English or Kiswahili and not vernacular."

What emerges from these interviews and records is that enforcement is a serious concern. Groups certainly invest time and resources in resolving the problem. Moreover, they do not rely exclusively on social sanctions but also resort to changes in rosca design as a way to address the issue.

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 one of the largest in Kenya. It extends over 225 hectares of land and houses a population of approximately half a million 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. All household members were first surveyed for information on their education, work activity, and income. Households 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 385 were roscas.

For the purposes here, we categorize rosca groups by their structural aspects. As discussed in the previous sections, these include; membership, cycle length, contributions and pot size, fixed versus random ordering of ranks and degree of formalization. Groups were characterized as having some formalization if they either had a governing body or written rules, they were characterized as having full formalization if they had both.[23] The following table lists the different types of roscas by their structural aspects:

[23] Within the category of some formalization, 74.5 % had a governing body and 25.5 % had written rules.

	All Roscas	Fixed Order	Random Order	No Formal.	Some Formal.	Full Formal.
Members	16.04	15.61	17.10	13.03	12.7	20.22
	(11.44)	(10.58)	(13.27)	(7.03)	(8.97)	(13.62)
Cycle	250.27	209.90	347.18	239.95	166.13	314.90
	(255.86)	(219.12)	(307.81)	(210.66)	(198.15)	(296.22)
Pot	4123.10	3199.91	6338.77	4757.73	3748.89	4010.97
	(5706.44)	(4121.25)	(7964.47)	(6013.51)	(6635.79)	(4774.24)
Contrib.	321.20	294.97	384.14	354.89	366.19	272.01
	(452.25)	(475.36)	(386.02)	(350.22)	(661.04)	(311.26)
Fixed	0.71	1	0	0.38	0.83	0.82
	(0.46)	(0)	(0)	(0.49)	(0.38)	(0.38)
Random	0.29	0	1	0.62	0.17	0.18
	(0.46)	(0)	(0)	(0.49)	(0.38)	(0.38)
No Form.	0.27	0.14	0.56	1	0	0
	(0.44)	(0.35)	(0.50)	(0)	(0)	(0)
Some For.	0.29	0.34	0.17	0	1	0
	(0.46)	(0.48)	(0.38)	(0)	(0)	(0)
Full Form.	0.44	0.51	0.26	0	0	1
	(0.50)	(0.50)	(0.44)	(0)	(0)	(0)
Change order	0.79	0.75	0.90	0.91	0.71	0.78
	(0.40)	(0.43)	(0.30)	(0.29)	(0.46)	(0.41)
Memb. Fee	0.29	0.32	0.21	0.03	0.16	0.53
	(0.45)	(0.47)	(0.41)	(0.17)	(0.37)	(0.50)
Women only	0.68	0.73	0.58	0.73	0.65	0.67
	(0.46)	(0.45)	(0.49)	(0.45)	(0.48)	(0.47)
Same ethnic	0.37	0.34	0.45	0.33	0.29	0.45
	(0.48)	(0.47)	(0.50)	(0.47)	(0.46)	(0.50)
Friends	0.56	0.48	0.74	0.67	0.49	0.53
	(0.50)	(0.50)	(0.44)	(0.47)	(0.50)	(0.50)
Relatives	0.09	0.10	0.05	0.03	0.06	0.13
	(0.28)	(0.30)	(0.23)	(0.17)	(0.24)	(0.34)
Neighbors	0.21	0.26	0.10	0.12	0.34	0.19
	(0.41)	(0.44)	(0.30)	(0.33)	(0.47)	(0.39)
Profession	0.11	0.12	0.10	0.17	0.11	0.08
	(0.32)	(0.32)	(0.30)	(0.38)	(0.31)	(0.27)
No. Obs.	374	264	110	100	110	163

Table 1: Rosca Characteristics[24]

Roscas with a random order and formalization tend to have the largest membership and largest cycle. Large pots are also associated with random roscas. Though in contrast to the first rela-

[24]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.

tionship, roscas with the least formalization have larger pots. 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), however the degree of correlation is low.[25]

A fixed order of ranks seems to correspond to formalization. By contrast, random order roscas tend to have no formal structure. Fixed order roscas are more likely to have only female members. Random roscas and those with more formalization are slightly more likely to be organized around a single ethnicity. Of these single 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 and those with formalization are more likely to be started with neighbors or relatives, and less likely to be started with friends compared to other types of roscas. One may conjecture that neighbors and relatives are more reliable than friends in the sense that you share close proximity or family ties.

It should be emphasized that, in accord with our theoretical analysis, a minority of rosca groups have a membership fee as predicted in Conjecture 5. On average, this up-front fee is only equal to approximately 25% of the monthly contribution, and is more likely to be imposed if the rosca is formalized. Therefore its purpose likely covers these extra costs rather than solve an enforcement problem. Also in line with our theoretical model, random roscas are more likely to allow members to change their order of ranks if necessary. This is consistent with Conjecture 3. There are only 11 random roscas in our sample which do not allow the order to change under any circumstances.

We now turn to examining the individuals who join these different roscas which vary by their structural aspects. The 520 households interviewed represent approximately 2300 individuals. After omitting all individuals aged less than 18 years, we are left with a sample of roughly 1250. The following table describes the individual and household characteristics of participants by type of rosca:

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

	No Rosca	All Roscas	Fixed Order	Random Order	No Formal	Some Formal	Full Formal
Female	0.40	0.86	0.86	0.84	0.93	0.83	0.83
	(0.49)	(0.35)	(0.34)	(0.37)	(0.26)	(0.38)	(0.38)
Married	0.56	0.66	0.67	0.64	0.66	0.66	0.66
	(0.50)	(0.47)	(0.47)	(0.48)	(0.48)	(0.47)	(0.47)
Age	29.65	32.86	32.28	34.24	33.33	32.54	32.80
	(9.34)	(8.33)	(8.38)	(8.08)	(8.00)	(8.87)	(8.22)
At least Primary Sch.	0.62	0.48	0.47	0.48	0.48	0.49	0.47
	(0.49)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Perm. wrk	0.37	0.60	0.53	0.75	0.73	0.57	0.53
	(0.48)	(0.49)	(0.50)	(0.43)	(0.45)	(0.50)	(0.50)
Formal	0.28	0.19	0.11	0.38	0.35	0.13	0.13
	(0.45)	(0.39)	(0.31)	(0.49)	(0.48)	(0.33)	(0.34)
yrs. in slum	7.43	8.15	7.86	8.84	7.60	8.14	8.52
	(6.37)	(5.93)	(5.69)	(6.45)	(5.54)	(6.26)	(5.94)
Hhold Inc.	8028.84	9188.81	7977.69	12067.55	10121.96	9636.36	8333.74
	(7482.10)	(9762.93)	(9272.73)	(10330.35)	(9396.59)	(12163.97)	(8008.41)
Hhold Size	4.98	4.86	4.67	5.33	5.06	4.51	4.99
	(2.13)	(2.08)	(2.05)	(2.11)	(2.00)	(2.01)	(2.16)
Own room	0.19	0.21	0.10	0.47	0.39	0.13	0.16
	(0.39)	(0.41)	(0.30)	(0.50)	(0.49)	(0.33)	(0.37)
Kikuyu	0.21	0.24	0.12	0.52	0.48	0.17	0.14
	(0.41)	(0.43)	(0.33)	(0.50)	(0.50)	(0.38)	(0.35)
Luhya	0.19	0.18	0.22	0.08	0.11	0.24	0.18
	(0.39)	(0.38)	(0.41)	(0.27)	(0.31)	(0.43)	(0.39)
Luo	0.41	0.38	0.46	0.18	0.28	0.38	0.44
	(0.49)	(0.49)	(0.50)	(0.39)	(0.45)	(0.49)	(0.50)
Kamba	0.05	0.07	0.06	0.09	0.04	0.08	0.09
	(0.23)	(0.26)	(0.25)	(0.29)	(0.20)	(0.27)	(0.28)
Kisii	0.10	0.10	0.09	0.11	0.08	0.08	0.12
	(0.30)	(0.30)	(0.29)	(0.31)	(0.27)	(0.27)	(0.32)
No. Obs	848	374	264	110	100	110	163

Table 2: Individual and Household Characteristics[26]

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 Table 2 is that the more reliable individuals belong to random roscas compared to fixed roscas: they are more likely to be employed as a

[26] All income variables are caculated by month and measured in Kenyan shillings.

permanent worker in the formal sector, have higher incomes, and lived longer in Kibera. A similar relationship seems to exist for the degree of formalization in rosca groups, where the more reliable is an individual, the less formal is the rosca to which they belong.

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 household, and who own property are more likely to belong to random roscas with no formalization. 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%) with little formalization (53% belong to groups with no formalization). In contrast, more than 85% of Luhya and Luo rosca participants are in fixed order roscas with some degree of formalization (18% belong to groups with no formalization). The Kamba and Kisii fall in between, where approximately 65% belong to fixed order roscas with formalization (19% belong to groups with no formalization).

¿From the raw data, it would seem that more reliable individuals select into random roscas with less formalization. This finding is in accord with our predictions from Section 3. We now turn to the empirical analysis.

6. Empirical Estimates

6.1. Reliability and Enforcement

This section aims to directly test Conjectures 1, 2, and 4. To do this we estimate the probability that an individual selects into a rosca with particular structural features as a function of their reliability.

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:

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

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 rosca with particular structural features, 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 reliability (according to Definition 1). We assume that the variable Y is observed only if $R = 1$. In our main estimations, Y either represents a binary choice, or an ordered multinomial choice. For example, to directly test Conjecture 1 and compare random and fixed roscas, we assume that $Y = 1$ if an individual is in a random rosca and $Y = 0$ if she is in a fixed rosca. Alternatively, to directly test Conjecture 4, we consider an ordered choice variable, where: $Y = 0$ if an individual belongs to a fixed rosca where the order cannot be changed in case of need; $Y = 1$ if the individual belongs to a fixed rosca where the order can be changed; $Y = 2$ if the individual belongs to a random rosca where the order can be changed; and $Y = 3$ if the individual belongs to a random rosca where the order cannot change in case of need.

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' reliability 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 reliability. In our previous work using this data (Anderson and Baland 2002), we argued that women join roscas in order to save at a higher rate than they would at home and demonstrated that female bargaining power within the household is a strong determinant of rosca participation. This variable is essentially unobservable to group members and therefore is unlikely to be used as an indicator of reliability. Therefore we use female bargaining power, proxied by her share in household income, to identify the sample selection equation (6.1) in the estimations.

The results from our first stage estimation of (6.1) are listed in the first column of Table 10 in Appendix E. The tables below summarize our second stage results from estimating (6.2).

Alternative estimations which ignore the sample selection issue are presented in Appendix E.[27]

	Random (1)	Random (2)	Random (3)	Random (4)	Random (5)	Random (6)
Female	-0.17 (0.38)	-0.15 (0.24)	0.27 (0.26)	-0.61 (0.33)*	-0.30 (0.36)	-0.14 (0.59)
Married	-0.38 (0.41)	-0.78 (0.33)**	-0.71 (0.30)**	-0.33 (0.39)	-0.42 (0.40)	-0.56 (0.54)
Female*Married	-0.35 (0.49)	0.91 (0.79)	0.58 (0.46)	-0.14 (0.46)	-0.15 (0.48)	0.13 (0.89)
Age	-0.02 (0.01)	-0.004 (0.02)	-0.004 (0.01)	-0.03 (0.01)**	-0.02 (0.01)*	-0.02 (0.02)
At least Primary	-0.04 (0.16)	-0.05 (0.20)	-0.07 (0.14)	-0.19 (0.17)	-0.20 (0.18)	0.20 (0.18)
Permanent worker		0.74 (0.14)***	0.54 (0.16)***			0.20 (0.47)
Formal sector				0.80 (0.21)***	0.69 (0.21)***	0.64 (0.27)**
Houshold Income	0.30 (0.09)***		0.21 (0.08)***		0.22 (0.09)**	0.22 (0.09)***
Own room	0.90 (0.22)***	0.46 (0.22)**	0.59 (0.23)***	0.78 (0.21)***	0.84 (0.21)***	0.80 (0.27)***
Hhold size	0.13 (0.04)***	0.07 (0.10)	0.07 (0.05)	0.15 (0.04)***	0.14 (0.04)***	0.13 (0.06)**
≤ 2 yrs in kibera	0.29 (0.33)	-0.29 (0.70)	-0.19 (0.31)	0.42 (0.31)	0.29 (0.33)	0.16 (0.51)
Kikuyu	0.99 (0.23)***	0.86 (0.19)***	0.85 (0.19)***	0.87 (0.23)***	0.88 (0.23)***	0.89 (0.22)***
Luhya	-0.15 (0.26)	0.05 (0.48)	-0.02 (0.24)	-0.25 (0.25)	-0.24 (0.26)	-0.21 (0.29)
Other	-0.11 (0.49)	0.04 (0.79)	-0.19 (0.41)	0.34 (0.44)	0.06 (0.47)	-0.01 (0.50)
Kamba	0.59 (0.32)*	0.84 (0.35)**	0.81 (0.25)***	0.39 (0.31)	0.52 (0.31)*	0.64 (0.40)
Kisii	0.37 (0.29)	0.36 (0.30)	0.32 (0.24)	0.27 (0.28)	0.27 (0.29)	0.29 (0.29)
Constant	-3.00 (1.30)**	-2.33 (0.59)***	-3.99 (0.65)***	0.18 (0.67)	-2.31 (1.15)**	-2.92 (1.91)
Log likelihood	-680.41	-682.77	-678.58	-678.48	-675.73	-675.63
No. Obs	373	373	373	373	373	373

Table 3 - Estimations of whether individual select into random or fixed order roscas[28]

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 more reliable individuals (those with a high s_i) are more likely to belong to random roscas. A final result is that members of the Kikuyu tribe are more likely to be in random roscas.

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

[28]The results are from a maximum-likelihood probit estimation with sample selection. To implement this we used the HECKPROB command in STATA. 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%.

	Decreasing Enforceability	No formalization	Decreasing Formalization	Increasing Risk
Female	-0.13 (0.27)	5.89 (1.11)***	0.63 (0.31)**	-0.42 (0.25)*
Married	-0.06 (0.46)	5.60 (1.59)***	0.20 (0.54)	-0.49 (0.32)
Female*Married	-0.29 (0.67)	-5.81 (1.76)***	-0.19 (0.78)	-1.11 (0.36)**
Age	-0.01 (0.01)	-0.03 (0.01)**	-0.02 (0.01)*	0.002 (0.01)
At least Primary	-0.14 (0.15)	-0.07 (0.17)	0.02 (0.14)	-0.05 (0.14)
Permanent worker	-0.03 (0.33)	0.27 (0.35)	0.33 (0.36)	-0.31 (0.17)**
Formal sector	0.56 (0.20)***	0.65 (0.21)***	0.40 (0.18)**	0.25 (0.16)
Household Income	0.10 (0.09)	-0.07 (0.08)	-0.02 (0.10)	0.22 (0.04)***
Own room	0.47 (0.19)**	0.43 (0.22)**	0.23 (0.21)	0.64 (0.19)***
Household size	0.11 (0.04)***	0.004 (0.04)	-0.05 (0.04)	0.03 (0.03)
≤ 2 yrs in kibera	-0.02 (0.32)	0.09 (0.37)	-0.26 (0.35)	0.22 (0.28)
Kikuyu	0.47 (0.19)**	0.60 (0.22)***	0.65 (0.20)***	0.03 (0.19)
Luhya	-0.08 (0.18)	-0.19 (0.24)	-0.05 (0.19)	0.10 (0.16)
Other	0.38 (0.30)	-0.41 (0.58)	-0.14 (0.42)	-0.18 (0.37)
Kamba	0.40 (0.25)	-0.30 (0.40)	-0.06 (0.30)	-0.17 (0.30)
Kisii	0.32 (0.27)	-0.18 (0.31)	-0.24 (0.23)	0.24 (0.19)
Log likelihood	-897.11	-691.49	-899.08	-789.49
No. Obs	373	373	373	373

Table 4 - Estimations of how people select into different types of roscas[29]

The first column of Table 4 is a direct attempt to estimate Conjecture 4. We construct an index which differentiates between roscas which allow members to change their order if necessary. We consider four types of roscas which we order as follows: fixed with no order change, fixed with order change, random with order change, and random without order change. The lowest value of the index corresponds to fixed roscas, where the allocation order can never be changed, and the highest value is random roscas where the allocation order cannot be changed if necessary. We consider this index to be increasing in the risk of default. We estimate an ordered probit with sample selection. The results are consistent with Conjecture 4 which states that the least reliable individuals belong to fixed order roscas with no changing order and the most reliable individuals belong to random roscas where changing order is possible.

The second and third columns compare the degree of formalization. The second column is a probit estimation, with sample selection, where the index variable is equal to one if the rosca has no formalization. The third column estimates an ordered probit, with sample selection, where the

[29]For the results in column two, we estimated a maximum-likelihood probit estimation with sample selection. To implement this we used the HECKPROB command in STATA. For the results in the other columns, we estimated an ordered probit model with sample selection using LIMDEP software.

highest value is attributed to no formalization. We see that individuals who work in the formal sector and own their living quarters are more likely to join roscas with no formalization. These results are consistent with Conjecture 2.

The final column in Table 4 considers an additional measure of the risk of default. Given our discussion in Section 3, we might consider that roscas with larger membership, longer cycles, and larger pots are more susceptible to defaulters. This index is constructed so that the highest value (i.e., the highest risk) is associated with roscas with high membership, long cycles, and large pots. In this case, individuals who are employed and own their living quarters are more likely to select into these high risk roscas. Alternative estimations, where each of these institutional aspects (membership, cycle length, pot, and contribution) are estimated independently are listed in Appendix D.

The results from Table 4 demonstrate, once again, that more reliable individuals select into roscas with more enforcement problems. Significant indicators of economic reliability include being a permanent employee in the formal sector and owning one's living quarters. Other measures of reliability include a larger household size, which is likely an indicator of permanence in the slum. Again members of the Kikuyu tribe are more likely to belong to roscas with more risk of default.

It would seem that more trustworthy individuals (in terms of job stability and permanence in Kibera) select into random roscas with more enforcement problems. This finding is in accord with our analysis of sections 2 and 3, where we argue that these types of roscas have higher benefits but are more difficult to enforce. What is also clear from the estimations above is that ethnic identity seems to play an important role. In particular, members of the Kikuyu tribe are more likely to select into risky roscas with higher benefits.[30] Nairobi forms part of the original land of the Kikuyu. They are a tribe known for their participation in the struggle for Independence. During the rule of the Kikuyu President Kenyatta (1963-1978), they were very favoured both politically and economically and they are still advantaged from an economic standpoint. In more recent times, they have been the target of ethnic violence and are often resented by other groups. These factors may contribute to more cohesive social bonds among tribe members and explain why they are able to sustain roscas without relying on formal structures.

[30] In addition to the results of Table 3, the estimations listed in Appendix C demonstrate that members of the Kikuyu tribe select into roscas with larger membership, longer cycles, larger pots, and higher contributions.

6.2. Sustainability

We now make an attempt to estimate the sustainability or roscas. Predictions on this issue are unclear. On the one hand, we would expect roscas which develop less enforcement mechanisms to encounter more problems and be less successful. On the other hand, if these roscas are composed of more reliable individuals, they should then be more successful. As a result, the overall outcome is determined by the relative strength of these two effects, and is therefore an empirical issue.

We list below some possible measures of success by rosca type. We consider the total time the rosca group has existed (in months) and the proportion of new members (termed growth). We also look at whether the group has encountered money problems, either in the form of theft or failure to make payments, and if they were able to solve these problems amongst themselves without relying on either outside intervention (for example, a village elder) or expulsion of members.

	All Roscas	Fixed Order	Random Order	No Formal	Med Formal	Full Formal
Time exist	28.86	27.59	31.88	21.76	21.86	38.00
	(35.79)	(27.54)	(50.31)	(19.36)	(18.57)	(48.52)
Growth	0.61	0.48	0.94	0.77	0.44	0.64
	(0.99)	(0.91)	(1.10)	(0.96)	(1.01)	(1.00)
money prob	0.39	0.31	0.59	0.47	0.26	0.44
	(0.49)	(0.46)	(0.49)	(0.50)	(0.44)	(0.50)
Solved	0.69	0.56	0.86	0.81	0.57	0.67
	(0.46)	(0.50)	(0.35)	(0.40)	(0.50)	(0.47)
No prob	0.51	0.61	0.27	0.37	0.67	0.49
	(0.50)	(0.49)	(0.45)	(0.48)	(0.47)	(0.50)
No. Obs	374	264	110	100	110	163

Table 5 - Measures of Success

Formal roscas have lasted the longest. Growth in membership is highest in random roscas. In accord with our analysis, random roscas and those with no formalization are more likely to have suffered money problems. To counter-act this, however, they are more likely to have solved these problems within their own group, resorting to only mild measures (approximately 9% of groups used expulsion). When we compare the statistics of the proportion of roscas with money problems to that of no problems, we see that money problems are clearly the most common problem these groups face. Other possibilities included problems of attendance, breaking or changing the rules, leadership, and rivalry.

If it is the case that random roscas and those with no formalization are still successful and able to solve enforcement problems, one wonders if these groups are relying on some form of social capital instead. In our sample of roscas, 68% are women only groups and 37% have formed groups along a single tribal group. These variables, especially the first one, may not mean much, given that 86% of rosca participants are women, it follows that the majority of groups include only women. Similarly, rosca groups may include individuals from just two ethnic groups instead of one, which would still imply they are forming roscas according to tribal identity. In any case, the table below lists the measures of success in terms of these indicators of social capital and some others which indicate with whom the group started.

	All women Roscas	Same ethnicity Roscas	Friends	Relatives	Neighbors	Same Profession
Time exist	27.24	33.29	27.24	34.21	21.34	27.95
	(25.11)	(48.01)	(24.75)	(38.61)	(20.18)	(31.27)
Growth	0.63	0.65	0.71	0.65	0.38	0.47
	(1.00)	(0.95)	(0.11)	(0.78)	(0.83)	(0.82)
money problems	0.37	0.47	0.46	0.31	0.31	0.33
	(0.48)	(0.50)	(0.50)	(0.47)	(0.46)	(0.48)
Solved within group	0.71	0.81	0.70	1.00	0.62	0.57
	(0.46)	(0.39)	(0.46)	(0)	(0.49)	(0.51)
No problems	0.54	0.43	0.43	0.62	0.60	0.59
	(0.50)	(0.50)	(0.50)	(0.49)	(0.49)	(0.50)
No. Observations	249	138	208	29	80	42

Table 6 - Measures of Success and social capital indicators

Roscas organized along tribal lines and with relatives have lasted the longest. Those which started with friends or relatives have increased in size significantly compared to those which began with neighbors or co-workers. Roscas of the same ethnicity or comprised of friends have suffered the most problems. Yet at the same time those of the same ethnicity are able to better solve their problems and those comprised mainly of relatives were always able to do so, though this latter sample is very small.

We list below the results from estimations on the measures of success, where indicators of social capital and the different structural aspects of roscas are included as regressors. The degree of formalization is likely an endogenous variable. Since, for example, if a group suffered money problems in the past, they are more likely to have developed more rigid rules to address this problem. However, the Hausman test rejected this possible endogeneity and the main results are unchanged if we estimate using instrumental variables instead.

	Time exist	Growth	Money Prob.	No Prob	Solved Prob.
Random Order	1.42	0.26**	0.23***	-0.24***	0.23**
	(4.28)	(0.12)	(0.07)	(0.07)	(0.10)
Same ethnic	2.20	-0.03	0.11**	-0.14**	0.17**
	(3.60)	(0.10)	(0.06)	(0.06)	(0.08)
Women only	-0.03	0.30***	-0.04	0.07	0.15
	(3.76)	(0.11)	(0.06)	(0.06)	(0.10)
Same prof	0.27	-0.30*	-0.09	0.16*	-0.03
	(5.50)	(0.16)	(0.08)	(0.09)	(0.15)
Neighbor	-2.93	-0.13	-0.04	0.03	0.06
	(4.28)	(0.12)	(0.07)	(0.07)	(0.10)
Relative	15.43**	0.09	-0.13	0.16	
	(6.43)	(0.18)	(0.09)	(0.10)	
No formal	-5.11	0.08	0.03	-0.15**	0.14
	(4.33)	(0.13)	(0.07)	(0.07)	(0.10)
Change rank	-3.39	0.23**	0.03	-0.02	-0.19*
	(4.17)	(0.12)	(0.07)	(0.07)	(0.08)
Pot	-6.7e-4*	5.1e-5***	-4.1e-6	-3.6e-6	1.8e-5
	(3.9e-4)	(1.1e-5)	(6.8e-6)	(7.8e-6)	(1.3e-5)
# Memb	0.63***	0.02***	0.005*	-0.01***	0.001
	(0.20)	(0.01)	(0.003)	(0.004)	(0.005)
Cycle	0.05***	-2.6e-4	1.2e-4	-2.9e-7	2.3e-4
	(0.01)	(3.2e-4)	(1.9e-4)	(2.0e-4)	(3.0e-4)
Constant	11.7**	-0.29*			
	(5.76)	(0.17)			
$\overline{R}^2$	0.23	0.18	0.08	0.12	0.21
No. Obs	366	366	366	366	133

Table 7 - Estimations of Measures of Success[31]

¿From the above table it would seem that random roscas and those made up of only women are more successful in terms of growth. On the other hand, random roscas and those organized along ethnic lines are more likely to suffer problems, though they are also more able to solve them within their groups. Roscas with no formalization and those with large memberships are also more likely to have problems. Both time existed and growth are strongly correlated with membership and growth is also higher the larger the size of the pot.[32]

[31]The first two estimations use ordinary least squares. The final three are probit estimations where the coefficients reported are the derivatives of the probit function evaluated at the sample means.

[32]We did not interact the possibility of changing ranks with random order because our sample of random roscas where it is not possible to change ranks is too small.

7. Conclusion

It is typically assumed that informal groups rely on social sanctions to solve their enforcement problems. In contrast, this paper asks whether the actual institutional features of these groups are chosen in some part to prevent members from defaulting on their responsibilities. There seems to be some evidence in favour of our hypothesis since the more reliable individuals tend to participate in roscas with features that are more susceptible to enforcement problems. In particular, reliable individuals tend to belong to roscas where the order of the ranks is randomly drawn at each cycle and where members can request to change their rank in case of necessity. These roscas also tend to have a less formal structure in terms of written rules and hierarchical organization.

There is also evidence that these unstructured roscas not only depend for their success on the reliability of these individuals in terms of job stability and permanence in the slum, but also on their social capital via their tribal connections. This latter relationship falls into the category of social sanctions but is distinct from the previous literature which focused on expulsion from the group as punishment. In contrast, we demonstrate that theoretically this sanction in itself is never a sufficient deterrent for rosca members and empirically, when rosca groups did suffer problems, very few groups turned to expulsion measures to solve the problem.

8. Appendix A: Temporal Expected Utility[33]

In this section, we provide an example of the temporal expected utility preferences framework as developed by Kreps and Porteus (1978) and Epstein and Zin (1989). To do this in simple terms, consider a two-member rosca which lasts for two cycles. To simplify further the discussion, assume that, within a cycle, the utility of a member with the first rank is $u(c_1)$, while that of the member with the second rank is $u(c_2)$, where $u(c_1) > u(c_2)$. Consider now a random rosca, where ranks are redrawn at the beginning of each cycle. In each cycle, each member faces a fifty percent chance of being first, and a fifty percent chance of being second. Hence, the certainty equivalent associated with the within cycle risk is equal to $u^{-1}\left(\frac{1}{2}u(c_1) + \frac{1}{2}u(c_2)\right)$. We now introduce another utility index, $v(.)$, to evaluate intertemporal consumption and a discount factor $\beta \in (0, 1]$. The utility level associated with the random rosca can then be written as:

$$\begin{aligned} U_r &= v \circ u^{-1}\left(\frac{1}{2}u(c_1) + \frac{1}{2}u(c_2)\right) + \beta v \circ u^{-1}\left(\frac{1}{2}u(c_1) + \frac{1}{2}u(c_2)\right) \\ &= (1+\beta)\, v \circ u^{-1}\left(\frac{1}{2}u(c_1) + \frac{1}{2}u(c_2)\right) \end{aligned}$$

Now consider the fixed order rosca, where ranks are randomly allocated once and for all, so that there all the uncertainty about the second cycle is resolved in the first period. At the beginning of the first cycle, each member has a probability one-half of being first in the two cycles, and a probability one-half of being second. The utility of a fixed rosca can then be written:

$$U_f = v \circ u^{-1}\left(\frac{1}{2}u(c_1) + \frac{1}{2}u(c_2)\right) + \beta\left(\frac{1}{2}v \circ u^{-1}(u(c_1)) + \frac{1}{2}v \circ u^{-1}(u(c_2))\right)$$

A random order rosca is preferred to a fixed order rosca iff $U_r > U_f$. In the homothetic preference case where

$$u(c) = c^{1-\alpha} \quad and \quad v(c) = c^{1-\rho},$$

$U_r > U_f$ if and only if $\rho > \alpha$, where α is the constant coefficient of relative risk aversion (within periods), and $\frac{1}{\rho}$ is the elasticity of intertemporal substitution. Hence, the more substitutable utility flows are across periods compared to within cycle risk aversion, the lower the level of risk aversion across periods, and the more likely it is that members prefer a fixed rosca (since the expected utility of the first period differs from the ex post utility in the second period). On the other hand, if consumption flows are strong complements across periods (if risk aversion across periods is strong) then members should prefer a random rosca (as expected utility are the same across the two periods).

[33] This appendix owes much to an in-depth discussion with Simon Grant, who provided us with the basis of the illustration presented here. Refer to his early work, Grant, Kajii, and Polak (1998), for a formal exposition.

9. Appendix B: 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 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_i for the amount reimbursed to a member in period i. The budget constraint implies that: $\sum_{i=1}^{n} f_i = 0$. The expected utility of a member joining a rosca with a fee can be written as:

$$E(U(Fee)) = \left(\frac{n-1}{n}\left(\sum_{i=1}^{n}\delta^i u(c_R + f_i, 0)\right) + \frac{1}{n}(\delta^1 + \delta^2 + ... + \delta^n)\left(u(c_R + f_i, 1) - u(c_R + f_i, 0)\right)\right) + \delta^{n+1}E(U(Fee))$$

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 $f_j \geq 0$ for $j = 2, ...n$. 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:

$$E(U(Fee)) = U(c_t^*)$$

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 utility is equal to:

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

where the last inequality follows from the fact that, as the fee is smaller than the pot, members must still save in net over the periods 2 to n. 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: $c_R + f_i < y$ for $j = 2, ...n$. The inequality demonatrates 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 C: Data methodology

1. 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.

2. Definitions of Key Variables

Household income: Sum of individual income from any income generating activity (includes both formal and informal sector labor and self-employment) across all working household members.

Decreasing Formalization: Index variable equal to: 0 if rosca has both a governing body and written rules; 1 if rosca has either a governing body or written rules; and 2 if has neither.

Decreasing Enforceability: Index variable equal to: 0 if rosca has fixed order and order cannot change in case of need; 1 if rosca has fixed order and order can change in case of need; 2 if rosca has random order and order can change in case of need; and 3 if rosca has random order and order cannot change in case of need.

Increasing Risk: Index variable equal to: 0 if rosca has low (less than or equal to the median) membership, cycle length, and pot size; 2 if rosca has high (greater than the median) membership, cycle length, and pot size; and 1 otherwise.

Growth: [Number of new members - Number of members left]/[Total members - (Number of new members - Number of members left)]

11. Appendix D: Additional Estimations

	Membership	Cycle length	Pot	Contribution
Female	0.08 (0.20)	0.13 (0.28)	-0.09 (0.31)	-0.23 (0.29)
Married	0.29 (0.22)	-0.12 (0.30)	-0.05 (0.35)	-0.29 (0.33)
Female*Married	-0.33 (0.28)	-0.02 (0.36)	-0.07 (0.44)	0.17 (0.41)
Age	0.01 (0.005)**	0.02 (0.01)**	0.01 (0.01)	0.001 (0.01)
At least Primary	-0.13 (0.07)**	0.07 (0.12)	0.23 (0.13)*	0.36 (0.13)***
Permanent worker	-0.05 (0.11)	0.27 (0.14)*	0.45 (0.18)**	0.44 (0.15)***
Formal sector	-0.08 (0.09)	0.16 (0.16)	0.04 (0.18)	0.14 (0.17)
Hhold. income	0.03 (0.04)	-0.02 (0.05)	0.12 (0.06)**	0.09 (0.06)
Own room	0.11 (0.10)	0.24 (0.17)	0.52 (0.20)***	0.42 (0.21)**
Hhold size	0.03 (0.02)*	0.07 (0.03)**	0.04 (0.04)	0.01 (0.04)
≤ 2 yrs in kibera	0.15 (0.13)	-0.12 (0.24)	-0.17 (0.27)	-0.28 (0.24)
Kikuyu	0.16 (0.10)	0.34 (0.17)**	0.51 (0.19)***	0.34 (0.19)*
Luhya	-0.06 (0.09)	0.29 (0.16)*	0.29 (0.20)	0.35 (0.19)*
Other	-0.21 (0.17)	-0.29 (0.40)	-0.33 (0.43)	-0.09 (0.38)
Kamba	-0.10 (0.15)	0.35 (0.26)	0.22 (0.26)	0.27 (0.23)
Kisii	0.22 (0.11)**	0.44 (0.18)**	0.58 (0.21)***	0.36 (0.24)
Constant	1.79 (0.47)***	3.55 (0.64)***	5.23 (0.80)***	3.68 (0.66)***
λ	-0.02 (0.14)	0.32 (0.14)	0.25 (0.22)	0.16 (0.14)
Log likelihood	-830.17	-1056.80	-1095.48	-1085.89
No. Obs	373	373	373	373

Table 8 - Estimations of structural aspects of roscas[34]

[34] The dependent variables are in logs. The Heckman two stage approach is used where female income share identifies the sample selection equation. Robust standard errors are in parentheses.

12. Appendix E: Alternative Estimations

The table below lists identical estimations to those in Section 6.1 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.

	Random	Decreasing Enforceability	No formalization	Decreasing Formalization	Increasing Risk
Female	-0.09 (0.12)	-0.12 (0.32)	0.44 (0.04)***	0.62 (0.27)**	-0.12 (0.28)
Married	-0.16 (0.14)	-0.09 (0.33)	0.80 (0.07)***	0.31 (0.31)	0.06 (0.33)
Female*Married	-0.01 (0.14)	-0.23 (0.37)	-0.99 (0.01)***	-0.37 (0.36)	-0.31 (0.38)
Age	-0.01 (0.004)*	-0.01 (0.01)	-0.01 (0.003)***	-0.02 (0.01)**	0.02 (0.01)*
At least Primary	-0.07 (0.06)	-0.14 (0.13)	-0.02 (0.04)	0.02 (0.14)	-0.10 (0.14)
Permanent worker	0.03 (0.06)	0.002 (0.13)	0.08 (0.04)*	0.25 (0.14)*	0.23 (0.15)
Formal sector	0.24 (0.08)***	0.56 (0.17)***	0.18 (0.07)***	0.41 (0.19)**	0.20 (0.20)
Hhold. inc	0.07 (0.03)**	0.09 (0.06)	-0.02 (0.02)	0.01 (0.06)	0.20 (0.07)***
Own room	0.30 (0.08)***	0.46 (0.19)**	0.11 (0.06)**	0.24 (0.19)	0.74 (0.19)***
Hhold size	0.04 (0.01)***	0.11 (0.03)***	-0.0001 (0.01)	-0.05 (0.03)	0.0004 (0.04)
≤ 2 yrs in kibera	0.09 (0.11)	-0.05 (0.25)	0.01 (0.08)	-0.19 (0.26)	-0.20 (0.20)
Kikuyu	0.32 (0.08)***	0.47 (0.21)**	0.17 (0.07)***	0.63 (0.20)***	0.10 (0.20)
Luhya	-0.07 (0.08)	-0.08 (0.17)	-0.04 (0.05)	0.03 (0.17)	0.20 (0.20)
Other	0.01 (0.16)	0.37 (0.47)	-0.08 (0.08)	-0.13 (0.32)	-0.49 (0.38)
Kamba	0.21 (0.12)**	0.42 (0.29)	-0.06 (0.07)	-0.10 (0.24)	0.15 (0.26)
Kisii	0.10 (0.11)	0.32 (0.20)	-0.04 (0.06)	-0.25 (0.24)	0.34 (0.28)
Log likelihood	-164.08	-370.16	-179.92	-371.31	-267.21
$\overline{R}^2$	0.27	0.10	0.17	0.07	0.13
No. Obs	373	373	373	373	373

Table 9 - Esimations without sample selection[35]

[35]Columns 1 and 3 are probit estimations, where the coefficients reported are the derivatives of the probit function evaluated at the sample means. The other columns are ordered probit estimations.

The table below lists similar estimations to those above but including the instruments of the the first stage sample selection equation. The first column reports the results from the estimation of the sample selection rule.

	Rosca Participation	Random	Decreasing Enforceability	No formalization	Decreasing Formalization	Increasing Risk
Female	0.26 (0.04)***	-0.08 (0.12)	-0.09 (0.32)	0.44 (0.04)***	0.61 (0.27)**	-0.08 (0.29)
Married	-0.16 (0.06)***	-0.15 (0.14)	-0.07 (0.34)	0.80 (0.07)***	0.30 (0.32)	0.15 (0.34)
Female*Married	0.34 (0.08)***	-0.02 (0.16)	0.09 (0.42)	-0.99 (0.01)***	-0.34 (0.39)	-0.82 (0.42)
Female inc. share	0.67 (0.24)***	0.20 (0.39)	0.17 (0.91)	-0.04 (0.29)	-0.26 (0.87)	2.16 (0.95)**
$(\text{Female inc. share})^2$	-0.80 (0.28)***	-0.43 (0.44)	-1.44 (1.08)	-0.21 (0.34)	0.33 (0.91)	-1.42 (1.11)
Age	0.01 (0.002)***	-0.01 (0.004)	-0.005 (0.01)	-0.01 (0.002)***	-0.02 (0.01)**	0.02 (0.01)*
Primary	-0.003 (0.03)	-0.07 (0.06)	-0.15 (0.12)	-0.02 (0.04)	0.02 (0.13)	-0.09 (0.14)
Permanent	0.25 (0.04)***	0.03 (0.06)	0.06 (0.16)	0.09 (0.05)*	0.26 (0.16)*	0.02 (0.15)
Formal	-0.08 (0.04)**	0.24 (0.08)***	0.57 (0.17)***	0.18 (0.07)***	0.42 (0.19)**	0.16 (0.20)
Hhold. inc	0.01 (0.01)	0.07 (0.03)**	0.11 (0.06)*	-0.01 (0.02)	0.01 (0.07)	0.17 (0.08)**
Own room	-0.06 (0.04)	0.31 (0.08)***	0.54 (0.20)***	0.12 (0.06)**	0.25 (0.19)	0.69 (0.20)***
Hhold size	-0.02 (0.01)***	0.04 (0.01)***	0.10 (0.03)***	-0.001 (0.01)	-0.04 (0.03)	0.002 (0.04)
≤ 2 yrs in kibera	-0.17 (0.03)***	0.08 (0.10)	-0.09 (0.25)	0.01 (0.01)	-0.19 (0.26)	-0.15 (0.21)
Kikuyu	0.03 (0.04)	0.31 (0.08)***	0.44 (0.21)**	0.17 (0.07)***	0.63 (0.20)***	0.11 (0.20)
Luhya	0.06 (0.04)	-0.07 (0.08)	-0.09 (0.17)	-0.04 (0.05)	0.03 (0.17)	0.21 (0.20)
Other	-0.11 (0.05)*	0.01 (0.16)	0.36 (0.47)	-0.08 (0.08)	-0.12 (0.32)	-0.52 (0.39)
Kamba	0.27 (0.08)***	0.22 (0.12)**	0.49 (0.30)	-0.05 (0.07)	-0.11 (0.24)	0.15 (0.24)
Kisii	0.05 (0.06)	0.10 (0.11)	0.34 (0.20)*	-0.04 (0.07)	-0.25 (0.24)	0.34 (0.28)
Log likelihood	-511.58	-163.36	-365.78	-179.25	-371.26	-262.90
$\overline{R}^2$	0.32	0.28	0.11	0.17	0.07	0.14
No. Obs	1220	373	373	373	373	373

Table 10 - Estimations with instruments

¿From the above table, we see that the main results of Section 6.1 are generally robust to the inclusion of these additional variables. The main variable used as an instrument for the sample selection equation, female income share, is insignificant in all the estimations except that in Column 6.

Column 3 shows that there is some evidence that married females are more likely to belong to roscas with more formalization. This is somewhat consistent with our discussion in Section 2.4 where we argued that enforcement problems may even be more severe for married women if, in accord with our previous work (Anderson and Baland 2002), they join roscas to protect their savings against claims by their husbands for immediate consumption.

References

[1] Anderson, Siwan and Jean-Marie Baland, "The Economics of Roscas and Intra-household Resource Allocation", *Quarterly Journal of Economics*, 117(3), August 2002, p. 963-995.

[2] Ardener, Shirley, "The Comparative Study of Rotating Credit Associations", *Journal of the Royal Anthropological Institute of Great Britain and Ireland,* XCIV (1964), 202-229.

[3] Ardener (1995) "Women making money go round: roscas revisited", p. 1 -19 in *Money-go-rounds: The importance of Rotating Savings and Credit Associations for Women,* Ardener, S. and S. Burman (eds) , BERG, Washington DC

[4] Banerjee, Abihijit., Timothy Besley, and Timothy Guinnane, "Thy Neighbor's Keeper: The Design of a Credit Cooperative with Theory and a Test", *Quarterly Journal of Economics,* 109 (2), 1994, p. 491-515.

[5] Besley, Timothy, "Savings, Credit and Insurance", Jere Behrman and T.N. Srinivasan, eds. *Handbook of Development Economics, Volume III* (Amsterdam: North-Holland, 1995), 2123-2207.

[6] Besley, Timothy, Stephen Coate, and Glenn Loury,"The Economics of Rotating Savings and Credit Associations", *American Economic Review,* LXXXIII (1993), 792-810.

[7] Besley, Timothy, Stephen Coate, and Glenn Loury "Rotating Savings and Credit Associations, Credit Markets and Efficiency", *Review of Economic Studies,* LXI (1994), 701-719.

[8] Besson, Jean "Women's Use of Roscas in the Caribbean: Reassessing the Literature", Shirley Ardener and Sandra Burman, eds. *Money-go-rounds: the Importance of Rotating Savings and Credit Associations for Women* (Washington D.C.: BERG,1995), 263-288.

[9] Bonnett, Aubrey, *Institutional Adaptation of West Indian Immigrants to America: an Analysis of Rotating Credit Associations.* (Washington, D.C.: University Press of America, 1981).

[10] Bouman, Fritz, "Indigenous Savings and Credit Societies in the Third World: A Message" *Savings and Development,* I (1977), 181-218.

[11] Bouman, Fritz, "Rotating and Accumulating Savings and Credit Associations: a Development Perspective", *World Development* XXIII (1995), 371-384.

[12] Epstein, Larry and Stanley Zin, "Substitution,Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework", *Econometrica*, 57(4), July 1989, p. 937-69.

[13] Fernando, E. (1986) "Informal Credit and Savings Organizations in Sri Lanka: the Cheetu System" *Savings and Development*, volume 10, no. 3. p. 253-263.

[14] Geertz, Clifford, "The Rotating Credit Association: a 'Middle Rung' in Development". *Economic and Development and Cultural Change,* X (1962), 241-263.

[15] Grant, S., A. Kajii, and B. Polak, "Instrinsic Preference for Information". *Journal of Economic Theory,* 83(2), 1998, p. 233-259.

[16] Gugerty, Mary Kay, "You Can't Save Alone: Testing Theories of Rotating Saving and Credit Associations". mimeo, Harvard University, 2000.

[17] Handa, Sudhansu and Claremont Kirton, "The Economics of Rotating Savings and Credit Associations: Evidence from the Jamaican 'Partner"', *Journal of Development Economics,* LX *(1999), 173-194.*

[18] Klonner, Stefan,"Rotating Savings and Credit Organizations as Insurance", *International Economic Review*, 2003 (forthcoming).

[19] Kovsted, Jens and Peter Lyk-Jensen, "Rotating Savings and Credit Associations: the Choice Between Random and Bidding Allocation of Funds", *Journal of Development Economics,* LX *(1999), 143-172.*

[20] Kreps, David and Evan Porteus, "Temporal Resolution of Uncertainty and Dynamic Choice Theory", *Econometrica*, 46(1), 1978, p. 185-200.

[21] Kurtz, Donald, "The Rotating Credit Association: an Adaptation to Poverty", *Human Organization*, XXXII (1973), 49-58.

[22] Light, Ivan and Deng Zhong, "Gender Differences in Rosca Participation within Korean Business Households in Los Angeles", Shirley Ardener and Sandra Burman, eds. *Money-go-rounds: the Importance of Rotating Savings and Credit Associations for Women* (Washington D.C.: BERG,1995), 217-240.

[23] Miyanaga, Kuniko, "Economic Kou (Roscas) in Japan: a Review", Shirley Ardener and Sandra Burman, eds. *Money-go-rounds: the Importance of Rotating Savings and Credit Associations for Women* (Washington D.C.: BERG,1995), 149-162.

[24] Srinivasan, Shaila, "Roscas among South Asians in Oxford", Shirley Ardener and Sandra Burman, eds. *Money-go-rounds: the Importance of Rotating Savings and Credit Associations for Women* (Washington D.C.: BERG,1995), 199-208.

[25] Summerfield, Hazel, "A Note on Roscas among Northern Somali Women in the United Kingdom", Shirley Ardener and Sandra Burman, eds. *Money-go-rounds: the Importance of Rotating Savings and Credit Associations for Women* (Washington D.C.: BERG,1995), 209-215.

[26] Tsai, Kellee, "Banquet Banking: Gender and Rotating Savings and Credit Associations in South China", *The China Quarterly*, CLXI(2000), 142-170.

[27] van den Brink, Rogier and Jean-Paul Chavas "The Microeconomics of an Indigenous African Institution: The Rotating Savings and Credit Association", *Economic Development and Cultural Change,* XLV (1997), 745-772.