Why use ROSCAs when you can use banks?
Theory, and evidence from Ethiopia•

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Abstract

Much of the existing literature on the use of informal credit arrangements such as ROSCAs (Rotating Saving and Credit Associations) theorises that the use of such institutions arises from market failures in the development of formal saving and credit mechanisms. As economic development proceeds, formal institutions might therefore be expected to displace ROSCAs. We show, using household data for Ethiopia that in fact use of formal institutions and ROSCAs can co-exist, even within the same household. We examine usage of both formal and informal institutions across the household income gradient, and provide a theoretical model consistent with these empirical facts.

Key Words: Household saving Credit institutions ROSCAs Ethiopia

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1. Introduction

Rotating Saving and Credit Associations (ROSCAs) are informal saving and credit institutions that are pervasive in developing countries and among immigrant communities in some developed countries. In ROSCAs, groups of individuals voluntarily pool their regular savings, with disbursements determined either by random draw or bidding until every member has received the 'pot'. The economics literature on ROSCAs, which has expanded apace since the seminal contributions of Besley *et al.* (1993, 1994), has typically rationalised the existence of ROSCAs as informal responses to diverse financial market failures that are deemed commonplace in developing countries and among immigrant communities in developed economies.[1] These market failures are assumed to constrain poor people's access to both credit markets and to formal instruments of saving, such as bank accounts. The existence of ROSCAs is thereby explained by identifying different ways in which such institutions mitigate these financial constraints, even if in limited, second best, fashion.

If ROSCAs are rationalised as responses to the failure of formal financial markets, then ROSCAs should tend to be displaced during the process of economic development; indeed their continued existence among some communities in economies with access to formal banking and other credit /saving institutions would be a mystery. The question of who is more likely to participate in, and thereby benefit from, ROSCAs in a world where formal credit and saving institutions also exist is, therefore, a topic of great interest. In contrast, in a stylized world where ROSCAs are the only instrument available for both saving and borrowing, such as that typically considered in the existing theoretical literature, this question is evidently redundant.

One plausible suggestion is that, even within a developed economy with formal credit institutions, certain households, such as those with low incomes, might face major credit constraints due to the absence of collateral. Consequently they would not be able to access formal credit institutions and would be the residual users of informal institutions such as ROSCAs. As this paper shows however, using evidence from urban Ethiopia where formal and informal credit and saving institutions co-exist, this delineation of users by income status is wide of the mark. Some households

[1] In the models of Besley *et al.* (1993, 1994), ROSCAs solve the indivisibility problem associated with purchases of lumpy goods in the absence of credit markets, by allowing participants to benefit from pooling their savings (see also Levenson and Besley 1996; and Besley and Levenson 1996). Empirical evidence by Handa and Kirton (1999) supports this view. Other contributors point to market failures associated with insurance motives to rationalise the existence of ROSCAs, where such institutions allow insurance against adverse wealth shocks (Calomiris and Rajaraman 1998), or permit individuals to negotiate contracts in the presence of information asymmetries (Klonner 2003). A further strand of the literature places ROSCAs in their social context, as institutions that allow individuals to fulfil mutual social obligations (Ambec and Treich 2003; Dagnelie and LeMay-Boucher 2012) or serve as a vehicle for saving in households where there are resource allocation conflicts (Anderson and Baland 2002).

appear neither to access informal institutions such as ROSCAs nor formal saving and credit institutions, whilst others use both formal and informal saving and credit institutions (ROSCAS and banks). While such differential use may be in part related to heterogeneous preferences, we also show that usage of both sets of institutions is related to the income gradient in a systematic fashion, albeit not in the manner hypothesised by the existing literature. This requires an alternative theorisation of how income levels affect ROSCA participation, which is provided in the present paper.

The line of investigation that we wish to explore has an intuitive entry point. Poor households, like other investors, tend to choose portfolios that balance return and risk (e.g. Collins *et al*. 2009). Interest-paying bank savings deposits provide a relatively low-yield, but also relatively safe, instrument of investment for poor people. Random draw ROSCAs, in contrast, are inherently risky investments. The basic source of uncertainty in a random ROSCA is the randomness in the timing of the payout of the ROSCA savings/funds. Since ROSCAs do not pay interest as such, a late payout implies the loss of the interest income that a bank deposit would have generated. However, given borrowing constraints, an early ROSCA payout provides the major source of financing for lumpy but high yield investment in capital goods, including consumer durables. Thus, ROSCA investment is risky but high yield, whereas investment in bank deposits is safe but low yield.

The ensuing problem for a household which cannot borrow is to allocate its savings between these two investment instruments. The problem thus becomes one of straightforward investment-portfolio diversification. Analogously, when the purchase of capital assets constitutes an inherently risky investment, formal (bank) credit generates both higher expected returns (because the asset can be purchased for sure) and higher risk (because the loan has to be repaid even in case of investment failure, which becomes more likely with certain purchases) compared to ROSCA financing (which, in effect, involves risk sharing). Thus, access to formal credit need not necessarily preclude ROSCA participation: ROSCA loans may co-exist with, or indeed displace, formal credit when households are risk averse. There is an intuitive parallel here with a limited literature on credit-constrained individuals engaging in risky strategies such as purchase of lottery tickets to overcome indivisibilities in consumption (Ng 1965; Crossley *et al.* 2011).[2]

We accordingly set up a simple model of ROSCA participation where a risk-averse household has to allocate a given amount of savings between a risky but high yield ROSCA and a safe but low yield bank deposit. The ROSCA is risky due to uncertainty over its payout timing, but early payout provides the household with a lump-sum that can be invested in a high yield capital asset, provided this lump-sum is larger than some threshold amount. This investment threshold captures indivisibilities and lumpiness in capital assets. It immediately follows that households with savings

[2] Note also that empirical studies of lotteries generally have data on the behaviour of winners, rather than whether an individual plays the lottery. As shown below, our data are able to show both the propensity to engage in a ROSCA and the level of contribution (saving). Our theoretical framework is also quite different.

large enough to permit direct purchase of the capital good will use neither ROSCAs nor bank deposits as investment outlets, but instead invest directly in the capital good. We identify such households as wealthy households. The investment strategy of poorer households would depend on how risk aversion interacts with the higher expected returns that ROSCAs potentially offer. We show that, given the conjunction of increasing relative risk aversion and diminishing absolute risk aversion, the following pattern is likely to arise. Households are likely to hold only ROSCA accounts at low levels of wealth. However, they will come to save in bank accounts, in addition to ROSCA accounts, once their wealth crosses a certain threshold. Thereafter, bank savings and ROSCA savings are *both* likely to increase with wealth till the household can afford direct investment in a capital asset. Thus, at intermediate levels of wealth, ROSCA participation and simultaneous holding of ROSCA and bank accounts are both likely to be positively correlated with wealth. Households are however likely to use only ROSCA accounts as investment vehicles at low levels of wealth. We also sketch, via a simple example, how our theoretical analysis may be extended to permit access to formal credit: risk aversion may induce households to abjure formal credit in favour of ROSCA credit.

We proceed to offer empirical validation of our theoretical conclusions using data from a panel survey of households in urban Ethiopia (1994-2004). Ethiopian ROSCAs (*equb*) predominantly allocate pay-offs by random draw. Using both parametric and non-parametric techniques, we find that the proportion of respondent households that has ROSCA membership increases with income over an intermediate range. A significant proportion of households hold both ROSCA and bank accounts,[3] and this proportion increases with income over an intermediate range as well. Specifically, the proportion of households saving in ROSCAs shows a quadratic relationship with income: this proportion first rises and subsequently falls. The proportion of households saving in both ROSCAs and bank accounts exhibits a similar relationship with income. Thus, our empirical results support our theoretical conclusions, and our theoretical analysis appears to provide the most plausible and parsimonious rationalization of our empirical findings. Our analysis suggests that formal institutions and ROSCAs provide somewhat different *economic* functions, and that it is financial considerations that explain the co-existence (i.e. simultaneity of savings both in the formal and informal financial institutions) of these different savings vehicles in the household portfolio. Our theoretical analysis leads us to argue further that lack of access to formal credit *per se* is not necessary to explain this co-existence: it is rather the absence of formal instruments for sharing of investment risk, such as equity participation and insurance, that provides the conceptual key.

The remainder of the paper is structured as follows. Section 2 provides some relevant institutional details before setting up our model of ROSCA participation. Section 3 outlines our empirical strategy, followed by details of the data used. Section 4 presents our empirical findings. Section 5 concludes. Detailed proofs are presented in the Appendix.

[3] Carpenter and Jensen (2002) report a similar finding for Pakistan.

2. ROSCAs as vehicle for portfolio diversification

2.1. Background

Existing models of ROSCAs do not emphasise that such institutions provide an investment vehicle with a risky but potentially high return, relative to a deposit account at a saving bank paying a known return. Typically through the late 1990s and early 2000s, the nominal annual interest rate on saving deposits in Ethiopia was fairly stable at around 6%, falling somewhat towards the end of the period. Inflation was more volatile than nominal interest rates, with year-on-year fluctuations and considerable seasonality, but average returns on deposits were positive, albeit low, over the period. Formal sector borrowing typically incurred a minimum additional premium of 4% above the deposit rate, reflecting an average nominal rate of return of more than 10% on direct investment in capital assets.[4] Thus, ROSCA payouts could yield a much higher return than bank deposits, if used to purchase capital assets (including consumer durables) or shares in businesses.

In our urban household survey for Ethiopia, 60-80% of the respondents did indeed report objectives such as purchasing capital assets and participating in a business venture as their reasons for joining a ROSCA. In the 1994 and 1995 waves of the survey, 55-60% of participants reported their purpose of ROSCA membership to be the purchase of household durables; this proportion was 40% in the 2000 wave. In addition, around 20% of the sample consistently reported joining the ROSCA to obtain capital to start or develop a small business. This typically involved using ROSCA payouts to purchase stocks of goods for street vending, or more ambitious projects such as accumulating funds in order to purchase, or make a down payment on, a taxi. Indeed 'taxi *equbs*' ('*equb*' being a local term for ROSCAs) are a well-known phenomenon among urban ROSCA participants in Ethiopia. Other uses of funds from *equb* pay-outs that are documented include the purchase and resale of second hand cars, and the establishment of small retail outlets such as tea stalls and coffee shops.[5]

Investing in a ROSCA however involves several potential uncertainties. The basic source of uncertainty in a random ROSCA is the timing of the return in the form of the payout. A typical ROSCA in urban Ethiopia has monthly contributions and draws (although weekly ROSCAs are also not uncommon) and lasts for a cycle of around 2 years, implying that the membership of a ROSCA averages around 24 people. For a typical ROSCA monthly contribution of 30 Ethiopia *birr*,[6] the best case scenario therefore for an investor is an initial lump-sum payout of 720 *birr*, which would yield an

[4] See IMF *International Financial Statistics*, January 2006, Washington DC.

[5] In a similar vein, it is common for communities or groups to raise sufficient capital to purchase an expensive means of transportation as a solution to mobility problems in least developed regions such as Sub-Saharan Africa (World Bank 1996, p. 26). Note that in the other available wave of the Ethiopian urban survey, 1997, the proportion reporting the durable purchase motive is far lower, but we ascribe this to a coding error during the transfer of the data to an electronic format.

[6] This is the average contribution to a ROSCA, taken from the 2000 wave of the Ethiopian urban household survey. 1 US $ = 18 Ethiopian *birr*. Monthly contributions may average rather more since weekly ROSCAs tend to require smaller contributions and we are averaging over ROSCAs with different characteristics.

income of about 90 *birr* if invested in a saving deposit for two years, but possibly much more if invested directly in a capital asset for the same period. The worst case scenario is of course one where the investor receives the pay-out in the last round, i.e., at the end of the cycle, thereby achieving a zero nominal return after two years and a negative real return on the investment. This is the risk that we shall highlight in our formal model of ROSCA participation in Section 2.2 below.

Uncertainty also stems from the possibility of a low payout from the ROSCA arising from depletion of members as the early 'winners' opt not to continue their contributions (i.e. defaulting). Social pressures, reflected in the self-selection of ROSCA members from among relatives, friends, or work colleagues should reduce this risk, but this systemic risk may be harder to avoid in the more anonymous urban environment than in a close-knit village setting.

The third source of uncertainty arises from the intended uses of funds drawn from ROSCAs, and whether payouts in practice allow participants to implement their objectives. If the participant has in mind a specific durable purchase, then the risks attached to this investment strategy arise from any subsequent limit on availability of the good in question, along with inflation risk (especially if the good is imported where this risk also incorporates exchange rate risk). With investment-oriented motives, there is the real possibility that the ROSCA disbursement, whenever it occurs, may not be sufficient to realise the planned investment opportunity, quite apart from the possibility that the venture itself may be successful or unsuccessful. If insufficient, participants may buy the cheapest but same durable good (World Bank 1996). We shall discuss how the introduction of this third form of uncertainty may affect our formal conclusions in Section 2.3 below.

The role of ROSCAs as a *risky* but high yield investment vehicle has been played down in the literature. It is however at the core of our model of why ROSCAs co-exist with bank savings accounts in urban areas. The lack of basic formal saving institutions in rural areas provides a sufficient rationale for ROSCAs in those settings. In urban areas, however, an increasing proportion of households have access to basic saving and deposit institutions and it is the lack of developed institutions for raising investment capital (arising from the lack of a formal venture capital market, of sophisticated credit scoring agencies…etc.) and risk sharing that provides the rationale for the continued existence of ROSCAs. ROSCAs allow households to raise investment capital, and simultaneously to reduce investment risk. However, they do not eliminate investment risk. This residual riskiness in turn provides a rationale for simultaneous saving in bank accounts. On the other hand, credit financed investment provides higher expected returns, but also entails higher risk, than ROSCA financed investment. Consequently, risk-averse households may continue to utilize ROSCA credit even when formal investment credit is made available to them.

In the next section, we develop a formal model in which individuals choose to join ROSCAs with a risky investment motive, while also possibly using bank saving accounts as a safe investment

option. To clarify ideas, we develop the model under the assumption that ROSCAs provide the only source of investment capital, i.e., under the assumption of zero credit. In the subsequent section, we indicate how our benchmark analysis may be extended to explain ROSCA holdings even in the presence of investment credit: in the absence of formal risk sharing instruments such as equity participation and insurance, such credit may be deemed too risky compared to ROSCA financing.

2.2. A model of ROSCA participation

Consider a household which has savings S in period 0. It wishes to invest these savings, in order to maximize its expected utility in the next period, period 1. The household can invest its savings in a bank account at some positive nominal interest rate *r*. Alternatively, it can invest in a capital good which yields a nominal rate of return (flow of capital services) ($r + d$) in period 1, $d > 0$.[7] Thus, the household has a prospective investment opportunity that yields a higher rate of return than bank deposits. However, due to indivisibilities in investment, investment in the capital good will yield this return only if the magnitude of such investment is at least $2\underline{a} > 0$.[8] No output is generated if investment in the capital good is less than $2\underline{a}$, so that the initial investment is entirely lost. Household savings in period 0 (S) are at least $\underline{a}$, but may be less than $2\underline{a}$.

Our interest lies in the pattern of portfolio diversification, i.e. in how any given amount of savings is allocated among alternative investment vehicles. Our comparative static exercise will only involve specifying how changes in total savings affect portfolio diversification, under a *given* vector of returns to investment. Thus, S is determined in our formulation by exogenously given incomes in periods 0 and 1. Under standard assumptions, S would be an increasing function of the household's income in period 0. We shall therefore identify savings S with the household's income/wealth in period 0, and characterize households with greater savings in period 0 as wealthier households.

Due to the assumed absence of collateral, agents cannot borrow in period 0. However, they can join a ROSCA in period 0. For simplicity, we assume that all ROSCAs are two-person ones.[9] ROSCAs are differentiated from banks by each having a fixed contribution level and by not paying any interest. So, if the household joins a ROSCA of level a, it pays an amount a in period 0. Each ROSCA member receives the 'pot', i.e. the amount $2a$, as its ROSCA payment with equal probability at the beginning (period 0) of the ROSCA cycle. The winner repays the loser her contribution, a, at

[7] We can allow the rate of return on investment in the capital good to be stochastic, to capture the uncertainties associated with such investment *per se*, without altering our conclusions. See Sections 2.3(i) and 2.3(ii) below for this extension. A *negative real* interest rate on bank deposits is quite compatible with our formulation.

[8] This assumption captures the indivisibility issue noted by Besley *et al.* (1993, 1994).

[9] Generalization to n-person ROSCAs is cumbersome, but does not add any insight. With n-person ROSCAs, we must consider n rounds of pay-offs, rather than just two. We are assuming that a household can always find a ROSCA of the desired size to join. This amounts to assuming that every household can always find an identical household to match and form a ROSCA with; a reasonable assumption in our large population context.

the end (period 1) of the cycle.[10] By putting its savings in a ROSCA, the household stands to lose the interest payment it could have received from a bank deposit (*ar*) with probability $\frac{1}{2}$. However, by joining a ROSCA, the household gets to double its investment in period 0 with probability $\frac{1}{2}$. If $a \geq \underline{a}$, the ROSCA payout is high enough to be used to purchase the investment good and thereby earn a rate of return greater than that provided by bank deposits. Thus, ROSCAs are high yield but risky investments compared to saving through bank deposits. For notational simplicity, we assume that the household receives no income in period 1 other than that from its investment *S* in period 0.[11]

Households are risk averse: their utility in period 1 is given by some differentiable, strictly concave VNM utility function $u(I_1)$, where I_1 is the household's income in period 1. Clearly, a household has no incentive to join a ROSCA of a level lower than $\underline{a}$. Given any ROSCA participation level $a \in [\underline{a}, S]$, in period 0, period 1 investment income is given by:

$$I_1 = 2a(R+d) - a + (S-a)R$$

in the case of an early ROSCA pay-out, and

$$I_1 = a + (S-a)R$$

in the case of a late ROSCA pay-out; each outcome being realized with probability ½.

If $S \geq 2\underline{a}$, the household can purchase the investment good outright in period 0, receiving:

$$Eu^P = u(SR + Sd). \qquad (1)$$

By joining a ROSCA of level $a \geq \underline{a}$, expected utility at the end of the period is:

$$\begin{aligned} Eu^R &= \tfrac{1}{2}\left[u\left(2a(R+d) + (S-a)R - a\right) + u\left((S-a)R + a\right)\right] \\ &= \tfrac{1}{2}\left[u\left(SR + a(r+2d)\right) + u\left(SR - ar\right)\right]. \end{aligned} \qquad (2)$$

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[10] We abstract from default risk, i.e. the possibility that an early winner will default on his payments in later rounds, since it is not necessary in order to make our analytical point.

[11] We could model a ROSCA as involving a payment of *a* in both periods 0 and 1 by both members, with the loser in period 0 receiving *2a* for sure in period 1. Since this merely involves the loser paying an additional *a* in period 1 and receiving it back, her net income in period 1 remains *a*. However, one then needs to assume a non-investment income in period 1 sufficient to cover the ROSCA payment of *a* in that period. Addition of this constant throughout the algebra, while increasing the notational burden, makes no substantive difference to our conclusions. We therefore choose to adopt the parsimonious formulation of ROSCA membership above. At the end of a ROSCA cycle, the household pools its total income from all sources and decides how much to invest, and in what manner, in the next period. In terms of our model, we think of this as a determination of total savings S_2 in period 2, part or all of which may be invested in a ROSCA lasting periods 2 and 3. If S_2 is high enough, it will be entirely invested in direct purchase of the capital good in period 2.

The household's expected utility from putting its savings entirely in a bank account is $u(SR)$. Since $a \leq S$, (1) to (2) imply that the expected return from joining a ROSCA cannot in this case exceed that from investing its entire savings in outright purchase of the capital good. Since households are risk averse, it follows that if $S \geq 2\underline{a}$, the household will neither join a ROSCA nor invest in a bank account, preferring to invest directly in the capital asset. Thus, when households have high wealth (i.e. $S \geq 2\underline{a}$), they will invest neither in a bank account nor in a ROSCA, but only in the capital good.

Evidently, only that part of the conclusion above which relates to ROSCA holdings is relevant for empirical analysis. At high wealth levels, households are indeed likely to hold bank accounts for two reasons abstracted from in our theoretical analysis. First, these households are much more likely to be engaged in economic activities in the formal sector. Financial transactions in the formal sector, including wage and salary payments, are mostly mediated through banks, and involve cheques and bank drafts. Consequently, transactions cost considerations would compel high wealth households to hold and operate bank accounts. Second, as discussed earlier, returns from direct investment in capital goods are likely to be inherently risky. Such risk would induce high wealth households to invest some part of their wealth in safe assets, viz. bank deposits.[12] These risks are independent of the risks associated with the timing of ROSCA payouts that we have isolated and highlighted in our formal analysis, but are nevertheless very real. Hence, in reality, high wealth households are likely to hold bank accounts for reasons that are obvious but external to our theoretical analysis; our analysis however leads us to predict that such households would not hold ROSCA accounts.

Consider now the more interesting case where households have some, but not a large amount of savings, i.e. where $S \in [\underline{a}, 2\underline{a})$. In this range, the household cannot afford to purchase the investment good outright, but has a 50% chance of being able to buy it immediately if it joins a ROSCA. Thus (noting (2)), the expected period 1 return from investing only in a ROSCA is $(SR + Sd)$, whereas that from investing entirely in a bank account is *SR*. Since in this case the expected income from joining a ROSCA is always higher than that from saving entirely in a bank account, if households are risk-neutral, they would invest their entire savings in a ROSCA account. Thus, ROSCA levels chosen by risk-neutral households would be *S*. However, (2) implies that, while ROSCA investment dominates in case of an early payout, bank investment dominates in case of a late payout. Intuitively, it is then clear that risk-averse households may choose a mix of ROSCA participation and bank savings. We proceed now to examine this possibility in formal detail. Denote:

$$H \equiv SR + a(r + 2d), \tag{3}$$

$$L \equiv SR - ar, \tag{4}$$

[12] This is evidently possible even if the real return on bank deposits turns negative due to inflation.

$$b \equiv S - a\,. \tag{5}$$

Then, using (2)-(4), the household's problem can be written as:

$$\underset{a}{Max}\, 2Eu^R = \left[u(H) + u(L)\right] \text{s.t.}\ \underline{a} \le a \le S\,. \tag{6}$$

Using (3)-(6), we get:

$$2\frac{\partial Eu^R}{\partial a} = -2\frac{\partial Eu^R}{\partial b} = u'(H)(r+2d) - ru'(L)$$

$$= (r+2d)u'(L)\left[\frac{u'(H)}{u'(L)} - \left(\frac{r}{r+2d}\right)\right]. \tag{7}$$

Furthermore (noting $u'' < 0$ and using (7)),

$$2\frac{\partial E^2 u^R}{\partial a^2} = 2\frac{\partial E^2 u^R}{\partial b^2} = u''(H)(r+2d)^2 + r^2 u''(L) < 0\,. \tag{8}$$

By (8), given any *S*, there must exist a unique solution to the household's maximization problem (6). We shall assume that an interior solution in *a* exists at $S = 2\underline{a}$.

Assumption 1. $\left.\frac{\partial Eu^R}{\partial a}\right|_{S=2\underline{a},\underline{a}=a} > 0 > \left.\frac{\partial Eu^R}{\partial a}\right|_{S=2\underline{a}=a}$.

Noting (8), Assumption 1 implies that, at $S = 2\underline{a}$, there exists a unique value of ROSCA holding a, say $\vec{a}$, which maximizes expected utility; $\vec{a} \in (\underline{a}, 2\underline{a})$. Noting (7), the LHS inequality in Assumption 1 requires that the additional return from investing in the capital asset, *d*, be large enough to justify holding ROSCA investments despite their risky nature. The RHS inequality requires that the household's risk aversion be strong enough to preclude complete concentration in the risky asset.

Before proceeding further, we need to embed assumptions regarding the household's attitude towards risk. While the assumption of *diminishing absolute* risk aversion (DARA) is generally uncontroversial, there appears to be no such consensus regarding *relative* risk aversion in the literature. In their seminal contributions to the theory of risk aversion, both Pratt (1964) and Arrow (1965) hypothesized *a priori* in favour of *increasing relative* risk aversion (IRRA). A number of subsequent investigations (e.g. Holt and Laury 2005, 2002; Halek and Eisenhauer 2001; Eisenhauer and Halek 1999; and Binswanger 1980) have offered empirical support for IRRA. Building on this

tradition, we first model household risk attitudes as a combination of IRRA and DARA, and derive the implications of this modelling choice for the household's ROSCA (as well as bank) savings.[13]

Proposition 1. *Let Assumption 1 holds. Suppose the household's preferences exhibit both IRRA and DARA, with* $\frac{\partial Eu^R}{\partial a}|_{S=\underline{a}=a} > 0$. *Then there exists* $\widetilde{S} \in (\underline{a}, 2\underline{a})$ *such that:*

(a) $a = S$ *when* $S \in [\underline{a}, \widetilde{S}]$,

and

(b) for all $S \in (\widetilde{S}, 2\underline{a})$, $a \in (\widetilde{S}, S)$; *with a and b both increasing in S in the interval* $(\widetilde{S}, 2\underline{a})$ **Proof:** See the Appendix.

The relationship between savings (or wealth) and ROSCA holdings, summarized by Proposition 1, is illustrated by the schedule DEF in Figure 1 below.

Insert Figure 1 here.

The assumption $\frac{\partial Eu^R}{\partial a}|_{S=\underline{a}=a} > 0$, which implies that the household will invest only in ROSCA accounts at the lower bound on savings($S = \underline{a}$), intuitively requires that expected returns from investing in a ROSCA (through investment in income generating assets in case of an early pay-out) be sufficiently higher than the interest rate on a bank savings account. This is especially likely to hold in situations of relatively high inflation: nominal returns to investment in physical capital assets typically go up in tandem with general inflation, but government-determined interest rates on bank savings often lag behind, leading to a widening of the gap between the two rates.[14]

By Proposition 1, at moderate levels of wealth (savings), the household will hold only ROSCA accounts: the higher return in case of an early ROSCA pay-out will more than compensate for the forgone interest income (from bank savings deposits) in case of a late ROSCA pay-out. A

[13] The standard formulation of a utility function which exhibits *both* IRRA and DARA is the so-called 'power-expo' form: $u(S) = \frac{1 - \exp(-\alpha S^{1-\gamma})}{\alpha}$, $0 < \gamma < 1$, $\alpha > 0$. Relative risk aversion is then given by: $R_R \equiv R_A S = \gamma + \alpha(1-\gamma)S^{1-\gamma}$. This functional form is used, for example, by Holt and Laury (2002).

[14] During our period, Ethiopia has experienced at times inflation at over 8% and official bank savings rates of less than 6%, suggesting a large gap between the return on ROSCA investment and bank savings. Since a late ROSCA payment implies zero nominal return on investment, but nominal returns on bank savings are always positive, a negative real rate of return on bank savings is quite compatible with our analysis.

marginal rise in savings would therefore be entirely invested in ROSCA holdings, as illustrated in Figure 1 for the interval $[\underline{a}, \widetilde{S}]$. However, due to increasing relative risk aversion, the household will hold a diversified investment portfolio at intermediate levels of wealth: it will continue to invest in a ROSCA, but open and invest in a bank savings account as well. In this intermediate wealth zone $(\widetilde{S}, 2\underline{a})$ in Figure 1), the household will increase both ROSCA exposure and bank deposits as its wealth rises. Increasing relative risk aversion will induce the household to invest part of any additional wealth in the safe asset, thereby increasing bank savings. At the same time, diminishing absolute risk aversion will induce it to invest part of any additional wealth in the risky asset. Consequently, both ROSCA exposure and bank holdings will rise with wealth. As already discussed, at high levels of wealth ($S \geq 2\underline{a}$), the household will not hold ROSCAs; it will instead invest its wealth in the direct purchase of the high yield asset, since it can now afford to purchase the capital good outright in period 0. It is nevertheless likely to continue holding bank accounts for reasons empirically important but abstracted from in our theoretical enquiry.

As discussed earlier, our modelling choice of IRRA and DARA has a distinguished pedigree, empirical as well as theoretical. A parallel literature however exists which purports to provide evidence of *constant relative risk aversion* (e.g. Harrison and Rutstrom 2008; Harrison *et al.* 2007; Szpiro and Outreville 1988; and Szpiro 1986a, 1986b). An *a priori* CRRA specification is common in experimental studies of risk aversion in developing countries (e.g. Brick *et al.* 2012 for South Africa, Yesuf and Bluffstone 2009 for Ethiopia, and Harrison *et al.* 2010 for Ethiopia, India and Ghana). We therefore proceed to contrast the consequences of such modelling choice for ROSCA savings behaviour with those implied by the combination of IRRA and DARA, as articulated in Proposition 1 above. We identify how investment behaviour changes with wealth under the general assumption of *non-increasing relative risk aversion* (NIRRA), which implies DARA and subsumes CRRA. Our empirical analysis in subsequent sections will allow us to adjudicate between these competing hypotheses within our specific context of ROSCA savings behaviour in Ethiopia.

Proposition 2. *Let Assumption 1 holds. Suppose the household's preferences exhibit NIRRA. Then, if the household operates a ROSCA account, there exists* $\widetilde{S} \in (\underline{a}, 2\underline{a})$ *such that:*

(a) $a = \underline{a}$ *when* $S \in [\underline{a}, \widetilde{S}]$,

and

(b) for all $S \in (\widetilde{S}, 2\underline{a})$, $a \in (\underline{a}, S)$ *; with a increasing in S in the interval* $(\widetilde{S}, 2\underline{a})$.

Additionally, under CRRA, b also increases in S in the interval $(\widetilde{S}, 2\underline{a})$.

Proof: See the Appendix.

Given an interior solution in ROSCA holdings at wealth holding $S = 2\underline{a}$ (Assumption 1), NIRRA implies that: (i) there must exist some wealth level $\widetilde{S}$ between $\underline{a}$ and $2\underline{a}$ below which ROSCA holdings remain constant and above which they keep increasing, and (ii) bank holdings may possibly increase with wealth above $\widetilde{S}$ as well (indeed, they must *necessarily* do so if CRRA holds). At all wealth levels below $\widetilde{S}$, Assumption 1 and NIRRA together imply that $\left.\frac{\partial Eu^R}{\partial a}\right|_{a=\underline{a}} < 0$, so that the household would reduce its ROSCA holdings below $\underline{a}$ if ROSCA investments were perfectly divisible. However, due to assumed indivisibilities in investment, the household's choice at these saving/wealth levels is in fact between constant ROSCA holding at $\underline{a}$ (and thus, bank investment of the entire residual $S - \underline{a}$) and bank holdings alone. Assuming that returns on bank savings are sufficiently low relative to those on investment via ROSCA financing, so that the household always maintains a (minimum balance) ROSCA account, it follows that ROSCA holdings will remain constant at the minimal threshold level $\underline{a}$ at wealth levels below $\widetilde{S}$. Non-increasing relative risk aversion implies that ROSCA investment will keep increasing once wealth crosses $\widetilde{S}$. Bank savings will be positive and, possibly (necessarily under CRRA), increasing throughout the wealth range $(\underline{a}, 2\underline{a})$. This situation is illustrated by the schedule DEF in Figure 2 below.

Insert Figure 2 here.

To summarize, given Assumption 1 and DARA, Propositions 1 and 2 suggest the following testable empirical patterns.

(i) At low levels of wealth, households are likely to hold *only* ROSCA accounts, and *no* bank accounts, if risk preferences are best characterized by IRRA. However, if these are best characterized by NIRRA, households would be likely to hold bank accounts even at low levels of wealth. Under NIRRA, if low wealth households hold ROSCA accounts at all, their ROSCA investments must remain unchanged with marginal increases in wealth, in contrast to the increase dictated by IRRA.

(ii) At intermediate levels of wealth, households are likely to hold both ROSCA and bank savings accounts. ROSCA investment is likely to increase with wealth, bank savings is likely to do so as well under both IRRA and CRRA.

(iii) At high levels of wealth, households are unlikely to hold ROSCA accounts.

The crucial difference in implications of IRRA and NIRRA thus relate to *low wealth* households. If they hold only ROSCA accounts, this may be construed as indirect evidence for IRRA. If they hold

bank accounts as well, the presumption would be in favour of NIRRA. In our empirical analysis, we shall exploit this difference to adjudicate between IRRA and NIRRA, and find support for IRRA.

2.3. Extensions

(i) ROSCA participation and formal credit

Like most of the theoretical literature on ROSCAs, we have assumed in our model in Section 2.2 that households lack access to credit. This serves to keep the algebra simple, and, arguably, provides a reasonable approximation for the empirical reality facing most poor people in developing countries. It needs to be emphasized, however, that credit constraints are in no way fundamental to our explanation for ROSCA participation. Indeed, risk aversion and portfolio diversification considerations might lead to ROSCA participation even if formal investment credit were available, and households may abjure formal credit in favour of ROSCA financing, or use both forms of investment financing, because of the lower risk associated with ROSCAs, compared to direct borrowing. Rigorous support for, and expansion of, these claims can be provided by following a line of reasoning very similar to the one that leads us to Proposition 1 above. Since that analytical exercise merely involves, in essence, an algebraically more cumbersome retelling of the key themes in Section 2.2 above, we do not attempt it here. Such an exercise is of limited interest also because its conclusions do not lend themselves to empirical validation: our data set does not allow us to explicitly test comparative static hypotheses regarding formal credit. We therefore confine ourselves to providing a simple example that highlights the intuition underlying our claims regarding ROSCA participation and formal credit.

Suppose the expected rate of gross return on investment of at least $2\underline{a}$ in the capital asset is $(R+d)$, as in our benchmark model, but this is stochastic: it can either be $2(R+d)$ or 0 with equal probability (recall the discussion of investment risk in Section 2.1). As earlier, assume the investment yields 0 output if $I < 2\underline{a}$. Given savings $S \in [\underline{a},2\underline{a})$, suppose the household borrows an identical amount and invests the total, $2S$, in purchase of the capital asset in period 0. Suppose, most generally, that the household borrows *S* with some probability $p \in (0,1]$ from a bank, saving *S* in a bank account with the remaining probability (1 $-p$). Thus, we consider an investment strategy consisting of a pure bank borrowing strategy and a pure bank saving strategy, mixed together in some fashion. The borrowing cost is (r + √), where √ is the premium over the bank's cost of capital, *r;* $0 \leq \surd \leq d$. Then the household receives, as investment income in period 1, either [$4S(r+d)$ + 3*S*-*S*(r + √)] or [$-S$ (*R* + √)] with probability *p/2*, net of loan repayment; while it receives *SR* with probability (1 $-p$). By investing entirely in a ROSCA (a pure strategy), instead, it receives $4S(r+d)+3S$ or –

S with probability $\frac{1}{4}$ each (early payout and subsequent investment), and S with probability $\frac{1}{2}$ (late payout). The (net) expected income from the first (mixed bank loan) strategy is:

$$p[S(R+d)+S(r+d)-S(r+\sqrt{})]+(1-p)SR = pS(2d-\gamma)+SR;$$

while that from investing entirely in a ROSCA is $S(R+d)$, as in our benchmark model. Since $\sqrt{} \leq d$, expected income from the bank loan strategy is maximized by choosing the deterministic strategy p = 1, so that the maximum possible expected income from this strategy is $S[(d-\gamma)+(R+d)]$. Since $\sqrt{} \leq d$, the expected income from investing entirely via a ROSCA can never exceed that from entirely using bank finance. Thus, ROSCA as a source of investible resources is *not* cheaper, (it does *not* provide a cost advantage) over bank finance. ROSCAs cannot therefore be explained on cost grounds when bank credit is available: a risk neutral household has no incentive to prefer ROSCAs over bank financing, and would strictly prefer the latter when the borrowing cost does not exhaust the entire expected surplus from investment $(d > \gamma)$. In the absence of investment risk *per se*, as in our benchmark model of Section 2.2 which assumes a deterministic return on the capital good, even a risk averse household would evidently prefer direct borrowing to ROSCA financing when $d > \gamma$.

This conclusion changes under risk aversion. Given stochastic returns on the capital good, the worst outcome conditional on ROSCA participation is $-S$, and the best outcome is $4S(r+d)+3S$, both of which occur with probability $\frac{1}{4}$. The worst outcome under bank financing with probability p (and investment in a savings account with probability (1-p)) yields $[-S(R+\sqrt{})]$, and the best outcome $[4S(r+d)+3S\text{-}S(r+\sqrt{})]$, both of which occur with probability $p/2$. Thus, the lowest pay-off and the highest pay-off under a ROSCA are both higher than that under the latter, due to interest payment on capital borrowed from a bank. There is also an intermediate pay-off under the former (S), which obtains when the ROSCA pay-off is late, and occurs with probability 1/2. First suppose p = 1, i.e., the household follows a pure investment strategy of bank financing alone, and compare this with a pure investment strategy of ROSCA financing alone. Given $d \geq \gamma$, we have:

$$[-S(R+\sqrt{})] < S < [4S(r+d)+3S\text{-}S(r+\sqrt{})].$$

Hence, given sufficiently high (absolute) risk aversion,

$$\frac{1}{4}[u(4S(r+d)+3S\text{-}S(r+\sqrt{}))+u(-S(R+\sqrt{}))] < \frac{u(S)}{2}.$$

Thus, the household would prefer (only) ROSCA borrowing to (only) bank borrowing if sufficiently risk averse. Now suppose 0 < p < 1. This mixed strategy is dominated by one which correspondingly mixes ROSCA borrowing and bank savings (i.e. one where ROSCA participation occurs with

probability p and bank saving with probability $1 - p$), when risk aversion is sufficiently high: due to risk aversion, ROSCA borrowing yields a higher expected utility than bank borrowing, while the bank saving strategy is adopted with the same probability ($1 - p$) under either mixed strategy.

Thus, the implicit risk-sharing offered by ROSCAs may lead to participation by households in such schemes even if they have access to formal credit. Portfolio diversification considerations that generate simultaneous holding of bank savings and ROSCA accounts also suggest the possibility that households may borrow from *both* banks and ROSCAs. Hence, there appears to be no *a priori* reason to expect that greater access to formal credit *per se* will necessarily reduce ROSCA participation: it is the absence of formal instruments of risk sharing (such as equity participation by lenders or insurance contracts that directly reduce investment risk) which may be conceptually more important in explaining the persistence of ROSCA participation among poor people in developing countries.

The entire investment risk is borne by the borrower in a random-draw ROSCA, who also receives the entire surplus generated. This residual claimant status for the investor serves to reduce the standard agency problems associated with output-contingent repayment (or profit-sharing) schemes with non-contractible effort on part of the investor. The consequent efficiency gains are however achieved at the cost of greater risk-exposure for the investor. The efficiency gains from the residual claimant status of the investor are maintained, but each individual's *ex ante* risk exposure is reduced, by randomly allocating the *identity* (or role) of the investor to some member of a ROSCA community. Thus, random draw ROSCAs spread investor's risk *horizontally*, i.e. among all members of a ROSCA community, but not vertically, i.e. not between an investor and his or her lenders. Other informal instruments of risk-sharing, such as mutual implicit insurance among household, village, neighborhood or extended family and clan members, may be effective in spreading individual-specific, i.e. idiosyncratic, risks, with negative or low correlation among community members. In contrast, random draw ROSCAs permit the sharing of non-idiosyncratic/covariate investment risks *common* to individual investors from a localized small community, who share broadly similar economic locations. Formal, anonymous, instruments of risk sharing, in effect, pool risk *across* multiple small communities, by connecting individuals from very different economic locations. Such instruments therefore reduce the exposure of individual investors to their localized community-specific risks. Random-draw ROSCAs, perform the same function, but by randomly distributing the identity of the investor *within* a small localized community. Hence, ROSCAs may be rationalized as an informal institutional response to the relative absence of formal instruments of risk sharing within developing countries, itself a reflection of low financial integration due to institutional weaknesses and high information/enforcement costs *across* small localized communities.

(ii) Bidding ROSCAs

We have only considered a random-draw ROSCA. This makes our theoretical analysis commensurate with our empirical analysis below, since ROSCAs in Ethiopia overwhelmingly adopt random allocation procedures. In other settings, however, one finds *bidding* ROSCAs: members bid for the ROSCA pot and the winning bid is transferred from the winner to the losers. In terms of our model, given $\underline{a} \leq S < 2\underline{a}$, the equilibrium bid must be $(R+d)S$, to be paid to the loser after the investment returns are realized. Since this is the expected income from our random-draw ROSCA, *sans* the uncertainty associated with the latter, risk-averse households should prefer bidding ROSCAs to random-draw ROSCAs. Why do we then observe the latter in practice, as, for example, in Ethiopia?

Recall the example with investor's risk in section 2.3(i). Since the entire risk in a bidding ROSCA is borne by the investor, the equilibrium bid, say β, must satisfy [$SR < \beta < S(R+d)$]. The winner receives either [$4S(R+d)-\beta$] or $-\beta$ with equal probability (1/2), while the loser receives β for sure, with the expected utility from winning the same as that from losing. By switching to a random draw ROSCA, each individual receives either [$4S(R+d)-S$] or $-S$ with probability ¼ each, and S with probability ½. Since $\beta > S$, a random draw ROSCA dominates in case of the best and worst outcomes. It is evident that, if the household is sufficiently risk averse,

$$\frac{1}{4}[u(4S(R+d)-\beta) + u(-\beta)] < \frac{1}{2}u(S),$$

so that a random-draw ROSCA provides greater expected utility than a bidding one. Thus, investor's risk, abstracted from in our benchmark model, explains why random-draw ROSCAs may be preferred over bidding ones, just as it explains why ROSCAs may persist despite the availability of bank credit.

(iii) Bank charges

We have assumed that there are no charges for a bank savings account, nor are there any minimum balance requirements. This is the general practice in the Ethiopian formal banking sector: typically, there are no charges for holding accounts, and the minimum balance required for a savings account is quite low (often as low as 100 Ethiopian *birr* currently and much lower in the recent past). To put this number in perspective, *monthly* ROSCA contributions typically amount to around 30 Ethiopia *birr* in our sample. Thus, bank charges and minimum balance requirements seem too low to make a significant difference to households' financial decisions in Ethiopia. Accounts with zero or negligible bank charges and minimum balance norms, designed to attract poor depositors, are widely offered in other developing countries as well, especially by public sector banks, and as a matter of public policy.

How would our theoretical conclusions, summarized by Propositions 1 and 2, change if bank savings accounts require a large minimum balance? Under risk neutrality, ROSCA investment always

dominates bank savings in our model. Since households have no incentive to hold bank accounts anyway under risk neutrality, the presence of large minimum balance norms makes no difference to their behavior. Thus, attitudes to risk remain crucial to any explanation for the simultaneous holding of ROSCA and bank accounts. It is easy to see intuitively that large minimum balance norms make no difference to the broad empirical pattern implied by IRRA, as articulated in Proposition 1. If households' risk preferences are best characterized by NIRRA, they would be likely to hold bank accounts even at low levels of wealth under zero minimum balance (Proposition 2). Evidently, this may change with the introduction of a large minimum balance norm: then low wealth households need not hold bank accounts even under NIRRA. At very low levels of wealth, households would put any additional savings entirely into their ROSCA accounts, since the minimum balance requirement would deter such households from holding a bank account altogether. However, beyond a savings threshold, ROSCA holdings would fall sharply as households open a savings account and transfer the required minimum balance from their ROSCA account to their savings account. Thus, if minimum balance requirements are non-negligible, under NIRRA, our model would predict a *sharp (discontinuous) fall* in ROSCA savings at some intermediate threshold wealth level where the household opens a bank savings account, constant ROSCA holdings for a wealth range thereafter, and subsequent increase for a range before falling again, as the household becomes rich enough to be able to dispense with ROSCA financing of investment altogether. The same outcome would also occur if banks, for some reason, only accepted as clients households above some wealth level $\tilde{a} \in (\underline{a}, S)$. However, as already discussed above, minimum balance requirements (and bank charges) for basic savings accounts appear too low in Ethiopia, as well as in many other developing countries, to make an appreciable difference to household savings behaviour. Furthermore, as discussed in sections 3 and 4 below, we find no evidence of the 'double-dip' relationship between ROSCA holding and wealth that is entailed by the conjunction of large minimum balance requirements and NIRRA.

3. Econometric framework and data

3.1. Econometric models

We now proceed to identify econometrically the factors which significantly impact on ROSCA participation, saving in banks and participation in both. We use both non-parametric and parametric econometric specifications to test our propositions.

We aim to specify the shape of the relationship between household saving decisions and wealth. The locally weighted regression (Lowess) is appropriate here because it does not impose any assumption about functional forms and allows the data to choose parameter estimates and the shape of the curve (Cleveland 1979, Cleveland *et al*. 1988). The Lowess technique gives a desirable smoother which tends to follow the data. The method "can be thought of as a series of linear regressions at different points appropriately stitched together…" (Deaton 1997, p.193). The smoothed values are

obtained by running a regression of the y variable (i.e. saving in ROSCAs, banks and both schemes) on the x variables (log of total household expenditure or its quadratic variant) with weights which are higher for the central point of the (y,x) combination than for points farther away. For each y, its smoothed version, say y_i^s, is computed according to Cleveland (1979).

Let y_i and x_i be the two variables and suppose they are ordered so that $x_i \le x_i + 1$ for $i = 1,...,N-1$. The subset used in calculating y_i^s is indices $i_- = \max(1, i-k)$ through $i_+ = \min(i+k, N)$, where $k = [N.bandwidth - 0.5/2]$. The weights for each of the observations between $j = i_-,...,i_+)$ are either 1 (i.e. no weight) or the tricube (default)[15],

$$w_j = \left\{1 - \left(\frac{|x_j - x_i|}{\Delta}\right)^3\right\}^3$$

where $\Delta = 1.0001 \max(x_{i_+} - x_i, x_i - x_{i_-})$. The smoothed value of y_i^s (saving in any scheme) is then the weighted mean regression prediction at x_i (log of household expenditure).

Due to the panel nature of the data on savings, we also estimated parametric models such as the random effects (RE) probit. For a reliable interpretation of our final coefficient estimates, we checked the stability of the quadrature approximation. As implied by the stability test, we adopted higher interpolation points to generate our estimated regression coefficients. Consider the model (Arulampalam 1998):

$$y_{it}^* = x'_{it}\beta + v_{it}, i = 1,2,...,n; t = 1,2,...,T \;;$$

$$v_{it} = \alpha_i + u_{it} \;;$$

and

$$y_{it} = 1 \;\; if \;\; y_{it}^* > 0; \;\; and \;\; 0 \;\; otherwise;$$

where (dropping the subscripts) y^* denotes the unobservable variable, y is the observed outcome (saving in ROSCA only, bank only or both)[16], x is a vector of time-varying and time invariant regressors that influence y^*, β is the vector of coefficients associated with the regressors, α_i denotes the individual specific unobservable effect and u_{it} is a random error. We assume that $u_{it} \sim IN(0, \sigma_u^2)$. In order to marginalize the likelihood, we also assume that, conditional on x_{it}, α_is are $IN(0, \sigma_\alpha^2)$ and independent of u_{it} and x_{it}. The above assumptions suggest that the correlation between two successive error terms for the same individual is a constant, given

[15] Note that the default bandwidth is 0.8 and Lowess was implemented in STATA using an ado file.

[16] By 'saving in ROSCA (bank) only' we mean all households with ROSCA (bank) but no bank (ROSCA) savings.

by $\rho = cor(v_{it}, v_{it-1}) = \frac{\sigma_\alpha^2}{\sigma_\alpha^2 + \sigma_u^2}$. The parameters of the random effect probit model can be estimated by noting that the distributions of y_{it}^* conditional on α_i are independent normal (Heckman 1981).

To allow for the joint determination of saving in both schemes and potential non-zero covariance of the errors in the ROSCA and bank equations, we further adopted a pooled bivariate probit model.[17] The results of this model serve as a robustness check to our findings under the RE probit model with regard to the relationship between household savings and wealth in Ethiopia. In order to assess more formally the interaction of the formal and the informal saving institutions or financial sectors, we modeled the determinants of saving in the two sectors jointly. The econometric approach adopted was the bivariate probit model, which has the following specification:

$$y_{1i}^* = \beta_1 x_{1i} + \varepsilon_{1i}, y_{1i} = 1 \text{ if } y_{1i}^* \geq 0, \ 0 \text{ otherwise;}$$

$$y_{2i}^* = x_{2i}\beta_2 + \varepsilon_{2i}, y_{2i} = 1 \text{ if } y_{2i}^* \geq 0, \ 0 \text{ otherwise;}$$

where $(\varepsilon_{1i}, \varepsilon_{2i})$ ~BVN(0,0,1,1, ρ), -1< ρ <1. Here y_{1i}^* is the propensity of an individual to save in a bank; y_{1i} is observed formal-sector status; y_{2i}^* is propensity of an individual to save through an *equb* (ROSCA) and y_{2i} indicates observed *equb* status. The two equations (one for the equb and one for the banks) can each be estimated consistently by individual single equation standard probit methods. However, this is inefficient in that it ignores the correlation between the disturbances. This correlation is of interest here because it enables us to assess the strength of the association between the unobservables affecting the propensity of using the two saving schemes. There is no issue of identifiability or estimability if the two equations have identical variables as in our case.[18]

3.2. Data

The data were collected in five waves: 1994, 1995, 1997, 2000 and 2004, from seven urban centres in Ethiopia by the Department of Economics of Addis Ababa University in collaboration with the Department of Economics of University of Gothenburg. Due to extreme outliers and unreasonable records which we could not verify by consulting the paper version of the completed questionnaire, we excluded the 1997 sample from the analysis. The cities covered include Addis Ababa (the capital city), Awassa, Bahar Dar, Dessie, Diredawa, Jimma and Mekele. A total of 1500 households were interviewed to provide information on household demographics, income, expenditure, education, assets, health and individual or household participation in formal and informal financial institutions. Across the four waves, the total number of individual members that are declared to be members of

[17] Separate bivariate probit estimates for each of the survey years are available on request.

[18] We estimate our model using STATA 11.2 with robust/sandwich estimator of variance to estimate the variance-covariance matrix of the estimators.

ROSCAs ranges from 1600 to 2100. The informant was the economic head of the household (in terms of income source) and was normally (but not always) male. The data were collected at slightly different times of the year in each wave. This is important because household patterns of consumption, and indeed motives for saving, may differ from month to month or across seasons. For example, weddings are traditionally held at certain times of the year, and the rainy and dry seasons affect both income and expenditure patterns which clearly have an effect on savings.

The information on *equbs* (Ethiopian ROSCAs) asks whether any member of the household is a member of *equb*, the frequency of saving per month, amount of *equb* contribution per month, amount paid out by *equb* and amount expected to be received from *equb*. We linked the identification (id) code of *equb* members with the id code from the demographic file to define individual level characteristics of *equb* participants such as gender, age, level of schooling, labour market status, ethnic origin and religious affiliation. We defined *equb* specific characteristics such as size of *equb* contribution and size of *equb*. We also know from the data whether individuals have a bank account, but we do not know how much, if any, regular saving they make into this account. From other sections of the data we can also define household-specific characteristics such as total household expenditure, food expenditure, household size, demographic composition and location.

Table 1 below presents the summary statistics. The proportion of households that save only in ROSCAs is about 20%, while 18% save only in banks. We observe some households saving in both saving schemes simultaneously and they constitute 4.7% of the overall sample. The average real monthly household expenditure is 627.1 Ethiopia birr and the mean household size is 6.4, which is comparable to results from larger surveys (e.g. population census). The average age of schooling years completed by household heads is 6, which corresponds to completion of primary/compulsory level of education. This shows that most households are headed by a head with a relatively low level of education. About 42% of the households are headed by females. The average age of heads is close to 50 and 57.3% of them are married. In terms of occupation, most are working as civil servants in the public sector (i.e. 18.6%) or are pensioners (14.6%), which might explain the relatively high average age among them. The average number of heads working as well as number of children working is very small, regardless of gender. This suggests that the most important source of income in urban Ethiopia is *not* employment income. Most work in the informal sector and eke out a living via support in the form of remittances both from domestic and external sources.

Table 1: Summary Statistics

Variable	Mean (standard dev.)	Number of observations
Saving in ROSCAs (%)	19.9	5801
Saving in Banks (%)	18.2	4649
Saving in Both (%)	4.70	5801
Total Expenditure	627.1	5801
Household size	6.4 (2.92)	5801
Years of schooling	6.0 (4.92)	5080
Age	49.7 (13.5)	5595
Gender (% female)	41.6	5609
Married (%)	57.3	5540
Employer (%)	1.3	5801
Self employed (%)	9.3	5801
Civil servant (%)	18.6	5801
Private sector employer (%)	7.1	5801
Skilled worker (%)	1.0	5801
Pensioner (%)	14.6	5801
No of men working	0.79 (0.83)	5801
No of women working	0.73 (0.84)	5801
No of male children working	0.007 (0.08)	5801
No of female children working	0.011 (0.12)	5801

N.B. Expenditure is expressed in Ethiopia birr.

4. Econometric Results

4.1. Wealth and saving

We examined the relationship between household wealth and the propensity to save only in ROSCAs, only in banks and *both in ROSCAs and banks*, using the Lowess regression function described in Section 3. The proportions of households saving in ROSCAs and those saving using both instruments show a non-linear quadratic relationship with the log of household expenditure, as implied by our model under IRRA and DARA (recall Proposition 1 and Figure 1, and note Figures 3 and 5 below).[19]

Insert Figures 3, 4 and 5 around here

[19] We utilise household expenditure rather than income or wealth because we believe that expenditure is better measured than either of the other two indicators, and is more closely correlated with lifetime income and wealth than income and wealth measured in a single period. However results using income and wealth measures are very similar to those illustrated here and are available from the authors on request.

The non-monotone relationship between ROSCA savings and household wealth supports Proposition 1, which predicts lower ROSCA participation at both low and high levels of wealth (see Figures 1 and 3). Very poor households do not participate in ROSCAs, nor do they hold bank accounts. This is because they have no investible surplus left after meeting basic needs. As wealth crosses the subsistence threshold, savings turn positive. For a range of wealth thereafter, some households invest, but only in ROSCAs; the proportion of households who do so increasing in wealth, since at a higher wealth level a larger proportion of households have investible savings. Beyond a savings threshold, some diversify into bank savings, while continuing to hold ROSCA accounts.

Notice that the threshold beyond which households start holding both bank and ROSCA accounts is higher than that beyond which households start holding only ROSCA accounts (Figures 3 and 5), as predicted by Proposition 1 (recall Figure 1). The proportion of such households is higher at higher wealth levels, since a larger proportion of households is above this savings threshold at a higher wealth level. At even higher wealth levels, however, some households withdraw from ROSCA participation, since they can directly purchase investment goods. This leads to a fall in ROSCA participation at very high wealth levels (even though some such households may possibly have used ROSCAs in the past to achieve their present high wealth). Even at such wealth levels, however, some households continue to hold ROSCA accounts. These households possibly join largely for non-monetary reasons such as social pressure and self-control problems (Ambec and Treich 2007, 2003). Thus, the quadratic relationship noted in Figures 3 and 5 can be easily rationalized in terms of our analytical conclusions under IRRA and DARA presented in Proposition 1 and Figure 1.

The relationship between bank saving only and household wealth is non-linear but not quadratic (Figure 4). Households in the lower portion of the wealth distribution are less likely to save in banks. At intermediate wealth levels, the proportion of households with bank accounts rises with wealth, as predicted by Proposition 1. As discussed in Section 2.2 above, the importance of bank-mediated formal sector financial transactions for high wealth households, and portfolio diversification considerations in the face of direct investment risks, factors abstracted from in our formal analysis, both serve to explain why the possession of bank accounts keeps rising even at high wealth levels.

Figure 6 shows the relationship between the value of ROSCA saving (whether a household saves only in ROSCAs or uses banks as well) and the log level of household expenditure. As predicted in Proposition 1(b), saving through ROSCAs increases with income and then peaks. Since we do not have data on amount of savings through bank accounts to supplement that on the propensity to hold a bank account, we cannot confirm that the second part of Proposition 1(b) holds for the level of savings as well as the propensity to save through bank accounts.

Insert Figure 6 near here

We find no evidence of constant ROSCA holdings at low levels of wealth, nor of low-wealth households using bank accounts as savings instrument in any significant manner. Thus, our empirical analysis contradicts the implications of NIRRA (recall Proposition 2 and Figure 2). Nor do we find any evidence of a 'double-dip' decline in ROSCA holdings, as is implied by the conjunction of NIRRA and significant minimum balance requirements (or other fixed costs) for bank holdings (recall Section 2.3(iii)). Thus, our results provide indirect support for a prior assumption of IRRA and DARA. Since ROSCA investment dominates bank investment under risk-neutrality, bank savings alone at intermediate wealth levels (Figure 4), in our context where such households mostly operate in the informal economy (and therefore transact in cash rather than cheques), appear very difficult to rationalize without resorting to considerations of risk-aversion along the lines of our analysis. Notice furthermore that our results do not appear to suggest life-cycle effects: households appear to save less, not more, when they consume less. Since saving through ROSCAs or bank accounts dominates cash holdings, there seems no reason to believe that, when a household exhibits low expenditure and low ROSCA and/or bank savings, their cash savings are anything but insignificant as well.

The parametric results based on random effects (RE) and seemingly unrelated pooled bivariate models are summarised in Tables 2 and 3 respectively. RE probit estimates show the significant bell-shaped quadratic relationship between saving and wealth. This is true for ROSCA savings, bank savings as well as simultaneous savings in ROSCAs and banks. This relationship is robust if we interact the quadratic of log of household expenditure with time dummies.[20]

[20] The interaction terms with all the time dummies were insignificant in all specifications of the random effects and pooled bivariate models.

Table 2: Predicting the propensity to save only in ROSCAs, only in banks and simultaneously both in ROSCAs and banks.

Variables	*Random Effects (RE) Probit Estimates*		
	Equb Savings	**Bank Savings**	**Saving in Both**
Log of expenditure	1.367***(0.454)	2.995***(0.817)	4.381***(1.174)
Log of expenditure squared	–0.084** (0.036)	–0.165***(0.062)	–0.281***(0.087)
Log of household size	–0.031 (0.096)	–0.288** (0.130)	–0.178 (0.175)
Years of schooling	0.006 (0.009)	0.082***(0.013)	0.016 (0.017)
Age of household head	–0.015***(0.003)	0.006 (0.005)	–0.002 (0.007)
Gender (1=female)	0.087 (0.116)	–0.073 (0.169)	–0.162 (0.228)
Married	0.011 (0.104)	–0.097 (0.153)	–0.272 (0.203)
Employer	–0.059 (0.309)	1.197***(0.382)	–0.021 (0.508)
Self employed	0.383***(0.130)	0.702***(0.193)	0.361 (0.236)
Civil servant	–0.178* (0.110)	0.084 (0.148)	0.017 (0.195)
Skilled worker	0.922***(0.353)	0.918** (0.430)	1.475***(0.520)
Pensioner	0.024 (0.128)	0.207 (0.172)	0.244 (0.229)
No of men working	0.167***(0.049)	0.154** (0.074)	0.097 (0.091)
No of women working	0.230***(0.043)	0.089 (0.059)	0.158** (0.074)
No of male children working	–0.037 (0.493)	0.757 (0.712)	0.630 (0.929)
No of female children working	–0.805** (0.375)	–0.847* (0.504)	–0.497 (0.703)
Wald χ^2 (p-value)	178.6*** (0.000)	216.8*** (0.000)	99.4*** (0.000)
LR test of ρ=0,(χ^2, p-value)	301.1*** (0.000)	246.2***(0.000)	120.8***(0.000)
Number of observations	4243	4243	4243

N.B. Other controls included in the model are location, time and ethnicity dummies. As suggested by quadchk (i.e. quadrature check), we used 20 points instead of 12 in the Gauss_Hermite quadrature.

One of our main objectives is to test whether simultaneous bank and ROSCA savings exist in the intermediate level of household wealth. This is corroborated both in the RE and pooled bivariate estimated results. The latter allows for the non-zero covariance of the errors in the ROSCA and bank saving equations. The correlation of the error terms (ρ) is significant which suggests the presence of significant interaction between households' decision of saving in ROSCAs and saving in banks.

Table 3: Seemingly Unrelated Bivariate Probit Estimates of saving propensities (Pooled)

Variables	Equb Savings	Bank Savings
Log of expenditure	0.864** (0.340)	1.254***(0.452)
Log of expenditure squared	–0.056** (0.027)	–0.053* (0.034)
Log of household size	0.016 (0.063)	–0.220***(0.067)
Years of schooling	0.006 (0.007)	0.049***(0.007)
Age of household head	–0.006***(0.002)	0.002 (0.003)
Gender (1=female)	–0.001 (0.084)	0.022 (0.089)
Married	–0.064 (0.077)	–0.045 (0.082)
Employer	0.022 (0.221)	0.613***(0.213)
Self employed	0.220** (0.093)	0.283***(0.098)
Civil servant	0.049 (0.072)	0.006 (0.077)
Skilled worker	0.638** (0.259)	0.617** (0.257)
Pensioner	0.069 (0.088)	0.110 (0.092)
No of men working	0.094** (0.037)	0.123***(0.039)
No of women working	0.180***(0.032)	0.073** (0.034)
No of male children working	–0.077 (0.421)	0.333 (0.416)
No of female children working	–0.645** (0.322)	–0.449 (0.297)
Wald χ^2 (p-value)	616.9***(0.000)	
LR test of ρ=0, (χ^2, p-value)	25.4***(0.000)	
Number of observations	3243	3243

N.B. Other controls included in the model are location, time and ethnicity dummies.

4.2. Other controls and saving

Apart from wealth, other socio-economic indicators were also found to be significant in affecting the saving portfolio of households. Since there are no sign reversals and loss of statistical significance in almost all the additional explanatory variables included between the RE and bivariate probit estimates, all our interpretations below apply to results obtained from both of these frameworks.

Consistent with our prior expectations, education has a significant and positive impact on the propensity to save in banks. This is probably due to: (a) literacy facilitating the operation of bank accounts, and (ii) education being associated with employment in the formal sector where payment is often by cheque, bank drafts, or directly into bank accounts. Larger households are less likely to save in banks and this result can be explained by referring to existing evidence on the relationship between household size and wealth position. Lipton and Ravallion (1994) find a significant negative

association between household size and income per person in poor countries such as Ethiopia. Large and poor households often devote their budget almost entirely to subsistence goods and are more likely to have low savings: consequently they are more likely to use only ROSCAs.

Households with older heads are less likely to save in ROSCAs. Those headed by skilled workers or the self-employed exhibit a higher likelihood of saving both in ROSCAs and banks. The former are also more likely to save simultaneously in banks and ROSCAs. Such heads are more likely to be better paid, and to be paid in cheques or via their bank accounts, rather than in cash. If the head is an employer, only bank saving is positively and significantly affected. The number of men and women working significantly increases the likelihood of saving in ROSCAs and banks (Table 3). The number of women working increases the likelihood of saving only in ROSCAs but not in banks in the RE probit results (Table 2). While the number of working women has a stronger impact on ROSCA saving, the number of men working has a stronger impact on bank saving. In Ethiopia, men are likely to be more educated than women. Hence, men are more likely to gain regular employment, which often pays wages directly via bank accounts. This would reinforce their propensity to use banks as a saving vehicle. The gender of the household head makes no difference to savings decisions.[21]

For simultaneous saving both in ROSCAs and banks by households, the only positive and significant coefficient was that associated with the number of men working. Except for a significantly negative coefficient in the bank saving equation in the bivariate model, ethnicity of the household head does not have a significant role in savings only in banks. It is however important in ROSCA savings. Amhara, Oromo and Gurage heads are more likely to save in ROSCAs relative to Tigre heads. The ethnic group Gurage constitutes a community famous for its formal and informal commercial activities which often evolve into mutual support and saving schemes such as ROSCAs. This is *not* reflected in the ROSCA savings equations. Compared to the capital city (the omitted category), households in Awasa and Bahar Dar are more likely to save in ROSCAs alone, banks alone as well as in both outlets while households in Diredawa are less likely to use any of the saving options.

5. Conclusion

This paper analyses how ROSCA participation and bank saving schemes may simultaneously interact with one another. We show that this depends on a household's income/wealth position and attitude towards risk. We also provide empirical support for our theoretical deductions. Our empirical estimates use an urban household panel data collected in four waves from seven major urban centres in Ethiopia from 1994 to 2004. Our empirical results support the theoretical proposition which

[21] This last finding perhaps indicates that resource-allocation conflicts between spouses do not play a major role in determining ROSCA participation, contrary to the argument advanced by Anderson and Baland (2002). However, since we do not have information regarding the identity or characteristics of *individual* ROSCA participants, we cannot address this issue in any comprehensive or conclusive fashion.

predicts the co-existence of savings both in banks and ROSCAs for intermediate wealth levels. ROSCA participation and the holding of bank accounts both appear to rise with wealth at intermediate levels: our theoretical analysis rationalizes this as a consequence of the conjunction of IRRA and DARA. Formally examining the interaction of bank and ROSCA savings jointly, we find the errors of the two equations to be statistically significant and positively correlated, which suggests the propensity to save in ROSCAs is not independent of saving in banks. The strong significance of the correlation might also suggest a possible substitution at work between the saving schemes. Our results are robust to alternative specification and using different sub-sample of the observations.

Our analysis provides both theoretical and empirical grounds for suggesting that the moderately poor may invest significantly more in both ROSCA-type schemes and bank savings accounts than the extremely poor. This finding has an important bearing on the organization of pro-poor micro-credit policies in developing countries. If random draw ROSCA-type mechanisms were intrinsically more likely to attract the poorest sections of the population, then an *a priori* case might be constructed for both NGOs and governmental organizations to encourage the formation and proliferation of ROSCA-type institutions as a means of improving credit access for these sections. Indeed, governments and NGOs in many countries actively encourage savings pooling via formation of 'self-help groups' among the poor (especially women), through matching transfers and/or organizational support: a random draw ROSCA type of disbursal mechanism may then be advanced as the appropriate way in which individual group members are to be permitted to withdraw resources from the group's collective savings pool. On the other hand, if, as suggested here, there are strong *a priori* reasons why the poorest individuals may self-select out from, or, more generally, save less in, random draw ROSCAs, then governments and NGOs would need to adopt other methods of disbursal if they are to effectively address the financing needs of the poorest sections. In addition, our results suggest that, among the moderately poor, the worse off are less likely to hold bank accounts, and may thus benefit less from a policy-induced increase in the interest rate on bank savings. Thus, broadly interpreted, our results suggest that direct income transfers or employment generation programmes may perhaps be more effective in reducing extreme poverty than micro-credit schemes involving formation of 'self-help' groups with ROSCA-type disbursal mechanisms.[22]

An extensive debate exists in the empirical literature on whether, in developing countries, poor households' attitudes towards risk are better characterized by increasing or constant relative risk aversion. We contribute to this debate by offering at least indirect evidence in favour of the former.

Lastly, our analysis leads us to conclude that it is not the absence of formal credit *per se*, but rather that of formal instruments for risk sharing such as equity participation and insurance, which

[22] That the poorest may self-select out of, or benefit little from, group-based micro-credit schemes in general has been noted in other contexts as well. See, for example, Bougheas*et al.* (2007) for a critique of micro-credit schemes conditional on group membership, such as those of the Grameen Bank in Bangladesh.

may provide the conceptual key to understanding the persistence of ROSCA-type mechanisms. Policy interventions which expand the provision of institutional credit to poor households may thus be more effective in reducing poverty when associated with measures to improve access to such formal risk sharing instruments. Implemented in isolation, the former type of interventions may disproportionately benefit the better off: poorer households may choose to continue their dependence on ROSCA-type informal mechanisms, despite greater availability of formal finance. While the policy literature typically concerns itself with factors constraining the supply of formal credit to poor households, our analysis thus serves to highlight factors possibly constraining its demand.

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Appendix

Preliminaries

At any arbitrary value of a, say $\hat{a} \in [\underline{a}, S]$, using (3)-(5), we have:

$$\frac{\partial[u'(H)/u'(L)]}{\partial S}|_{a=\hat{a}} = R\left[\frac{u''(H)u'(L) - u'(H)u''(L)}{(u'(L))^2}\right]; \tag{9}$$

and, analogously, at any arbitrary value of b, say $\hat{b} \in [0, S - \underline{a}]$,

$$\frac{\partial[u'(H)/u'(L)]}{\partial S}|_{b=\hat{b}} = \left[\frac{u''(H)u'(L)(R + r + 2d) - u'(H)u''(L)}{(u'(L))^2}\right]. \tag{10}$$

If the coefficient of absolute risk aversion $\Re_A \equiv -\frac{u''(S)}{u'(S)}$ is decreasing in wealth, then (since $H > L$), $[u''(H)u'(L) - u'(H)u''(L)] > 0$. It follows that:

$$\frac{\partial[u'(H)/u'(L)]}{\partial S}|_{a=\hat{a}} > 0 \text{ if DARA holds.} \tag{11}$$

If the coefficient of relative risk aversion $\Re_R \equiv \Re_A S$ is increasing in wealth, then:

$$\frac{u''(H)H}{u'(H)} < \frac{u''(L)L}{u'(L)} \equiv \theta < 0;$$

so that:

$$u''(H) < \frac{\theta u'(H)}{H}; u''(L) = \frac{\theta u'(L)}{L}. \tag{12}$$

Using (12), we get:

$$u''(H)u'(L)(R + r + 2d) - u'(H)u''(L) < \frac{\theta u'(L)u'(H)}{HL}[(R + r + 2d)L - H].$$

Now, (3)-(5) imply:

$$(R + r + 2d)L - H = 2bR(r + d) > 0 \ (= 0) \text{ for } b > 0 \ (\text{resp.} = 0).$$

Since $\theta < 0$, recalling (10), it follows that:

$$\frac{\partial[u'(H)/u'(L)]}{\partial S}|_{b=\hat{b}} < 0 \text{ if IRRA holds.} \tag{13}$$

By an exactly analogous argument, we also get:

$$\frac{\partial[u'(H)/u'(L)]}{\partial S}|_{b=0} \geq 0 \text{ if NIRRA holds;} \tag{14}$$

and

$$\frac{\partial[u'(H)/u'(L)]}{\partial S}|_{b=\hat{b}>0} < 0 \text{ if CRRA holds.} \tag{15}$$

Proof of Proposition 1. Let Assumption 1, DARA and IRRA all hold, and suppose $\frac{\partial Eu^R}{\partial a}|_{S=\underline{a}=a} > 0$. By Assumption 1, $\frac{\partial Eu^R}{\partial a}|_{S=2\underline{a},a=\underline{a}} > 0$. Then, by DARA (noting (7) and (11)), we get:

$$\text{for every } S \in [\underline{a},2\underline{a}],\ \frac{\partial Eu^R}{\partial a}|_{a=\underline{a}} > 0. \tag{16}$$

By Assumption 1, $\frac{\partial Eu^R}{\partial a}|_{S=2\underline{a}=a} < 0$. Then, by IRRA (noting (7), (13)), $\frac{\partial Eu^R}{\partial a}|_{S=\underline{a}=a} > 0$ implies:

$$\text{there exists } \widetilde{S} \in (\underline{a},2\underline{a}) \text{ such that: } \frac{\partial Eu^R}{\partial a}|_{S=\widetilde{S}=a} = 0; \text{ furthermore, [for every } S \in [\underline{a},\widetilde{S}),\ \frac{\partial Eu^R}{\partial a}|_{S=a} > 0] \text{ and [for every } S \in (\widetilde{S},2\underline{a}],\ \frac{\partial Eu^R}{\partial a}|_{S=a} < 0]. \tag{17}$$

In light of (8), (16)-(17) imply $a = S$ for every $S \in [\underline{a},\widetilde{S}]$, and that $a \in (\widetilde{S},S)$ for every $S \in (\widetilde{S},2\underline{a}]$. In light of (7) -(8), (11) and (13) imply both *a* and *b*are increasing in *S* in$[\widetilde{S},2\underline{a}]$. ◊

Proof of Proposition 2. Let Assumption 1 and NIRRA both hold. By Assumption 1, $\frac{\partial Eu^R}{\partial a}|_{S=2\underline{a}=a} < 0$. Then, noting (7) and (14), we get:

$$\text{for every } S \in [\underline{a},2\underline{a}],\ \frac{\partial Eu^R}{\partial a}|_{S=a} < 0 \text{ under NIRRA;} \tag{18}$$

which implies:

$$\frac{\partial Eu^R}{\partial a}|_{S=\underline{a}=a} < 0 \text{ under NIRRA.} \tag{19}$$

By Assumption 1, $\frac{\partial Eu^R}{\partial a}|_{S=2\underline{a},\underline{a}=a} > 0$. Then, since $\left.\frac{\partial Eu^R}{\partial a}\right|_{a=\underline{a}}$ is continuous in *S*, and since NIRRA implies DARA, noting (7), (11) and (19), it follows that:

there exists $\widetilde{S} \in (\underline{a}, 2\underline{a})$ such that $\frac{\partial Eu^R}{\partial a}|_{S=\widetilde{S},\underline{a}=a} = 0$; furthermore, [for all $S \in [\underline{a}, \widetilde{S})$, $\frac{\partial Eu^R}{\partial a}|_{\underline{a}=a} < 0$]; and [for all $S \in (\widetilde{S}, 2\underline{a}]$, $\frac{\partial Eu^R}{\partial a}|_{\underline{a}=a} > 0$]. (20)

Noting (7), (8), (11), and (18), it follows from (20) that:

for all $S \in [\underline{a}, \widetilde{S}]$, $a = \underline{a}$; (21)

for all $S \in (\widetilde{S}, 2\underline{a}]$, $a \in (\underline{a}, S)$; *a* increases in *S* in the interval $[\widetilde{S}, 2\underline{a}]$; (22)

Furthermore, (15) and (21) imply that the expected utility maximizing value of *b* must also be increasing in *S* in the interval $[\widetilde{S}, 2\underline{a}]$ if CRRA holds. ◊

Figure 1: ROSCA holding under IRRA and DARA

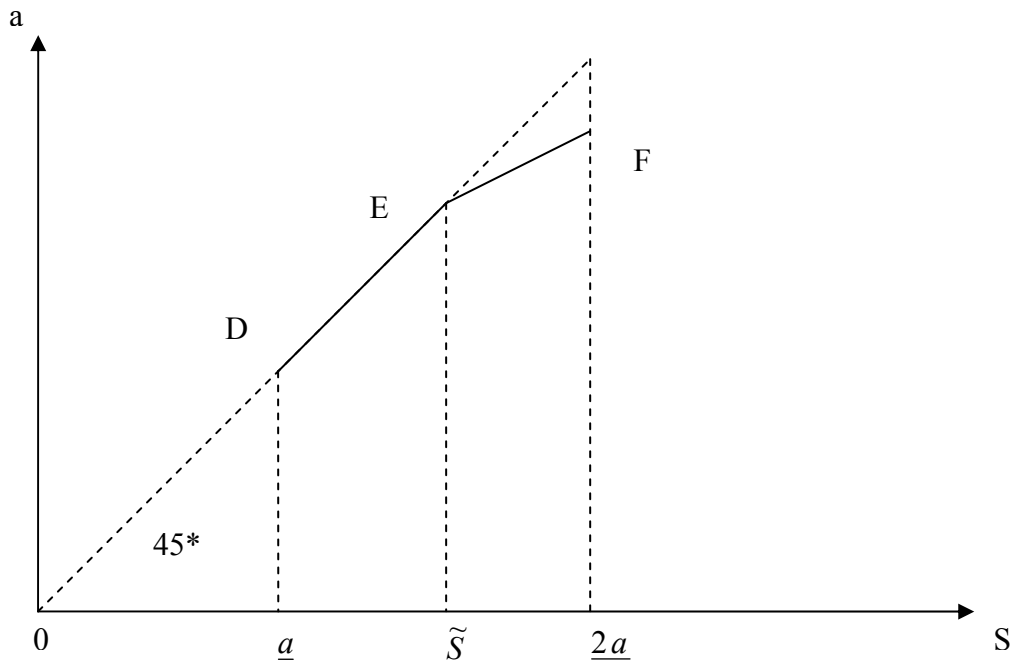


Figure 2: ROSCA holding under CRRA

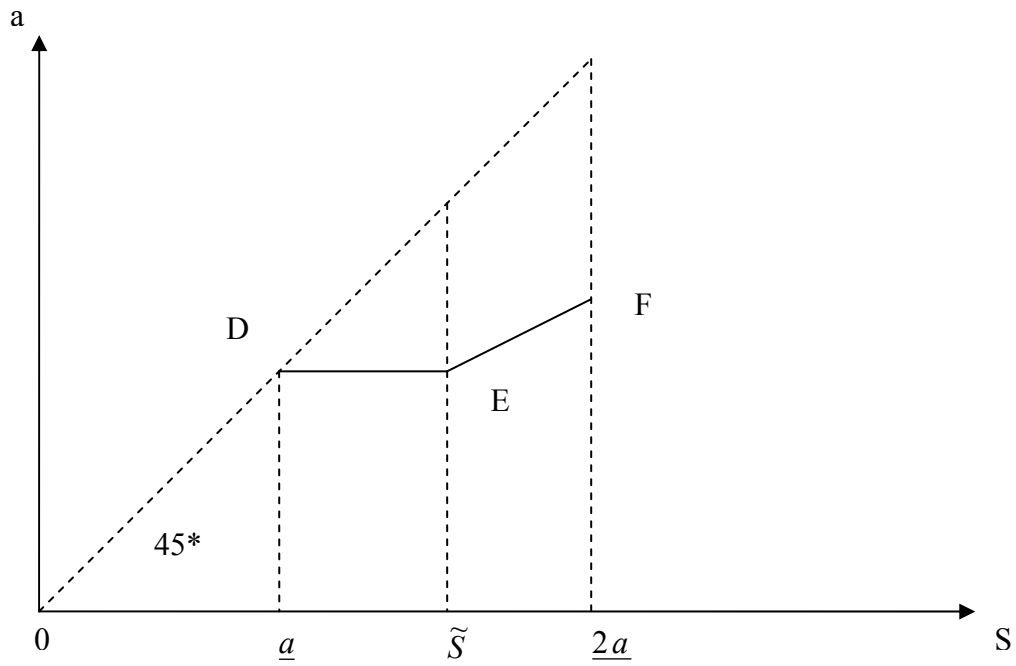


Figure 3: Propensity to save only in ROSCA by household expenditure

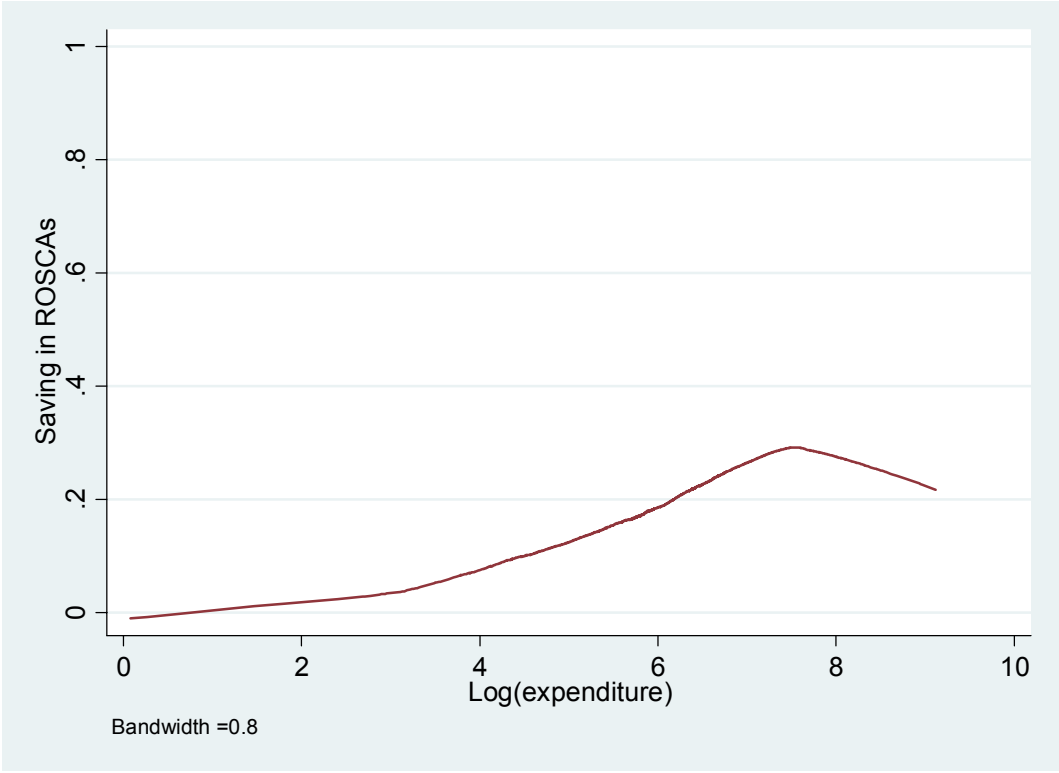


Figure 4: Propensity to save only in banks by household expenditure

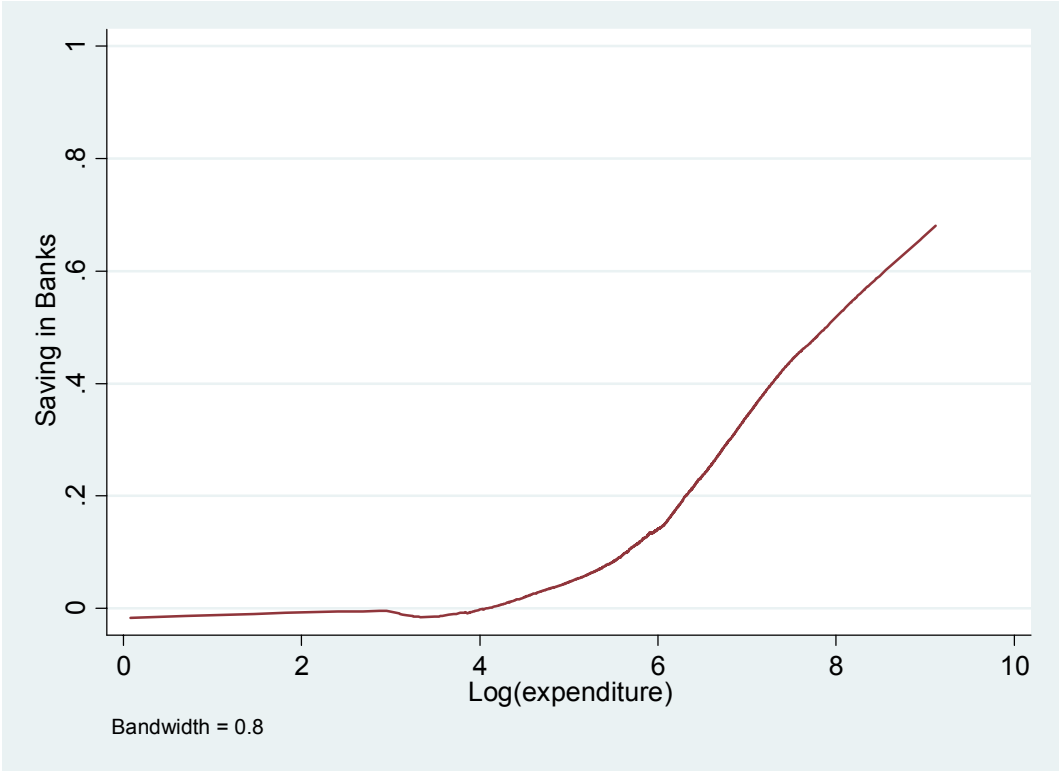


Figure 5: Propensity to save both in ROSCA and bank by household expenditure

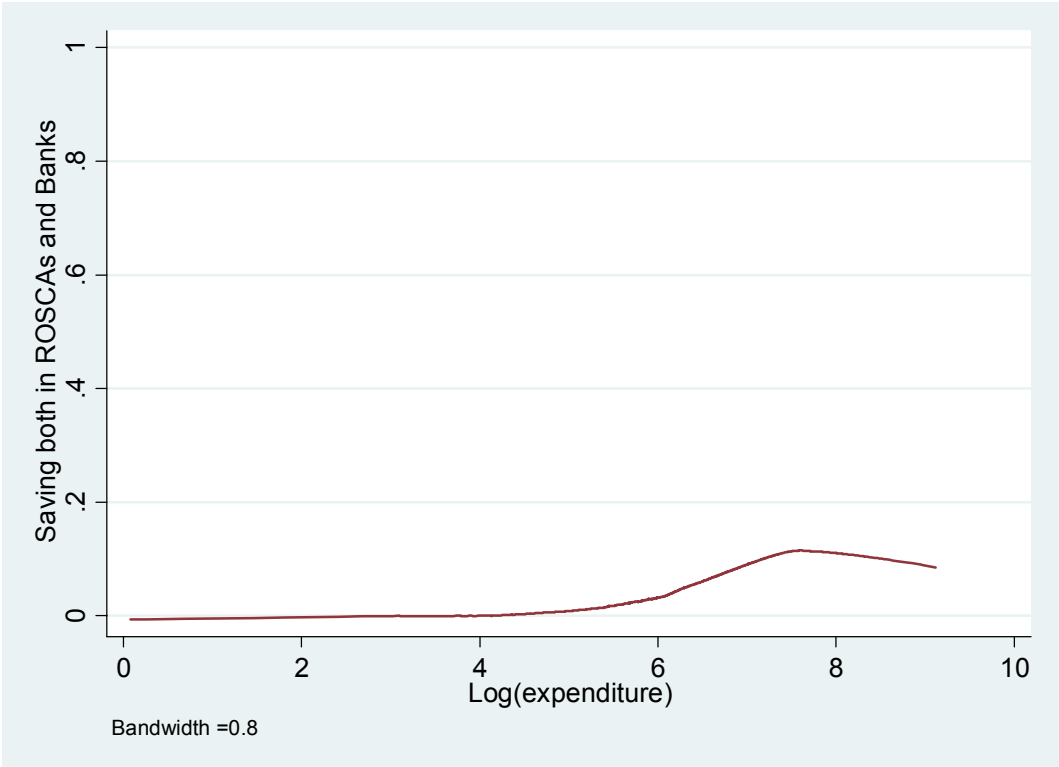
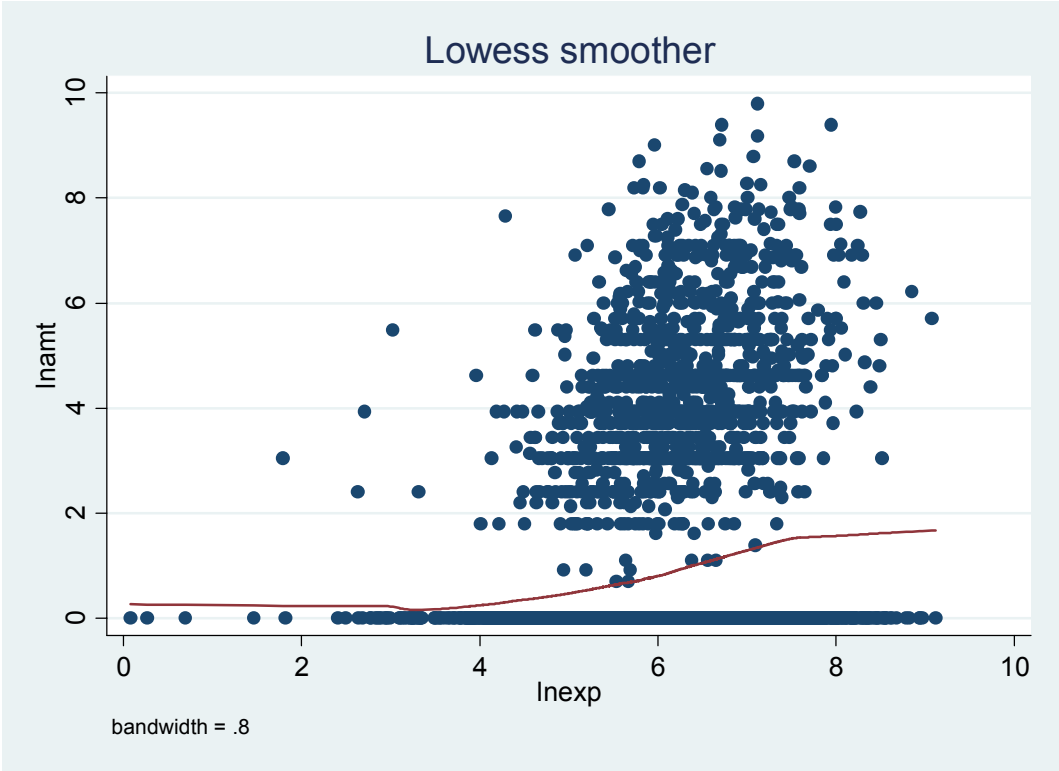


Figure 6: Amount of total ROSCA saving by level of household expenditure


Lowess smoother
lnamt
0
2
4
6
8
10
lnexp
bandwidth = .8