Financial Fragmentation And Insider Arbitrage

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`Preliminary`

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Abstract: If there were no impediments to the flow of capital across space, then the returns to capital should be equalized. We provide evidence to the contrary. There are large differences in the return to comparable investments across different towns in the state of Tamil Nadu in South India. We explore why these differences are not arbitraged away – and suggest that if an insider has monopoly power in arbitraging across towns then it is in his profit-maximizing interest to reduce but not eliminate the differences in returns to capital.

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1 Introduction

The misallocation of capital is widely thought to contribute underdevelopment and production inefficiencies (Banerjee and Duflo, 2005, Hsieh and Klenow, 2009). Recent micro-evidence has documented the inefficient flow of capital within developing countries. For instance, de Mel, Woodruff and Mckenzie (2009) and Paulson,Townsend and Karaivanov (2006) find that finance does not flow to high return entrepreneurs in Sri Lanka and Thailand respectively. Banerjee and Munshi (2004) suggest that finance does not flow across ethnic lines in India.

In this paper we investigate the flows of capital across space. We find large and significant differences in the returns to comparable financial investments across location-specific financial markets in a southern Indian state. If finance flowed to its highest use, such differences should not exist. The natural question then arises: Why doesn't arbitrage – borrowing from locations where finance is cheap and investing in locations where finance is scarce – eliminate these differences? We find that evidence of limited arbitrage by an "insider" and suggest a reason why it is costly for non-insiders enter the arbitrage business.

Imagine for illustrative purposes that there are just two locations, L and H. Several loan transactions take place in each location. Suppose that the average interest rates are significantly lower in location L than in location H, even when controlling for any differences in the size, term, riskiness, contractual features of the loans between L and H. This suggests financial fragmentation: an inefficiency in the allocation of capital over space. Location H apparently has higher return projects than location L – and capital should be flowing from L to H – so as to equalize the average returns. If an arbitrageur were to borrow from L and invest in H, he would make profits as long as the spread in interest rates was higher than the costs of arbitrage. Note that a wedge between the borrowing and savings interest rates will create such a transactions cost of arbitrage.

In the paper, we analyze data from 78 locations in the state of Tamil Nadu in south India. We use data from a non-bank financial intermediary that organizes auctions in different locations to intermediate between borrowers and savers in that location. There

are two advantages of this dataset. First, interest rate in each location are determined by auction and so should reflect local productivity shocks. In contrast, commerical bank interest rates are determined centrally in India and hence are identical across locations. Secondly, since loan contracts are standardized and explicit across locations and we can compare interest rates while adjusting for differences in loan characteristics. In contrast, the spatial variation in interest rates on informal loans by moneylender observed elsewhere could have arisen because of unobserved variation in contractual terms or riskiness (Banerjee and Duflo, 2005).

We find evidence of financial fragmentation across the 78 locations. Put differently, the interest rates across locations are significantly and substantially different from each other even when controlling for loan characteristics (such as the length and amount of the loan, the collateral required) and riskiness (as measured by ex-post default rates). The annual interest rates on savings range from 6.56 percent to 12.63 percent Remarkably, fragmentation occurs even though the company is engaged in arbitrage across locations. The company participates in about a third of the loan transactions and systematically borrows when interest rates are low and saves when they are high. We think of this as a form of insider arbitrage – and find that the company's behavior suggests that it has an investment opportunity with higher return than the average of the 78 locations it operates in. While our model suggests that efficiency would be lower (financial fragmentation greater) in the absence of insider arbitrage, we have cannot test this claim because we have no data on financial fragmentation in the absence of an inside arbitrageur. Finally, we provide some indirect evidence that the transactions costs associated with intermediation can explain why there are no outside arbitrageurs. These transaction costs (a) limit the interest-rate spread between locations and hence prevent financial efficiency and (b) allow the insider to make monopoly profits from the interest-rate spreads.

Our paper forms a bridge, then, between the empirical research on financial constraints in development (cited above) and a literature on the limits to arbitrage in financial markets (Shleifer and Vishny, 1997). While much of the latter literature studies how risk aversion,

transaction costs or agency difficulties can impede arbitrage, Borenstein et al (2008) explore a similar market power explanation for price differences despite arbitrage opportunities in California's electricity market. In their study, regulatory barriers prevent firms from exploiting the arbitrage opportunities. In our paper, there are no regulatory differences across locations that would prevent arbitrage.

The paper proceeds as follows. In Section 2 we provide background on bidding Roscas in South India and on our dataset. In Section 3 we outline some of the testable implications from a simple model. We discuss our results in Section 4.

2 Institutional Background

This study uses data on Rotating Savings and Credit Associations (commonly referred to as Roscas). Roscas intermediate between borrowers and savers but do so quite differently from banks (Anderson and Baland, 2003; Besley, Coate and Loury, 1994). In this section we provide some background on how the Roscas in our study operate. We also describe the sample of Rosca participants that we will use in our subsequent empirical analysis.

Rules

Roscas are financial institutions in which the accumulated savings are rotated among participants. Participants in a Rosca meet at regular intervals, contribute into a "pot" and rotate the accumulated contributions. So there are always as many Rosca members as meetings. In random Roscas, the pot is allocated by lottery and in bidding Roscas the pot is allocated by an auction at each meeting. Our study uses data on the latter.

More specifically, the bidding Roscas in our sample work as follows. Each month participants contribute a fixed amount to a pot. They then bid to receive the pot in an oral ascending bid auction where previous winners are not eligible to bid. The highest bidder receives the pot of money less the winning bid and the winning bid is distributed among all the members as an interest dividend. The winning bid can be thought of as the

price of capital. Consequently, higher winning bids mean higher interest payments. Over time, the winning bid falls as the duration for which the loan is taken diminishes. In the last month, there is no auction as only one Rosca participant is eligible to receive the pot. We illustrate the rules with a numerical example:

Example (Bidding and Payoffs) *Consider a* 3 *person Rosca which meets once a month and each participant contributes* \$10. *The pot thus equals* \$30. *Suppose the winning bid is* \$12 *in the first month. Each participant receives a dividend of* \$4. *The recipient of the first pot effectively has a net gain of* \$12 *(i.e. the pot less the bid plus the dividend less the contribution,* $30 - 12 + 4 - 10$*). Suppose that in the second month, when there are* 2 *eligible bidders, the winning bid is* \$6. *And in the final month, there is only one eligible bidder and so the winning bid is zero. The net gains and contributions are depicted as:*

Month	*1*	*2*	*3*
Winning bid	*12*	*6*	*0*
First Recipient	*12*	*-8*	*-10*
Second Recipient	*-6*	*16*	*-10*
Last Recipient	*-6*	*-8*	*20*

The first recipient is a borrower: he receives \$12 *and repays* \$8 *and* \$10 *in subsequent months, which implies a* 30% *monthly interest rate. The last recipient is a saver: she saves* \$6 *for* 2 *months and* \$8 *for a month and receives* \$20*, which implies a* 28% *monthly rate. The intermediate recipient is partially a saver and partially a borrower.*

The Sample

The bidding Roscas we study are large scale and organized commercially by a non-bank financial firm. The Rosca organizer is essentially the intermediary – participants of a Rosca either borrow (if they receive early pots) or save (if they win later pots), and the Rosca organizer takes on the default risk of the borrowers. So much like a standard financial

intermediary, the Rosca organizer screens borrowers and secures loan repayments, so that savers are assured of receiving funds in later rounds.

The data we use is from the internal records of an established Rosca organizer in the southern Indian state of Tamil Nadu.[1] Our sample comprises Roscas that started on or after January 1, 2002 and ended by November 2005. These Roscas took place in 78 branches of a non-bank financial firm. Our sample comprises 2056 Roscas of 34 different durations and contributions. The most common Rosca denomination had 25 participants and a Rs. 400 monthly contribution (with a total pot of Rs. $10,000$). There were also Roscas that met for longer durations (30 or 40 months) and with higher and lower monthly contributions. The average duration of the Rosca in our sample was 29.55 months. These different Rosca denominations serve to match borrowers and savers with different investment horizons. Descriptive statistics of the Rosca denominations are in Table 1. Descriptive statistics at the Rosca level are in Table 2.

For each Rosca in our sample, we compute the savings interest rate r as the solution to

$$\sum_{i=1}^{T-1}(-m + div_i)(1+r)^{T-i} + (Tm - c) = 0 \tag{1}$$

where m is the individual monthly contribution, div_t is the dividend in month t paid to each participant, T is the number of rounds/months/participants, and c is commission to the organizer in each round. The commission c is usually fixed at five percent of the value of the pot, i.e. $c = 0.05mT$. According to the rules of these Roscas, $div_1 = div_T = 0$. Moreover, for all $t = 2, ..., T-1$, the dividend is:

$$div_t = \frac{b_t - c}{T},$$

where b_t is the winning bid in the round-t auction. Notice that the minimum winning bid for $t = 2, ..., T-1$ is c. If none of the Rosca participants is willing to bid more than c in a

[1] Bidding Roscas are a significant source of finance in South India, where they are called chit funds. Deposits in regulated bidding Roscas were 12.5% of bank credit in the state of Tamil Nadu and 25% of bank credit in the state of Kerala in the 1990s, and have been growing rapidly (Eeckhout and Munshi, 2004). There is also a substantial unregulated chit fund sector.

given auction, the round t recipient of the pot is determined through a lottery among the eligible Rosca participants of that round. She receives the pot at a discount of precisely c.

The savers (last-round winners) in these Roscas are insured against winners of earlier pots failing to make contributions by the organizer. Rather than asking for physical collateral, the organizer requires auction winners to provide cosigners before releasing the loans. Cosigners are required to be salaried employees with a minimum monthly income that depends on the Rosca denomination. This is because the organizer has a legally enforceable claim against their future income as collateral for the loan. The organizer may also verify the auction winner's income before releasing the loan. For instance, a self-employed person will be asked for tax returns or bank statements while a salaried employee will be asked for an earning record. Verification is a form of costly screening because it takes time and effort.

The only risk that the saver faces therefore is the risk that the organizer itself may go bankrupt before the Rosca ends. This is indeed a real risk in the Indian context (where numerous chit fund companies have folded), but it is common to all the savers in all the 78 branches in the sample.

The average annual interest rate for a saver in these Rosca is 9.17 percent per year with a standard deviation of 1.18 percent. At each location, interest rates are determined locally through auctions. In contrast, the commercial bank savings rates are determined centrally and are not based on local supply and demand for credit. So there is no variation. We have obtained the rates on 3-6 month fixed deposits from the ICICI Bank, a large and well-networked commercial bank, and those rates were at 6 percent or below for all of the study period (2002-2005) with the exception of a six month period starting April 2002 when the rate was 7.75 percent. The interest rates on commercial bank savings are substantially lower than in the organized Rosca sector. This could reflect a risk premium that the Rosca saver must pay (since the organizer of the Roscas is more likely to go bankrupt than ICICI bank). In addition, there is a uncertainty with the realized interest rate for a Rosca participant (depending on the composition of the Rosca) that is absent in the commercial bank fixed

deposits.

"The Company"

In what follows we shall pay special attention to a particular investor who behaves quite differently from other Rosca participants. This investor operates in all 78 branches, and takes several postions in Roscas in each branch. Further, this investor is not considered a default risk by the Rosca organizer and so does not have to provide cosigners as collateral. Field conversations and observations indicate that this investor has close business ties to the Rosca organizer; for that reason it is not charged a commission for participation. Other participants, by contrast, are location-specific, are charged a commission, and need to provide cosigners when they win early pots. We shall interpret this investor as an insider and use the term "the company" to refer to the single entity that comprises this investor and the Rosca organizer in what follows.

3 A Model of Arbitrage in Roscas

In this section we consider a simple model of arbitrage between Roscas in two locations. Our aim is to clarify how arbitrage can reduce reduce financial inefficiencies but also to point out the incompleteness of such arbitrage when there are barriers to entry.

Consider two spatially separated locations, each with n private agents. Each agent is endowed with a dollar in the first period. Each agent has an investment opportunity with a fixed investment cost of 2 at date 1 and yield $2p$ at date 2. Agents do not discount the future. Agents vary in their productivity p. In each location, agents' types are distributed according to F_i. For analytical convenience, we assume that each of the density functions f_1 and f_2 is symmetric. Denote the corresponding mean and median by μ_i. Without loss of generality, we assume $\mu_1 > \mu_2$, i.e. agents in location 1 are on average more productive than in location 2. The aggregate cumulative distribution function of types will be denoted by F, where $F(p) = \frac{1}{2}\left(F_1(p) + F_2(p)\right)$. The mean of the aggregate distribution of types is

$\mu = (\mu_1 + \mu_2)/2$ and its median will be denoted by m. We assume private information on individual types, i.e. each agent observes only her own type and knows the distribution of types in her location.

In parts of the subsequent analysis, we employ the following additional assumptions:

A1 F_i is unimodal

A2 F_2 is a translation of F_1, i.e. $F_2(p) = F_1(p + \mu_1 - \mu_2)$

We model simple Roscas with two participants and hence two rounds. There is an auction only at date 1. Each Rosca participant contributes a dollar at date 1 and the auction is for the repayment amount b that is due at date 2. The winner of the auction receives the pot and invests. There is a fixed commission of c charged for any net transfer in a Rosca. As there are two net transfers in a Rosca, one in the first and one in the second period, the total commission is $2c$. We assume that each of the two participants pays a commission of c when the Rosca is over (for simplicity, c is not part of the winning bid). So at date 2, the winner pays b to the loser of the first-round auction and c to the organizer. The loser of the first-round auction receives b from the winner and also pays c to the organizer. Consequently, the interest rate on the auction loser's saving of \$1 in the Rosca is $b - 1 - c$ while the winner of the date 1 auction borrows at a rate of $b - 1 + c$. The difference between the borrowing and savings rate is $2c$. In this way, by slightly abstracting from the the specific rules that are used in practice in the Roscas in our sample, our model allows to relate the winning bid directly to the implied interest rates. In addition, the solution of the model is greatly simplified. Modelling two persons according to the actual rules of our sample Roscas gives identical qualitative results.

No Arbitrage

We first show that, in the absence of arbitrage, the interest rate difference across locations is given by differences in average productivity, $\mu_1 - \mu_2$. More formally, an agent's willingness

to pay for the date 1 pot is found by equalizing her payoff from winning, $2p - b - c$, to her payoff from losing, $b - c$, which gives

$$b^* = p.$$

In a Rosca, two individuals of a location are randomly matched. In each Rosca, each participant is uninformed about the other participant's type, and hence willingness to pay. We are thus in a situation of a symmetric, independent, private-value auction. Since the Roscas we consider have open-ascending bid auctions, the appropriate bidding equilibrium is most easily found by modelling the auction as a second-price sealed bid auction, which is payoff-equivalent. It can be shown that, in such an auction, each bidder determines her bid by a strictly increasing function $h_i(p)$, where $h_i(p) \geq p$ for all p, hence there is some overbidding relative to one's valuation of the pot. Denoting by $P_{i,k:2}$ the k'th highest order statistic of a sample of size two drawn from F_i, the difference in interest rates between branches, or spread for short, is

$$\Delta_r = E[h_1(P_{2:2}) - h_2(P_{2:2})].$$

Under assumption A2, we have that $h_2(p) = h_1(p) - (\mu_1 - \mu_2)$. Denoting $\mu_1 - \mu_2$ by Δ_μ we then have that

$$\Delta_r = \Delta_\mu.$$

When the efficiency of allocations is concerned, the best possible outcome in this scenario is that, in location i, all projects with a date 2 payoff greater than m_i are financed ($i = 1, 2$). Efficiency, on the other hand, implies that all projects with a date 2 payoff greater than m are financed in each of the two locations. It follows immediately that the aggregate allocation of capital will be inefficient if $\Delta_\mu > 0$.

Example with Uniform Distributions We consider uniform specifications of F_1 and F_2 with an identical range of α,

$$F_i(b) = \frac{(b - \mu_i)}{\alpha} + \frac{1}{2},\ \mu_i - \frac{\alpha}{2} \leq b \leq \mu_i + \frac{\alpha}{2}.$$

We will assume that the two distributions overlap sufficiently, specifically

$$\mu_1 - \mu_2 \leq \alpha.$$

When all above-median projects are financed in each location, the aggregate payoff at date 2 is

$$\Pi^a = \left(\mu_1 + \mu_2 + \frac{\alpha}{2}\right) n$$

because, in location i, the average payoff per doller invested is $E[P_i|P_i \geq m_i] = \mu_i + \alpha/4$. A fully efficient allocation of capital, on the other hand, implies an aggregate payoff of

$$\Pi^* = \frac{n}{\alpha}\left[\left(\mu_1 + \overline{\mu} + \frac{\alpha}{2}\right)\left(\mu_1 - \overline{\mu} + \frac{\alpha}{2}\right) + \left(\overline{\mu} + \mu_2 + \frac{\alpha}{2}\right)\left(\mu_2 - \overline{\mu} + \frac{\alpha}{2}\right)\right],$$

where $\overline{\mu} = (\mu_1 + \mu_2)/2$. Notice that $\frac{2n}{\alpha}\left(\mu_i - \overline{\mu} + \frac{\alpha}{2}\right)$ dollars are invested in location i while the respective mean payoff is $\frac{1}{2}\left[\overline{\mu} + (\mu_i + \frac{\alpha}{2})\right]$ per dollar invested. The amount which has to be moved from location 2 to location 1 to achieve an efficient allocation of capital, is

$$T^* = \frac{\Delta_\mu}{\alpha} n.$$

It can be shown, moreover, that each dollar which is moved from 2 to 1 earns an extra return of $\Delta_\mu/2$ on average. The expected welfare differenc between a fully efficiencient allocation of capital and autarky thus equals

$$\Pi^* - \Pi^a = \frac{\Delta_\mu}{2} T^* = \frac{\Delta_\mu^2 n}{2\alpha} \tag{2}$$

in absolute terms and

$$\frac{\Pi^* - \Pi^a}{\Pi^a} = \frac{\Delta_\mu^2}{4\alpha\left(\overline{\mu} + \frac{\alpha}{4}\right)} \tag{3}$$

in relative terms.

Insider Arbitrage, No entry

We next consider the case where the company can arbitrage across locations and has monopoly power. We find that interest rate differences persist but they are smaller than

inter-locational differences in average productivity, $\mu_1 - \mu_2$. In the aggregate, the arbitrager will borrow in the low productivity location and save in the high productivity location – while preserving a spread in order to make profits.

The Rosca company has the choice to become a Rosca member herself in each of the two locations at no cost. We consider the case where the company's agent enters one Rosca with each private agent. We assume that the private agent knows of his co-participant's identity and that the company's agent plays a pure strategy in each location, i.e. she bids b_i in all Roscas in location i where the company becomes a member. When the private agent in location i knows the company-agent's b_i, he will bid b_i minus an increment whenever $p < b_i$ and b_i plus an increment when $p > b_i$. In both of these cases, the auction price will be roughly b_i.

If the company holds one ticket in each of the branches, its expected profit is

$$\Pi^c = b_1(1 - F_1(b_1)) + b_2(1 - F_2(b_2)) - [b_1 F_1(b_1) + b_2 F_2(b_2)] \tag{4}$$

Notice that $(1 - F_1(b_1))$ is the expected number of period 1 pots that the company loses in location 1, $F_1(b_1)$ is the number of period 1 pots the company wins in location 1, each of which generates a liability of b_1 in the second period. Hence $b_1(1 - F_1(b_1))$ is the company's expected income in the second period from the lost auctions in location 1 and $b_1 F_1(b_1)$ the liability from the won auctions in location 1.

To balance the budget in period one (in expectation), the company cannot lose more period 1 pots than it wins,

$$F_1(b_1) + F_2(b_2) \geq (1 - F_1(b_1)) + (1 - F_2(b_2)). \tag{5}$$

The company maximizes its profits by choice of b_1 and b_2 subject to (5).

Lemma 1 A strictly positive profit of the company implies that she chooses bids such that

$$\mu_1 > b_1 > b_2 > \mu_2, \tag{6}$$

which implies that the difference in interest rates is greater than zero but smaller than

the difference in average productivity,

$$0 < \Delta_r < \Delta_\mu.$$

Proof: It is convenient to rewrite the company's profit as

$$\Pi^c = b_1(1 - 2F_1(b_1)) + b_2(1 - 2F_2(b_2)) \tag{7}$$

and the budget-balance constraint as

$$F_1(b_1) + F_2(b_2) \geq 1 \tag{8}$$

We first proof $\mu_1 > b_1$. To this end, suppose $b_1 \geq \mu_1$. This implies. We take each of the following two cases in turn, (i) $b_2 \geq \mu_2$ and (ii) $b_2 > \mu_2$. Under (i) $1 - 2F_1(b_1) \leq 0$ and $1 - 2F_2(b_2) \leq 0$, which implies $\Pi^c \leq 0$. This contradicts $\Pi^c > 0$. Under (ii) $1 - 2F_1(b_1) \leq 0$, $1 - 2F_2(b_2) > 0$, $b_2 > b_1$ and (8) implies that $1 - 2F_2(b_2) \leq -(1 - 2F_1(b_1))$. So we can write

$$\Pi^c \leq b_1 \left[(1 - 2F_1(b_1)) + (1 - 2F_2(b_2))\right] \leq b_1 \left[(1 - 2F_1(b_1)) - (1 - 2F_2(b_2))\right] = 0$$

Second we proof that $b_2 > \mu_2$. To this end, suppose $b_2 \leq \mu_2$. Based on the previous result, it is sufficient to consider $b_1 < \mu_1$. In this case $F_1(b_1) < 1/2$ and $F_2(b_2) \leq 1/2$, which implies that $F_1(b_1) + F_2(b_2) < 1$. This contradicts (8).
Next we proof that $b_1 > b_2$. To this end suppose that $b_1 \leq b_2$ and employ $\mu_1 > b_1$, which implies $F_1(b_1) < 1/2$ and $1 - 2F_1(b_1) > 0$, and $b_2 > \mu_2$, which implies $F_2(b_2) > 1/2$ and $1 - 2F_2(b_2) < 0$. We may now write

$$\Pi^c \leq b_2 \left[(1 - 2F_1(b_1)) + (1 - 2F_2(b_2))\right] \leq 2b_2 \left[1 - (F_1(b_1) - F_2(b_2))\right] = 0$$

where the last inequality follows from (8). But this contradicts $\Pi^c > 0$. □

This lemma implies that (i) interest rates will vary across locations, (ii) the arbitrager's rank is positively correlated with the interest rate and (iii) - provided the constraint (8) is binding - the average rank of the arbitrager is 0.5. The positive correlation between the local

interest rate and the arbitrager's rank follows from $\mu_1 > b_1$, which implies $F_1(b_1) < 1/2$, and $b_2 > \mu_2$, which implies $F_2(b_2) > 1/2$. In other words, across locations, the arbitrager is less likely to win the first pot, the higher b.

The way the company intermediates between locations is through its different average ranks in the two locations. In location i, the company wins the fraction $F_i(b_i)$ of first period pots and $1 - F_i(b_i)$ of second period pots. We say the rank of a Rosca member is zero is she wins the first pot and one if she wins the second pot. The company's average rank in location i is $0F_i(b_i) + 1(1 - F_i(b_i)) = 1 - F_i(b_i)$.

What about efficiency? Compared to autarkic branches, in location 1 all projects with a return between b_1 and μ_1 are now financed while an identical number of projects - with return between μ_2 and b_2 - is no longer financed in location 2. On the other hand, this allocation of capital still fails to be efficient. Moreover, since the company and private agents play a zero-sum game, the company's profits will be smaller than the efficiency loss due to the missallocation of capital. We hence have

Lemma 2 With insider arbitrage,

(i) the allocation of capital is not efficient;

(ii) the allocation of capital is more efficient than under autarky.

(iii) the arbitrager's profit is strictly smaller than the loss due to the missallocation of capital.

The following example illustrates these results:

Example with Uniform Distributions Notice that, for an efficient allocation of funds in this economy (which in the current setup implies an identical price of credit in the two locations), an amount of $n\left[\mu_1 - \alpha/2 - (\mu_2 - \alpha/2)\right] = n(\mu_1 - \mu_2)$ would have to be transferred by the arbitrager from location 2 to location 1 at date 1.

Define

$$g_i(b) = b + \frac{F_i(b) - \frac{1}{2}}{f_i(b)}.$$

In general, the solution to the company's problem of maximizing (7) by choice of b_1 and b_2 subject to (8) can be charcterized by the two equations

$$g_1(b_1) = g_2(b_2), \tag{9}$$

$$F_1(b_1) + F_2(b_2) = 1. \tag{10}$$

For the uniform distributions considered here, this gives

$$b_1 = \mu_1 - \frac{\mu_1 - \mu_2}{4},\ b_2 = \mu_2 + \frac{\mu_1 - \mu_2}{4}.$$

The average rank of the company in the strong and weak location are

$$rk_1^c = \frac{1}{2} + \frac{\Delta_\mu}{4\alpha} \text{ and } rk_2^c = \frac{1}{2} - \frac{\Delta_\mu}{4\alpha},$$

respectively. So the difference in the company's rank between the strong and weak location is

$$\Delta_{rk} = rk_1^c - rk_2^c = \frac{\Delta_\mu}{2\alpha}.$$

Thus, through the activity of the arbitrager, the interest rate difference is half the mean productivity difference,

$$\Delta_r = \frac{1}{2}\Delta_\mu.$$

The amount which is transferred from location 2 to 1 in the first period is the product of the rank difference and the number of memberships the company holds in each location,

$$T^{ma} = \Delta_{rk} n = \frac{\Delta_\mu}{2\alpha} n,$$

which is just half of the amount that would be transferred in an efficient allocation of funds across the two locations.

The company's profit is

$$\Pi^{c,ma} = \frac{1}{2}\frac{\Delta_\mu^2 n}{2\alpha}, \tag{11}$$

while the payoff to the private agents is

$$\Pi^{p,ma} = \frac{n}{\alpha}\left[\left(b_1 + \mu_1 + \frac{\alpha}{2}\right)\left(\mu_1 + \frac{\alpha}{2} - b_1\right) + \left(b_2 + \mu_2 + \frac{\alpha}{2}\right)\left(\mu_2 + \frac{\alpha}{2} - b_2\right)\right].$$

The term $\frac{b_i+(\mu_i+\alpha/2)}{2}$ is the average payoff for one dollar invested in location i and $\frac{2n}{\alpha}\left[(\mu_i + \alpha/2) - b_i\right]$ the amount invested in location i. Simplifying gives

$$\Pi^{p,ma} = \Pi^a + \frac{3}{8}\frac{\Delta_\mu^2 n}{2\alpha}. \tag{12}$$

It can be shown that each dollar which is moved from location 2 to location 1 earns an extra return of $\frac{7}{8}\Delta_\mu$. The expected welfare differenc between monopolisitc arbitrage and autarky thus equals

$$\Pi^{ma} - \Pi^a = \frac{7}{8}\Delta_\mu T^{ma} = \frac{7}{8}\frac{\Delta_\mu^2 n}{2\alpha} = \frac{7}{8}(\Pi^* - \Pi^a) \tag{13}$$

Put differently, we have that

$$\Pi^{ma} = \Pi^{p,ma} + \Pi^{c,ma} = \Pi^a + \frac{7}{8}\frac{\Delta_\mu^2 n}{2\alpha} = \Pi^* - \frac{1}{8}\frac{\Delta_\mu^2 n}{2\alpha}.$$

Hence the difference in welfare between a fully efficient allocation of capital and monopolistic arbitrage is

$$\Pi^* - \Pi^{ma} = \frac{1}{8}\frac{\Delta_\mu^2 n}{2\alpha} = \frac{1}{8}(\Pi^* - \Pi^a).$$

The last equality follows from (2). Hence monopolistic arbitrage reduces the gap between the aggregate payoffs with full efficiency and autarky ($\frac{\Delta_\mu^2 n}{2\alpha}$) considerably, by seven-eighths to be precise. The bulk of this additional surplus, four-eighths, is captured by the arbitrager, while the remaining three-eighths accrue to the private agents.

Costless Entry

We next consider a hypothetical case where there is costless entry into arbitrage. By costless entry, we mean the absence of the participation fee c for an entering arbitrager.

Put differently, if outsiders can arbitrage on the same terms as the insider (the company), then we find that interest rate differences will disappear.

Suppose the company bids any pair (b_1, b_2), satisfying $\mu_2 \leq b_2 < b_1 \leq \mu_1$. Then an entrant can become a Rosca member in the two locations, bid b_2 plus an increment in location 2 and b_1 minus an increment in location 1. The entrant will win for sure in location 2 at a price of b_2 and lose for sure at a price of b_1 in location 1. This will yield the entrant a positive profit of $b_1 - b_2$. When enough such entrants are active, the company's profits will become negative because now the company wins too many auctions in location 1 and loses too many in 2. The only equilibrium has $b_1 = b_2$, i.e. $\Delta_r = 0$, and zero profits for the compnay.

Note that if private agents in the two locations had access to a common financial market with a cost of intermediation equal to that in Roscas (i.e. $2c$ for a 1\$ loan), then too such interest rate differences would disappear. Such a financial market could, for example, be a bank that operates branches with identical borrowing and savings rates in both locations, where these two rates differ by precisely $2c$.

Insider Arbitrage, Costly Entry

We consider the final case where the company can arbitrage costlessly but entrants to arbitrage must pay the cost c of Rosca membership. We find that the differences in interest rates persist but are smaller than in the no-entry case when the difference in productivity is sufficiently large relative to the cost of entry ($\mu_1 - \mu_2 > 2c$), and equal to the no-entry case when the producitivity difference is not sufficiently large ($\mu_1 - \mu_2 \leq 2c$). More specifically, the difference in interest rates is capped by $\max(\mu_1 - \mu_2, 2c)$.

Suppose the company bids any pair (b_1, b_2), satisfying $\mu_2 \leq b_2 < b_1 \leq \mu_1$. Then an entrant can become a Rosca member in the two locations, bid b_2 plus an increment in location 2 and b_1 minus an increment in location 1. The entrant will win for sure in location 2 at a price of b_2 and lose for sure at a price of b_1 in location 1. But now he faces a total cost for the two memberships of $2c$. So the entrant will make a profit of $b_1 - b_2 - 2c$. This

is positive only when $b_1 - b_2 \geq 2c$. As a consequence, the company cannot sustain a higher spread than $2c$ in equilibrium. When c is sufficiently large - relative to the difference in average productivity -, there will be no entrants and the outcome will be the same as with monopolistic arbitrage and no entry.

We turn to the question of why arbitrage by outsiders (i.e. not the Rosca company) may be costly in practice. First, the cost of arbitrage predicted by our model due to the commission charged by the company will in practice equal 10% between the first and last round. For the sample Roscas, this amounts to comparing the interest rate over the entire duration of a Rosca which is on average 30 months. So a necessary condition for an outsider arbitrageur to make non-negative profits will be that the interst rate spread in months between two locations where she participates is at least (roughly) $10/30 = 0.33\%$. There are, however, two additional factors that complicate arbitrage by an entrant. First, whenever the arbitrageur obtains an early pot she has to provide cosigners, which may cause a (non-monetary) additional cost. Second, the arbitrageur faces uncertainty as he has to subscribe to Roscas in certain branches upfront, i.e. when Roscas start. If locations experience productivity shocks while Roscas are going on, however, the interest rate difference between two locations with an initially large spread may shrink and render the arbitrageur's profits negative. To summarize this point, in our institutional setup we would expect only limited scope for outside arbitrageurs unless interest rate differences between locations substantially exceed 0.33% per month for the majority of pairs of branches.

Testable Implications

The testable hypotheses arising from our theory so far are:

1. Interest rates do not differ across locations
2. (The monthly) interest rate spread across locations is bounded by 1/3% per month across locations
3. Arbitrager's rank across locations uncorrelated with interest rates across locations

The testable hypotheses are summarized in the following table

	Arbitrage		
	costless entry	insider arbitrage, costly entry	insider arbitrage, no entry
Interest Rate Variation	zero	positive, bounded	positive
Correlation between r and rank	n.a.	positive	positive

Variation: Cross-Arbitrage

We have so far only considered arbitrage between locations. It is entirely possible that the company has access to investment opportunities or financial markets that other Rosca participants do not have access to. For instance, the arbitrager may have significantly more collateral than ordinary Rosca participants and may hence be able to borrow from commercial banks – or the Rosca company may have outside investment opportunities because she is able to bundle funds and overcome indivisibilities. We consider this possibility within our basic model. Suppose now that the company has access to a perfect capital market, i.e. it can borrow/save a dollar and repay/earn $R \geq 1$ dollars one period later. In this situation, the company arbitrages not only between branches, but also between Roscas in general and the outside capital market. In this scenario, which we term "cross arbitrage", all testable implications continue to hold except for the company's average rank, which may now be greater or smaller than one half (depending on whether R is closer to μ_1 or μ_2).

The company's maximization problem (7) subject to (8) now becomes (the unconstrained problem)

$$\max_{b_1,b_2}(b_1 - R)(1 - 2F_1(b_1)) + (b_2 - R)(1 - 2F_2(b_2)).$$

Notice that the term $b_i - R$ is the period two profit for each pot won in location i. The solution can be characterized by the two equations

$$g_1(b_1) = g_2(b_2) = R. \tag{14}$$

Notice that the first equality is the same as in the situation of pure arbitrage; see (9). It hence follows that for an appropriate value of R, R' say, the two scenarios yield the same

values of b_1 and b_2, and hence identical testable implications. However, in general the previously derived implication "company's average rank equals one half" will not continue to hold (whenever $R \neq R'$). Denoting the company's average rank by $rk \in [0,1]$ (i.e. 0 for winning early and 1 one for winning late pots only), recall that

$$rk = 1 - \frac{F_1(b_1) + F_2(b_2)}{2}.$$

One can derive the comparative static result,

$$\frac{d\ rk}{dR} = -\frac{1}{2}\left(\frac{f_1(b_1)}{g_1'(b_1)} + \frac{f_2(b_2)}{g_2'(b_2)}\right).$$

As $g_i'(b_i)$ will usually be positive (a sufficient condition is A1), this multiplier will usually be negative. This is as expected: the higher the interest rate in the capital market, the more likely is the company to be a net borrower in Roscas.

Example with Uniform Distributions

We consider the same uniform specifications of F_1 and F_2 as in the previous example. The conditions (14) imply that

$$b_i = \frac{R + \mu_i}{2},$$

i.e. the company's bid is simply the average of the capital market interest rate and the average productivity in location i. As a consequence,

$$\Delta_r = \frac{1}{2}\Delta_\mu,$$

i.e. the interest rate spread accross branches is precisely the same as with pure monopolistic arbitrage. So, at least in this example, access to a perfect capital market does not affect sptatial price fragmentation in Roscas.

The average rank of the company is now

$$rk = \frac{1}{2}\left[1 + \left(R - \frac{\mu_1 + \mu_2}{2}\right)\right],$$

i.e. for $R = (\mu_1 + \mu_2)/2$, the rank is precisely one half (as with pure arbitrage), while a larger R implies a higher (=later) average rank of the company.

For the company's profits, we have

$$\Pi_{CM} = \frac{(\mu_1 - R)^2 + (\mu_2 - R)^2}{2\alpha}.$$

It can be shown that $\Pi_{CM} = \Pi_A$ iff $R = (\mu_1+\mu_2)/2$ and $\Pi_{CM} > \Pi_A$ iff $R \neq (\mu_1+\mu_2)/2$ (more precisely, Π_{CM} is convex in R and has its minimum at $R = (\mu_1+\mu_2)/2$). So the company will in generally be better off when it can combine inter-locational arbitrage with arbitraging between Roscas and the capital market more broadly.

Testable Implications The following table summarizes the testable implications of insider arbitrage and without access to an outside capital market.

	Pure Arbitrage	Cross-Market Arbitrage	
		Outside Return	
		High	Low
Correlation btw. observed r and company's rank	positive	positive	positive
Company's avg. rank	one half	< 0.5	> 0.5
Correlation btw. observed r and company's participation	zero	(possibly) negative	(possibly) positive

Note that if the outside return for the company is relatively high it is less likely to participate in Rosca locations where the interest rate is higher than average (and vice versa).

Extending the Theory

The Roscas we have considered in the model are simplifications of those observed in practice. In particular, (i) bids in the observed auctions are distributed as dividends in the same round, and not interest payments in later rounds and (ii) our sample Roscas have more

than two rounds. Nonetheless, the testable implications derived for our simplified model generalize to auctions that take the observed Rosca rules more literally (under certain assumptions).

More specifically, our model considers locations with differences in aggregate productivity that are known before the Roscas commence – and are observed by the company. One might be concerned about situations where the differences in productivity across locations are not know ex-ante. In a world with multi-period Roscas, for instance, such uncertainty may be even more of a concern. We imagine pure arbitrage occurs by taking positions in several Roscas and then borrowing from those with interest rates lower than the expected average for the entire economy and saving in those with interest rates higher than that average. Further, the information requirements for cross arbitrage are reduced relative to the pure arbitrage case considered above. With cross arbitrage, the arbitrageur simply needs to bid according to her outside return; i.e. borrow when the implied borrowing rate in the Rosca is lower than the outside return, and save otherwise. Note, however that we have assumed that the arbitrageur is risk-neutral – and indeed the theoretical results would generalize with many risk-neutral arbitragers – but arbitrage in face of location-specific uncertainty would be limited if the arbitrageurs were all risk averse.

4 Results

Financial Fragmentation

We first explore the extent of fragmentation of interest rates accross space. Towards this we estimate

$$r_{dij} = a_i + u_{dij}$$

by OLS, where d indexes denominations, i branches, and j Rosca groups of denomination d in branch i. The interest rate r is computed for each Rosca in our sample according to (1). The resulting branch means $\widehat{a}_i$ are plotted in figure 1, where a numerical branch identifier

is on the horizontal axis, and the (monthly) implied interest rate on the the vertical axis. Figure 2 maps branch interest rates. Statistics of the distribution of the $\widehat{a}_i$'s are set out in Table 3, column 1. Accordingly, the coefficient of variation is $0.099/0.76 = 0.13$. From Figure 2, the 95% confidence interval for this sample of branch averages is roughly $[0.60, 1.00]$, hence its width equals almost precisely four times the standard deviation. According to Table 3, column 1, the hypothesis of equality of all a_i's is rejected at the 1% level.

Now we will control for the denomination of a Rosca and the date when a Rosca takes place. This is important because a Rosca of a different denomination is a different financial product and the portfolio of Rosca denominations varies over branches. Moreover, even when there is no difference in interest rates over locations at any given point in time, this interest rate may vary over time. Therefore we also control for the date at which a Rosca was started. Our sample Roscas were started between January 2001 and October 2003. We denote by $quarter^k_{dij}$ a dummy variable which is equal to one for a Rosca that were started in quarter $k \in \{1, ..., 12\}$, where $k = 1$ covers the three months spell Januar to March 2001, and zero otherwise. We estimate

$$r_{dij} = \alpha_i + \gamma_d + \sum_{k=2}^{12} \xi_k quarter^k_{dij} + u_{dij}. \tag{15}$$

Rather than reporting the point estimates of this regression, column 2 of table 3 reports the properties of the estimated branch intercepts. Accordingly, the standard deviation is reduced by only about 4 percent, from 0.099 to 0.095. The hypothesis of equal interest rates accross branches is still clearly rejected. From this exercise, we conclude that the bulk of spatial variation fails to be explained by differences in Rosca denominations or Rosca dates. It is also interesting to note that the correlation beteween the estimated branch interecepts in columns 1 and 2 is 0.96.

Fragmentation: Borrower Risk, Collateral Requirements and Screening

The interest rate which we used as the dependent variable in the previous estimations is a pure savings rate. However, de facto it is an increasing function in the winning bids of

each rounds from 2 to $n-1$ in the Rosca. Hence it is also a kind of average of the price of funds implicit in all loans made over the course of a Rosca. An important question hence is whether spatial differences in our interest rates are due to fundamentally different borrowing conditions in local credit markets. Such differences may arise from at least two sources. On the demand side, borrowers may exhibit different risk characteristics with respect to repayment. On the supply side, loan officers' decisions may differ across locations. Both of these sources of spatial heterogeneity remain unobserved by the researcher, however. Luckily, data on defaults collateral and screening by the lender are in our data set. We can hence capture relevant non-monetary characteristics of loans by the default rate, the number of cosigners required on a loan and the screening effort of the lender. The latter is captured by an indicator which equals one if the Rosca company verified occupation and income of a borrower, and zero otherwise. Descriptive statistics of these three variables at the Rosca level are set out in table 2. Accordingly, 4.78% of dues have not been repaid by the time a Rosca ends, the company requires an average of 1.1 cosigners per loan and verifies the borrower's income 44% of the time.

Since we are interested in explaining *cross-patial* variation in interest rates (and not *intra-location* variation in interest rates), we will not simply add realizations of the variables at the Rosca level to estimation equation (15). Instead we shall separately calculate branch-specific fixed effects for default rates and for loan terms (collateral, screening), and use these branch-specific fixed effects to explain the spatial variation in interest rates. Note that if we had simply added the Rosca default rates to estimation equation (15), we would then confound the within-branch variation with the across-branch variation. From the theory section, however, the within-branch variation in Rosca interest rates might simply be a function of the small number of participants in each Rosca in a specific location and not due to inherent differences in returns to capital across locations.

Instead, we first estimate equation (15) with each of the three risk measures as left hand side variable in turn. This yields branch means net of time and denomination effects. In a second step, we use these estimated branch fixed effects as explanatory variables in a

regression with the estimated interest-rate branch intercepts from equation (15) as the left hand side variable. This latter regression thus has 78 observations, one for each branch.

To start out, in table 4 we have set out some descriptive statistics of the estimated branch fixed effects of three regressions (15) with default rate, number of cosigners, and income verification as the left hand side variable, respectively. According to the resulting coefficients of variation, these risk measures exhibit substantially greater spatial variation than the interest rate (where the CV is 0.13).

Column 1 of table 5 summarizes the results of a linear regression specification of the interest rate branch fixed effects on the estimated fixed effects of the three loan characteristics variables. Column 2 adds squared terms of the explanatory variables. According to the results, only defaults are significantly correlated with interest rates, where - as expected in e.g. a Stiglitz-Weiss world - riskier borrowers have a higher willingness to pay for loans. Column 3 of table 3 summarizes the distribution of the residuals from this regression. Accordingly, the standard deviation is reduced to 0.080 after controlling for the risk factors. The null hypothesis of complete market integration - conditional on loan characteristics - continues to be rejected, however.

The lower panel of that table gives p-values of tests for equal variances between pairs of the three samples of estimated fixed effects (or residuals in the case of column 3). While the difference between the first and the second, and the second and third specifications are zero, there is, at least at the 10 percent level, a significant reduction in fragmentation between the first and third specification. Thus risk together with controls for denomination and time significantly explain about 20 percent of spatial differences in interest rates as measured by the standard deviation. The remaining 80% remain unexplained, however.

Arbitrage

We next test if there is systematic arbitrage between locations by the company. We measure the rank (or position) of the winner of a pot on a 0 to 1 scale, where 0 represents a receipt of the first pot – and 1 represents the receipt of the last pot. More precisely, we define the

rank of the winner of the t'th pot in the j'th Rosca of denomination d in location i as

$$rank_{dijt} = \frac{t-1}{T_d - 1},$$

where T_d denotes the duration (in months) of denomination d. Descriptive statistics on the company's participation at the Rosca level are set out in table 2. Accordingly, the company holds about a third of all Rosca memberships and on average occupies a rank of 0.41, which indicates that the company on average wins pots earlier than in the middle of a Rosca. These same variables at the branch level are set out in table 4. According to the coefficient of variation, the company's activities exhibits spatial variation on a similar order of magnitude as the interest rate. The mean rank of the company of .41 indicates that the company is more interested in early than in late pots, and thus, within our theoretical framework, might be arbitraging not only across branches but also against an outside investment opportunity with a higher rate of return than the average in the Roscas. In all but three of the 77 branches, the institutional investor's rank is below 0.5.

Profit maximizing arbitrage by the company (which reduces spatial variation in interest rates without eliminating them) implies a positive correlation between the local interest rate and the company's rank in the respective location. Using only pots won by the company, we first estimate

$$rank_{dijt} = b_i + \gamma_d + \sum_{k=2}^{12} quarter_{dij}^k + v_{dijt},$$

where t indexes the round in a Rosca, $t = 2, ..., T_d$. Figure 3 plots the resulting branch fixed effects $\widehat{b_i}$ on the vertical axis against the estimated fixed effects of (15) in its original version (with the interest rate as the dependent variable) on the horizontal axis. Clearly, there is a positive relationship between these two variables. Hence,the institutional investor takes relatively early pots (i.e. borrows) where interest rates are relatively low, and waits to take later pots when interest rates are relatively high. We can also formally reject the null hypothesis of no arbitrage by the company: the correlation coefficient between the two variables is 0.48 and significantly bigger than zero at the one percent level. Column 3 of table 5, moreover, shows that this positive correlation also holds conditional on other loan

characteristics. The estimated coefficient of 1.232 suggests that an increase in the company's rank by one standard deviation (0.043) comes together with an interest rate that is 0.051 percentage points higher, more than half a (cross-branch) standard deviation of the interest rate.

Barriers to Entry

So far we have argued that the results support the idea of a monopolist arbitrager (the company) who intentionally preserves interest rate differences between locations. The natural question that arises is how the company can keep out potential entrants into arbitrage. Arbitrage is costly for potential entrants who have to pay the commission fee and provide cosigners at the time of borrowing; while such costs are not borne by the company. In this section, we briefly discuss how the observed interest rate heterogeneity across space is consistent with commission as a barrier to entry. According to the theory, competitive costly arbitrage will drive down the interest wedge between any two locations to twice the commission fee. As our sample Roscas have longer durations than those in the model, this fee has to be scaled to a fee per month to make it comparable to the monthly interest rates. Accordingly, the fee of 5% paid to the organizer by the winner of a Rosca auction amounts to roughly 0.33% in interest rate terms per month. This is calculated as follows: to arbitrage across any two Roscas requires an entrant to pay the commission twice, and since the commission is paid for an average Rosca duration of 30 months, the per month commission is $\frac{2}{30}$ 5%. An interest difference of 0.33% between any two branches in accordance with competitive, albeit costly, arbitrage in this institutional setup. According to table 3, column 1, the range of interest rates, 0.505, as well as the 95% confidence band with a width of about 0.40 is larger than 0.33. However, when we consider all possible pairs of branches, 97% percent of pairs have a difference not exceeding 0.33. The spatial distribution of interest rates appears to be largely consistent with insider arbitrage with costly entry, where the cost is about as large as the commission fee.

Within-Branch Variation

We next compare interest rate variation across branches (which has been the focus of the paper so far) with interest rate variation within a branch. Our theoretical model predicts that there should be no interest-rate variation within a branch (in two-period Roscas) because the insider arbitrager equates interest rates in all Roscas each location through its bidding. But the observed Roscas range in length from 25 to 40 rounds and the company only takes one-third of all positions on average, leaving considerable room for auctions in which the company has no role. So we would expect considerable unexploited variation within Roscas as well. To measure this, we estimate

$$r_{dij} = \gamma_{di} + \sum_{k=2}^{12} \xi_{dk} quarter_{dij}^{k} + u_{dij} \tag{16}$$

by OLS. The residuals of this regression capture exclusively deviations of Roscas of the same denomination in the same branch started in the same quarter. The distribution of the error terms will arguably be due to small sample variation in the composition of Rosca groups in the same branch and idiosyncratic shocks occuring to Rosca participants which the limited group size is not able to smooth fully. Hence the dispersion of the residuals from this regression capture the local interest rate dispersion (and hence fragmentation within a location) due to the fairly small scale of of intermediation in a Rosca - a feature uncommon to bank lending, for example. Using the same sample of Roscas underlying the results in table 3, estimation of (16) yields a regression standard error (which equals the standard deviation of the residuals) of 0.146. The corresponding cross-branch standard deviation of the interest rate of 0.095 (table 3, column 2) is roughly two thirds of this figure.

5 Conclusion

The principle of no-arbitrage, so crucial to economic reasoning, implies that risk-adjusted interest rates should be equalized across financial markets. We have presented evidence to the contrary. The financial markets we study are those organized in different towns

in the South Indian state of Tamil Nadu. The interest rates we analyze are determined by local auctions. These interest rates accrue to savers who face an identical risk across markets. What is remarkable about this variation in interest rates is that it persists despite the presence of an inside arbitrager who borrows in low-interest locations and saves in high-interest locations. We provide an explanation for why this arbitrager may deliberately choose to maintain the interest rate spread at the cost of financial efficiency and discuss entry barriers into arbitrage that enable such monopoly profits.

Our results raise questions about the competition between the organized (and regulated) Roscas in our study and the commercial banking sector. One might expect then that the variation in interest rates between financial markets may depend partly on the presence of bank branches in those locations. In ongoing research we are studying whether the presence of bank branches reduces the financial inefficiencies across markets. Relatedly, it would be useful to understand if the liberalization of the Indian economy in the 1990s has promoted more efficient flow of finance across markets. By historically studying the evolution of interest rates across Rosca locations we hope to provide an insight into this question.

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Table 1. Descriptive Statistics, Rosca Denominations

Duration (Months)	Contribution (Rs./month)	Pot (Rs.)	Frequency	Relative Frequency
25	400	10,000	488	23.74
25	600	15,000	8	0.39
25	800	20,000	9	0.44
25	1,000	25,000	278	13.52
25	2,000	50,000	214	10.41
25	4,000	100,000	80	3.89
25	8,000	200,000	2	0.10
25	12,000	300,000	1	0.05
25	20,000	500,000	3	0.15
30	500	15,000	282	13.72
30	1,000	30,000	98	4.77
30	1,500	45,000	2	0.10
30	2,000	60,000	22	1.07
30	2,500	75,000	11	0.54
30	3,000	90,000	7	0.34
30	4,000	120,000	1	0.05
30	5,000	150,000	53	2.58
30	10,000	300,000	22	1.07
30	20,000	600,000	4	0.19
30	25,000	750,000	1	0.05
30	30,000	900,000	2	0.10
40	250	10,000	176	8.56
40	375	15,000	1	0.05
40	500	20,000	3	0.15
40	625	25,000	85	4.13
40	750	30,000	2	0.10
40	1,250	50,000	77	3.75
40	1,500	60,000	3	0.15
40	2,500	100,000	99	4.82
40	3,750	150,000	2	0.10
40	5,000	200,000	4	0.19
40	7,500	300,000	4	0.19
40	12,500	500,000	4	0.19
40	12,500	500,000	3	0.15
40	15,000	600,000	1	0.05
40	25,000	1,000,000	4	0.19
Sum			2056	100.00

Table 2. Descriptive Statistics, Sample Roscas

	Mean	Std. Dev.	Minimum	Maximum
Duration (months)	29.64	5.99	25.00	40.00
Contribution (Rs./month)	1,468.12	2,462.76	250.00	30,000.00
Pot (Rs.)	44,277.72	81,223.17	10,000.00	1,000,000.00
Date of first auction	August 30, 2002	181 (days)	Jan 2, 2002	Sept 13, 2003
Monthly Interest Rate (%)	0.74	0.22	0.00	1.59
Default Rate (%)	4.78	2.55	0.00	19.68
Cosigners	1.10	0.62	0.00	3.89
Income Verification	0.44	0.25	0.00	0.97
Company Participation	0.32	0.19	0.00	0.95
Company Rank	0.41	0.10	0.08	0.83

Number of observations: 2,056

Table 3. Monthly savings rates, summary of estimated fixed effects/residuals

	Without Controls	With Controls (time, denomination)	Net of Defaults, collateral, screening
	(1)	(2)	(3)
Mean	0.760		
Standard Dev.	0.099	0.095	0.080
Range	0.505	0.475	0.463
Test for Equality (p)	0.000	0.000	0.000
Test for Equal Variances (p-value):			
(1) and (2)	0.716		
(1) and (3)	0.069		
(2) and (3)	0.147		

Number of observations: 78

Table 4. Distribution of Estimated Fixed Effects of other Variables

	Mean	Range	Std	Coeff. of Var.
Default Rate (%)	4.185	6.839	1.374	0.328
Cosigners	1.140	2.224	0.421	0.369
Income Verification	0.455	0.758	0.191	0.420
Company Participation	0.343	0.331	0.078	0.228
Company Rank	0.410	0.202	0.043	0.105

Notes: Number of observations: 78,

The mean is the average over all Roscas in the sample

Range and standard deviation are calculated from estimated branch fixed effects

CV is the standard deviation divided by the mean as reported in this table

Table 5. Explaining Spatial Interest Rate Differences

Dependent Variable: Branch intercepts from interest rate regression

	(1)		(2)		(3)	
Intercept	0.666	***	0.805	***	0.418	***
	(0.045)		(0.093)		(0.091)	
Defaults	0.028	***	-0.042		0.001	
	(0.007)		(0.030)		(0.008)	
Defauts Squared			0.009	**		
			(0.004)			
Cosigners	0.034		-0.003		0.038	
	(0.023)		(0.131)		(0.021)	
Cosigners Squared			0.016			
			(0.045)			
Screening	-0.083		-0.122		-0.110	
	(0.052)		(0.359)		(0.053)	**
Screening Squared			0.036			
			(0.313)			
Company's Participation					-0.599	***
					(0.142)	
Company's Rank					1.232	***
					(0.284)	
R-Squared	0.23		0.24		0.42	
Number of observations	78		78		78	

Notes:
all explanatory variables are estimated branch fixed effects
from a regression of the explanatory variable on branch FEs
denomination and time dummies

Figure 1. Distribution of Branch Interest Rates

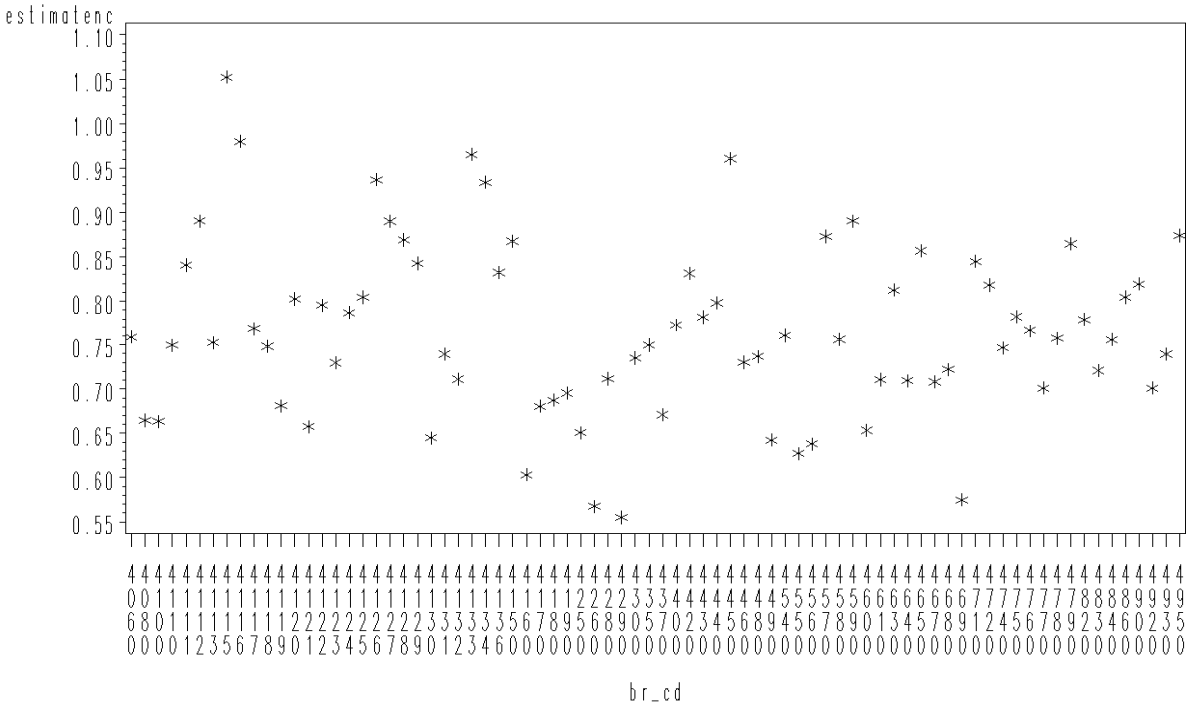

Figure 2. Map of Branch Interest Rates

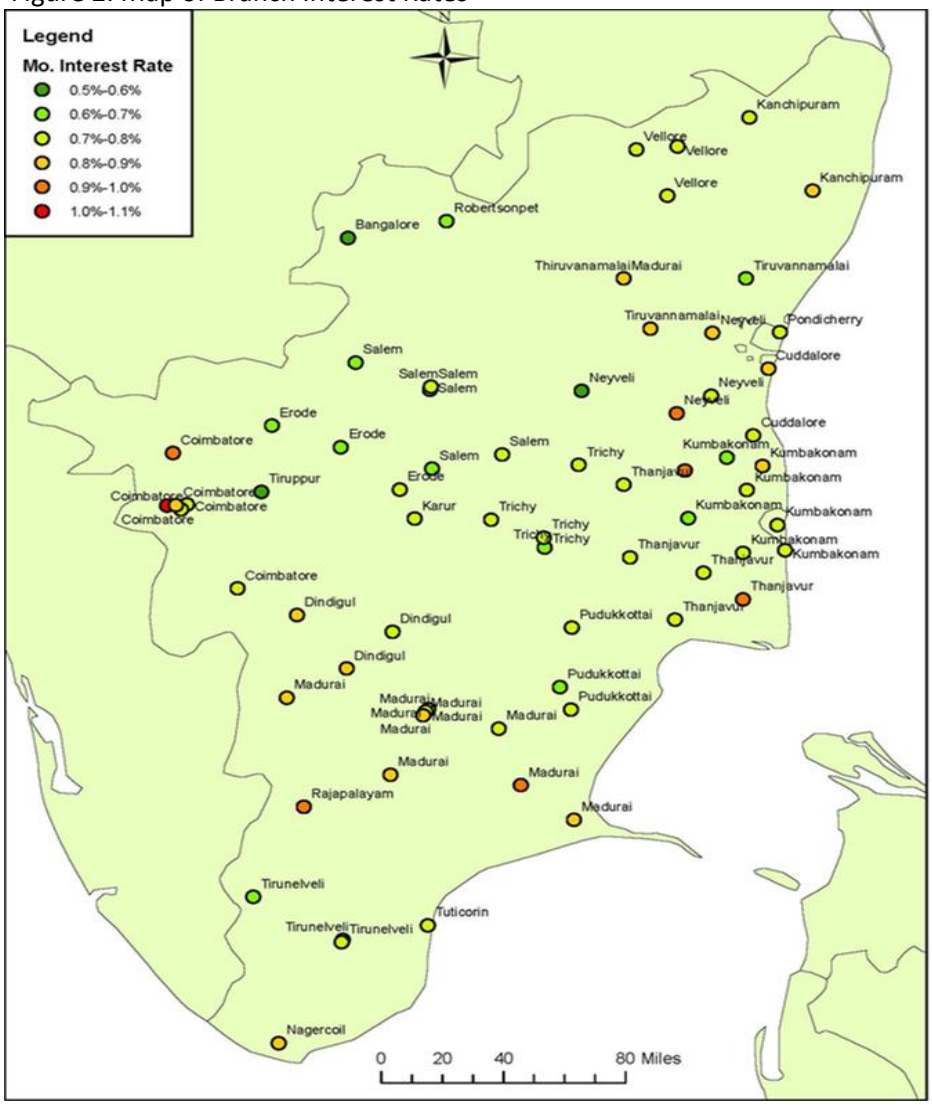

Figure 3. Scatter Plot of Company's Rank and Local Interest Rates

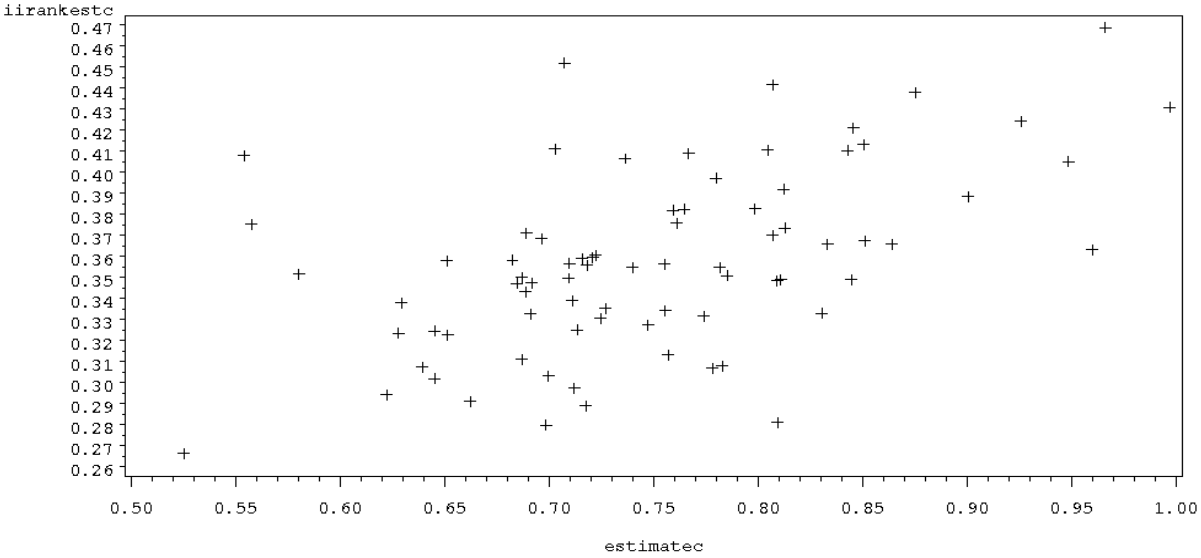

Figure 4. Scatter Plot of Company's Participation and Local Interest Rates