Economic Institutions as Matching Markets*

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Abstract

Many economic institutions such as firms, professional partnerships, and financial intermediaries, bring heterogeneous agents together to exploit gains from trade. This paper presents a general framework for analyzing decentralized matching into such economic institutions. The theory is tested using data from financial intermediaries in South India, that bring borrowers and lenders together in small groups of different durations. In line with the predictions of the theory, we find that participants sort remarkably well across the competing groups and that they re-sort immediately following an unexpected regulatory change.

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1 Introduction

Many economic institutions bring heterogeneous agents together to exploit gains from trade. Common examples of such institutions include firms, professional partnerships, and financial intermediaries. Law firms, for example, bring together partners and associates with varying levels of ability and seniority, and venture capitalists team up with technical specialists to provide them with funds to develop and execute new ideas. While the internal organization of such institutions has been extensively studied, both in theory and in practice, most previous analyses have treated the composition of participants as exogenously determined. In contrast, this paper explicitly acknowledges that participants can often choose between contending institutions in the market; when an associate joins a law firm, she will typically have the opportunity to join other partnerships as well. We present a general framework for analyzing decentralized matching into institutions, and the equilibrium composition of participants that consequently arises. The predictions from the theory are tested in a specific setting, that of financial intermediaries in South India. The payoff from choosing a particular institution is typically not observed *ex ante* in these matching markets, and will in general depend on the choices made by other participants. Nevertheless, we find that participants sort remarkably well across the competing institutions, and that they re-sort immediately following an unexpected regulatory change.

Like Roth's (1984) pioneering work on the analysis and design of two-sided matching markets, our focus is on characterizing the matching outcome, or equivalently the equilibrium composition of participants, across competing institutions in the market. Previous studies have found that the decentralized equilibrium in matching markets can be unstable, in the sense that participants matched together would want to re-sort *ex post*. Such instability could lead to "unravelling," with private agreements being made outside the market, as in the matching of interns to hospitals (Roth 1984). This has resulted, in turn, in the implementation of market design solutions that involve centralized matching (e.g. NIMP, the National Intern Matching Program of the American Medical Association). Transfers within individual institutional arrangements are absent in the applications that result in instability, such as the market for medical interns where salaries are fixed and constant across hospitals. These transfers are, however, present in the financial institution that we analyze in this paper, as well as in most economic institutions, which lead to a stable matching as the decentralized equilibrium.[1] We thus expect that the ability of participants to sort, and re-sort, so smoothly in the application that we consider would be replicated in other economic institutions as well (when within-institution transfers are available).

The institutions that we analyze in this paper – commercial chit funds – operate in cities and towns throughout South India. These chit funds are financial intermediaries that bring borrowers and lenders together in small groups. All participants in a group contribute a fixed amount each month, and the pot of money thus collected is subsequently auctioned within the group. The winning

[1] See Roth and Sotomayor (1990) for a discussion on strategy-proofness in matching models with transferable utility.

bidder keeps the pot minus the bid amount, which is distributed equally within the group as a "dividend". This process continues for as many months as there are participants, with a fresh auction each month, until all participants have received the pot once. The dividend generated endogenously within the group thus acts as an interest payment or transfer. Participants who win the pot early are effectively borrowers, while those who wait until the end are effectively lenders – the participant who wins last receives his principal and all the dividends generated over the course of the group. Registered chit fund companies facilitate the matching of thousands of participants into different chit fund institutions, i.e. groups of different sizes (and therefore of different durations). Our objective is to understand how borrowers and lenders match together in different types of groups across this matching market.[2]

Participants in the matching market choose a group size based on the *proportion* of borrowers and lenders that they expect to encounter in different types of groups, which in turn determines the payoffs that they will receive. Intuitively, an increase in the proportion of borrowers increases the competition for the pot, lowering the payoff for the borrowers and increasing it for the lenders. Without a participation price for each group to guide them, individuals use the anticipated composition of borrowers and lenders in each type of group to arrive at the decentralized matching, which leaves each agent indifferent between the various types of groups in equilibrium. The simple matching model we propose in this paper predicts a systematic relationship between group duration and the proportion of borrowers that we will subsequently verify, using data from a large registered chit fund company based in Chennai (formerly known as Madras): the proportion of borrowers, as a result of the equilibrium matching, is found to be decreasing in the duration of the group.[3]

Our analytical framework also allows us to predict the decentralized matching outcome after the introduction of an unexpected government regulation in September 1993, capping the bids at 30% of the pot amount. While this exogenous shock (the bid-cap) directly affected bids in the long duration groups alone, our matching model suggests that this shock would affect matching across the market. A cap on the bids reduces competition among the borrowers, and the matching equilibrium predicts that the proportion of borrowers will increase more in the long duration groups to equalize payoffs across different types of groups. In addition, the proportion of short duration groups should increase following the bid-cap. Using data before and after the policy shock we verify that the mix of borrowers and lenders within the group, as well as the mix of different types of groups in the market, respond immediately to the bid-cap, exactly as predicted by the theory. This further confirms the main finding in this paper, that even in the absence of a price signal about the attractiveness of

[2]For the purpose of this paper each group is treated as an institution. The set of all groups and their participants defines the matching market.

[3]A unique feature of this application is that it is easy to single out *ex ante* borrowers, since the organizing company privately records whether a participant is a "corporate subscriber". These subscribers, who account for roughly 20% of all participants, are financial companies who tend to win the auction on average much earlier than the "private subscribers".

different duration groups, the proportion of borrowers and lenders acts as an equilibrating force in this matching market.

The chit fund institution is particularly suited for testing the theory of decentralized matching into economic institutions. The rules of the game and the payoffs that participants obtain in this financial institution are well defined, participants can choose freely between alternative groups in the market, and there are transfers within groups. However, the analytical framework that we lay out is suitable for studying other economic institutions in which heterogeneous agents match together as well. Recent work by Garicano and Hubbard (2003) for example, shows that the internal organization of law firms varies across markets of different sizes. Associates and partners work together in law firms, in part because there are gains from dividing work between attracting and dealing with clients and writing legal opinions. Our framework could be applied in this case to study how the mix of partners and associates varies across firms of different sizes (or prestige) in the same market, or how the internal organization of firms responds to an exogenous change, for example in the demand for a particular legal specialty. Similarly, Moretti (2003) and others have studied the relationship between the skill composition of workers and their productivity in the U.S. economy. Our theory could be extended to analyze how high-skill and low-skill workers match together in firms to exploit gains from trade, how the skill composition varies across firms depending on the underlying production technology, and how this composition responds to skill-biased technological change of the sort described in Berman, Bound and Griliches (1994).

In addition to characterizing the matching process, our analysis also indicates that the particular economic institutions that we study – chit funds – capture substantial gains from trade.[4] The stream of dividends reflects the price of capital within the group, and we calculate that chit funds generate an implicit interest rate of around 18%, which is twice the rate in the monopolistic banking system where credit is severely rationed by government regulators and the Reserve Bank of India (RBI). This can certainly help explain the success of the commercial chit fund institutions in bringing together borrowers and lenders, especially in Southern India, where chit funds accounted for a substantial share of the credit market by the early 1990s.[5] We also find that the bid-ceiling imposed in 1993 distorted the price of capital across the matching market, as interest rates dropped substantially in both long duration and short duration groups. This decline in the interest rate explains the reduction in overall participation in the chit fund company that we observe. From a welfare perspective, it is clear that regulation that affects some of the institutions (here, the long duration groups) will have implications for all other institutions (the short duration groups) in the matching market.

[4]There are obvious inefficiencies associated with the chit fund – trade is restricted within the group and the opportunities for inter-temporal substitution are severely limited. These inefficiencies are unavoidable since the chit funds must adhere to a precise organizational structure, as specified by law, in order to be allowed to function. Yet, they appear to capture sizeable gains from trade.

[5]As described in Section 2, starting with almost no companies in the 1970s, deposits in *regulated* chit fund companies amounted to 12.5-25% of bank credit in the South Indian states of Tamil Nadu and Kerala by the early 1990s.

The paper is organized in six sections. Section 2 describes the commercial chit fund institution in South India in greater detail and the events leading up to the bid-cap in 1993. Section 3 presents a simple model of the chit fund, which generates predictions for the sorting of borrowers and lenders across groups, before and after the bid-cap. Section 4 tests the predictions of the model, and Section 5 concludes.

2 The Institutional Setting

While traditional chit funds have been widely prevalent in South Indian villages for centuries, the commercial chit fund is a relatively recent phenomenon.[6] Ardener (1964) places the emergence of commercially organized 'Chit Fund Groups' at the beginning of the twentieth century, mostly in Chennai (then known as Madras), and to some extent in Travancore and Cochin. But these commercial chit funds appear to have been quite rare, even as late as the 1970s. Anderson (1962) tells us that the first registered chit fund company in Hyderabad, the capital of Andhra Pradesh and another important center for chit fund activity today – the S.N. Chit Fund Co. – was founded in 1951. Similarly, the company that provided us with the data (Shriram Chits and Investments Pvt. Ltd.), one of the oldest and most established companies in Chennai, was founded in 1974. From our discussions with the founders of the company, there were only a handful of commercial chit fund companies in Chennai prior to that date.

The Indian financial system was nationalized in the early 1970s, after which only specially designated Non-Bank Financial Companies (NBFCs) were permitted to function as financial intermediaries, in competition with the government banks. One such NBFC was the commercial chit fund.[7] Companies that operate as registered chit funds have to satisfy a number of specific criteria. These criteria were first laid out in Section 2(2) of the Madras Chit Funds Act, 1961, which regulated the institution in the state of Tamil Nadu. Subsequently they were adopted in their entirety in the Miscellaneous Non-Banking Companies Directions, an interim regulatory document issued by the Reserve Bank of India in 1973, and ultimately in Section 2(b) of the central Chit Fund Act, 1982, which applies to the entire country:

[6] In its simplest form, as analyzed by Besley, Coate and Loury (1993, 1994), the chit fund or rotating savings and credit association (Rosca) is a savings mechanism that facilitates the purchase of consumer durables. Roscas are found, under various names, throughout the developing world, and even among migrant groups in the U.S. and other developed economies (see Geertz 1962 and Ardener 1964 for comprehensive surveys). In contrast, *commercial* chit funds are financial intermediaries that bring heterogeneous agents together to exploit gains from trade. They are found exclusively in south Indian towns and cities, and operate at a scale that far exceeds the level of activity in Roscas found elsewhere in the world.

[7] According to the Reserve Bank's definition, NBFCs include equipment leasing companies, hire purchase financing companies, loan companies, investment companies, mutual benefit financial companies (*nidhis*), miscellaneous non-banking companies (chit funds), residuary non-banking companies, and housing finance companies.

"Chit" means a transaction whether called chit fund, chit, kuri, or by any other name, by which its foreman [the company] enters into an agreement with a number of subscribers that every one of them shall subscribe a certain sum or a certain quantity of grain by installments for a definite period and that each subscriber in his turn as determined by lot or by auction or by tender or in such other manner as may be provided for in the agreement shall be entitled to a prize amount.

As long as the chit fund is organized precisely along the lines laid out above, the company can operate as a financial intermediary, regulated by the Registrar of Chit Funds in each state, rather than by the Reserve Bank of India. The stream of dividends reflects the competitive price of capital within the group, and so chit funds were able to generate an interest rate that was at least 3-4 percentage points higher than what could be obtained by depositing capital in the monopolistic banking system (James Raj Commission Report 1975). Businesses, and borrowers in general, also benefited from this institution, since credit was so severely rationed by the banks. Not surprisingly, chit funds captured an increasing share of the credit market over time. Starting with almost no registered companies in the 1970s, deposits in *registered* chit funds were estimated to be roughly 10% of the volume of bank deposits in the South Indian state of Tamil Nadu by 1993 (Bouman 1995), and 15% of the deposits in the neighboring state of Kerala (where chit funds play a more prominent role in the local economy) in 1987 (Shah and Johnson 1989). The same sources report that the amount of credit made available by the chit fund companies was 12.5% of bank credit in Tamil Nadu and 25% of the credit in Kerala.[8]

Government regulators, and particularly the Reserve Bank of India, were quick to take note of the growth of the chit funds and other NBFCs, following the nationalization of the banking system. Several committees were appointed to study the working of these companies, prominent among them being the Bhabatosh Datta Commission (1971) and the James Raj Commission (1975). These committees felt that while many NBFCs frequently resorted to unfair methods, and therefore needed to be regulated, prohibiting them entirely would adversely affect certain sectors of the economy that had limited access to bank credit, or chose not to deposit their money with the banks. For the particular case of the commercial chit fund companies, these study groups recommended a Model Bill, to be enacted as a Central Act of Parliament, to ensure uniform regulation throughout the country. They also recommended that the administration of the legislation should be left to the state governments.

The Government of India acted on these recommendations and passed the Chit Fund Act in 1982, with implementation of the Act left to the Registrar of Chit Funds in each state. The 1982 Act departed most notably from the 1961 Madras Chit Fund Act, which it replaced, by imposing a 30% ceiling on the bids. The stated reason for the ceiling was to protect the depositors from defaults that would occur when the bids were pushed too high – this would be the standard story with adverse

[8]Statistics from the references cited above are combined with banking statistics from Reserve Bank of India documents to compute these numbers. There is little doubt that these statistics substantially underestimate the importance of this institution in the local economy, since they do not account for the myriad unregistered chit funds, organized along the same lines, in these states.

selection or moral hazard, in which only risky investors participate or only risky projects are chosen when interest rates are high. But it is very likely that the interest rates were also capped to restrict competition from the chit fund companies, since it was well understood that the higher interest rates that these companies could provide was perhaps their principal comparative advantage over the banks.[9]

Not surprisingly the chit fund companies went to court over the imposition of the ceiling. They were initially successful, and the Madras High Court granted a stay order in 1984 on a number of provisions of the 1982 Chit Funds Act, including the 30% ceiling.[10] However, the case did ultimately work its way through the courts, and after numerous appeals the stay order was vacated by the Supreme Court in September 1993. Given the enormous legal backlog, it is always difficult to predict when a case will come up for hearing in the Indian judicial system, and the numerous appeals that were filed in this case would only have added to the uncertainty surrounding the timing of its completion. We will thus find it reasonable to treat the 30% ceiling imposed in September 1993, a full eleven years after the passing of the 1982 Chit Funds Act, as an unpredicted policy shock.[11] The empirical analysis will compare the sorting into groups, one year before and one year after September 1993.

3 A Simple Model of Chit Fund Institutions

We now proceed to formalize the matching into groups and the pattern of bids in the chit fund auctions. In this simple model, there are two types of participants: high types and low types. High types have superior investment opportunities, and because in equilibrium they collect the pot earlier on average than the low types, we will often refer to them as the borrowers. The low types are the lenders. We solve the model in two stages. The first stage is the matching stage. Each agent chooses to participate in a group of a certain duration, based on the expected future payoff from that group. The second stage determines the payoff from the sequence of auctions in the group.

Given a menu of groups, the participant chooses the group that maximizes her expected future payoff. We will see that the proportion of high types adjusts to leave each agent indifferent between the various types of groups in equilibrium. For example, if an exogenous shock increases the payoffs

[9] As the Shah Commission report (1992:20), prepared for the Reserve Bank, put it: *The importance of interest differential as a motivating factor for transfers of deposits from commercial banks to NBFCs is well recognized ... The NBFCs compete with the monetary system and there is need to regulate them.* In fact, from our data we find that default is extremely low, in part due to the strict legal requirements on deposits.

[10] The chit fund company is required to deposit a fixed proportion of the value of the pot with the Registrar of Chit Funds prior to commencement of the group as security. The required deposit level was increased in the 1982 Act over its 1961 level, which was another issue that the chit fund companies took to court.

[11] In fact, the bid ceiling was imposed only on the newly started funds, and did not affect those running after September 1993, but that started earlier. So even if it were anticipated, we don't expect to see any change in the bidding behavior. An anticipated shock may have lead borrowers to delay entry after the ceiling and lenders to speed it up to before the ceiling. This is also in line with the predictions of an unanticipated shock.

that the high types receive in one type of group, relative to the other groups that are available, then this will generate an inflow of high types into that group (which lowers the payoffs that they receive) until indifference is restored once again.

Section 3.1 describes the population and preferences, the matching technology and the auction technology. We solve the model backwards, starting in Section 3.2 with the pattern of bids in the second stage auction, and the payoffs that the participants receive. Subsequently, Section 3.3 derives the first stage matching equilibrium. Section 3.4 studies how the proportion of high types, in groups of different durations, responds to the exogenous 30% ceiling on bids that was put in place in September 1993. The analysis concludes in Section 3.5 by studying how the mix of groups of different durations shifts in response to this policy experiment.

3.1 Population, Preferences, Matching, and the Auction Technology

3.1.1 Population and Preferences

There is a continuum of infinitely lived chit fund participants. Each participant in this economy disposes of a fixed amount v each month that she can contribute to the chit fund. We could imagine, for example, that the participant saves a fixed fraction of her income each period. Every participant is indexed by an observable type $\gamma, \gamma \in \left\{\overline{\gamma}, \underline{\gamma}\right\}$, where $\overline{\gamma} > \underline{\gamma}$ and where the proportion of high types in the population is μ and the proportion of low types is $1-\mu$. Participants of type γ who manage to find finance have access to a deterministic investment opportunity with a return $1+\gamma$. The heterogeneity amongst agents derives from the return on the investment opportunity. Though both types can derive positive returns from investment, we will often refer to the high types $\overline{\gamma}$ as *borrowers* and the low types $\underline{\gamma}$ as *lenders*. This follows from the fact that the high types will have a higher willingness to pay for funding, and are therefore willing to move early in the chit fund auction. Time is discrete and all participants are risk neutral utility maximizers who discount the future at a common and constant discount factor $\delta \in [0,1)$.

3.1.2 The Matching Technology

The organizer of the chit fund announces a menu of groups for potential participants to choose from. Each group is characterized by the number of participants in the group N, the contribution that each participant must make each period v, and the proportion of high types in the group $p \in [0,1]$.

Matching is instantaneous and without frictions. Participants with a given savings of v must decide on a group duration. All agents simultaneously decide which type of group to participate in and therefore choose N to maximize their normalized expected payoff from participation $W(\gamma, N, p, v)$. This payoff will depend on the agent's type γ, the per period contribution v, the group duration N, and the proportion of high types in the group p. The proportion p is determined by the choice of other participants. In equilibrium, p will act as a balancing force, adjusting endogenously through

the matching process to leave agents indifferent between different group durations. The discussion that follows will describe how p varies across groups with different durations N, for a given v.[12]

3.1.3 The Auction Technology

The proportion of high types in groups of different durations N is determined endogenously through the first stage matching, as described above. Given p, in a group of duration N, the auction technology determines the (normalized) expected payoff for each type $W(\gamma, N, p, v)$ in the second stage. In each period $t = 1, ..., N$, all participants in a group contribute a rupee amount v to the fund, and at the same time, at each t a second price sealed bid auction is conducted in which the highest bid wins, and pays the second highest price. Each chit fund member can win the auction only once, so that participants in the auction are all those $N - t + 1$ chit fund members who have not won the auction yet. The winner receives the period's contribution of all N participants Nv minus her bid, which is distributed as a "dividend." The dividend is distributed equally amongst the remaining $N - t$ participants, i.e. those who have not won the auction yet.

The set up of the model is consistent with the actual organization of the chit fund auction in that there are no restrictions on the information concerning past bids, or the identity of past winners. However, the model departs from the actual chit fund auction in one aspect. All N participants in the group, including the most recent winner, share the winning bid equally each period in practice. While the assumption in the model does not change the nature of the auction, the advantage of the setup we have chosen is that it simplifies the expression for the payoff that we derive for each type and makes the model analytically tractable.

3.2 The Second Stage: Strategic Bidding

The agent compares her expected payoff from groups of different durations when she makes her participation decision in the first stage. An agent who joins an N-period group obtains an expected payoff denoted by $V_1(\gamma, N, v, p)$ in the first period from participation in that group. When this group terminates after N periods, the infinitely lived agent will join a new group with the same characteristics, receiving a payoff $V_1(\gamma, N, v, p)$, $N + 1$ periods in the future, which is equivalent to a discounted payoff $\delta^N V_1(\gamma, N, v, p)$. This process continues indefinitely in the future so that the normalized expected payoff $W(\gamma, N, v, p)$ that agents use to compare groups of different characteristics

[12] Instead of assuming an economy in which agents contribute a fixed amount v each period, we could have specified instead that agents participate in the chit fund with an exogenous savings target Nv in mind. In that case, they choose between different group durations N, with a fixed pot size Nv, and suitably adjusted savings patterns. Appendix B derives the equilibrium relationship between p and N in the economy with a savings target Nv, without changing the results reported below.

at the matching stage can be expressed as,

$$W(\gamma, N, v, p) = V_1(\gamma, N, v, p)\left[1 + \delta^N + \delta^{2N} + ...\right] = \frac{V_1(\gamma, N, v, p)}{1 - \delta^N}.$$

As noted, p will adjust so that $W(\gamma, N, v, p)$ is the same across different durations N for a given type γ in equilibrium. Let $\overline{W}(N, v, p)$, $\underline{W}(N, v, p)$ be the payoffs for high and low types respectively. The equilibrium condition that characterizes the matching in the first stage will later be expressed in terms of the difference between the payoff to the borrower and the lender, denoted by $\Delta W(N, v, p) \equiv \overline{W}(N, v, p) - \underline{W}(N, v, p)$, where

$$\Delta W(N, v, p) = \frac{\overline{V}_1(N, v, p) - \underline{V}_1(N, v, p)}{1 - \delta^N} = \frac{\Delta V_1(N, v, p)}{1 - \delta^N}$$

and so we will begin by deriving an expression for $\Delta V_1(N, v, p)$ in the second stage of the model, taking p and N as given. The comparative statics with respect to p and N, $d\Delta W(N, v, p)/dp$ and $d\Delta W(N, v, p)/dN$ that we subsequently compute will be used below to derive the equilibrium relationship between p and N in the first (matching) stage of the model.

Consider a group of duration N, with a proportion p high types. In Appendix A, the equilibrium bids are derived in greater detail, and we find that bids by high types always dominate bids by low types in equilibrium, so high types end up winning the pot in the first pN periods. Any high type's expected payoff in period $t \leq pN$ can be written as

$$\overline{V}_t = \frac{1}{pN - t + 1}\left(\overline{V}_N - \overline{b}_t\right) + \left(1 - \frac{1}{pN - t + 1}\right)\left(\delta\overline{V}_{t+1} + \frac{1}{N - t}\overline{b}_t\right)$$

where $\overline{V}_N = Nv(1 + \overline{\gamma})$ is the payoff in the last period, which is also equal to the return from investing. The probability of winning for a high type is $1/(pN - t + 1)$, where $pN - t + 1$ is the number of high types remaining in period t. When the individual wins, the payoff is the return on investment $\overline{V}_N$ less the bid $\overline{b}_t$. With complementary probability, the high type loses and gets the discounted expected payoff in the next period plus her share of the bid $\overline{b}_t$ that is distributed equally amongst the $N - t$ remaining players who have not won yet.

We also show in Appendix A that for $t = 1, ..., pN - 1$, the equilibrium strategy of the high types is to bid $\overline{b}_t = \frac{N-t}{N-t+1}\left(\overline{V}_N - \delta\overline{V}_{t+1}\right)$. The intuition behind this is that in all those periods, high types are competing with high types. This bidding strategy makes a player indifferent between winning the auction today, and losing and getting the discounted continuation payoff plus the dividend: $\overline{V}_N - \overline{b}_t = \delta\overline{V}_{t+1} + \frac{1}{N-t}\overline{b}_t$. For $t = 1, ..., pN - 1$, the expected payoff is thus given by

$$\overline{V}_t = \overline{V}_N - \overline{b}_t = \delta\overline{V}_{t+1} + \frac{1}{N - t}\overline{b}_t.$$

For the low types, who lose for sure in the early periods, the corresponding payoff is expressed as

$$\underline{V}_t = \delta\underline{V}_{t+1} + \frac{1}{N - t}\overline{b}_t.$$

We can now calculate ΔV_t immediately from the equilibrium payoffs above: $\Delta V_t = \delta \Delta V_{t+1}$. Solving recursively, $\Delta V_1 = \delta^{pN-1} \Delta V_{pN}$.

In period $t = pN$, there is only one high type left, and she now competes with all the low types. We show in Appendix A that both types bid as before, which in the case of the second price auction implies that the high type wins for sure and pays the low type's bid $\underline{b}_t = \frac{N-t}{N-t+1} (\underline{V}_N - \delta \underline{V}_{t+1})$. This implies that

$$\begin{aligned} \overline{V}_t &= \overline{V}_N - \underline{b}_t \\ \underline{V}_t &= \delta \underline{V}_{t+1} + \frac{1}{N-t} \overline{b}_t = \underline{V}_N - \underline{b}_t. \end{aligned}$$

Differencing the equations above at $t = pN$, we find that $\Delta V_{pN} = \Delta V_N$. Substituting this expression for ΔV_{pN} in the expression for ΔV_1 above,

$$\Delta V_1 = \delta^{pN-1} \Delta V_N,$$

where $\Delta V_N = Nv\Delta\gamma$.

¿From the expression for ΔW above, it immediately follows that

$$\triangle W(N, p, v) = \frac{\delta^{pN-1} Nv \triangle \gamma}{1 - \delta^N}. \tag{1}$$

We now derive two important properties of $\triangle W$ in any group, which indicate how the difference between the payoff to the borrowers and the lenders responds to changes in p and N. Differentiating ΔW with respect to p, it follows immediately that ΔW is decreasing in p.[13] As p increases, competition between the high types increases, pushing up the bids in the early periods. Higher early bids imply higher payoffs for the low types since the bid amounts are distributed among the losers, with an accompanying decline in the payoff for the high types.

Lemma 1. *Fixing the group duration N, the difference in the (normalized) expected payoff between borrowers and lenders is decreasing in the proportion of borrowers p.*

Next, we turn to the effect on $\triangle W$ of an increase in N. Consider a simple example with 10 borrowers and 10 lenders in the group ($p = 0.5, N = 20$). Borrowers win on average in the fifth period, while lenders win on average in the fifteenth period. Next, increase the group size to 24 participants, with the same proportion $p = 0.5$ of borrowers and lenders as before. Now borrowers win on average in the sixth period, while lenders expect to win in the eighteenth period. An increase in N, holding p fixed, evidently shifts back the winning time more for lenders than for borrowers. Note, however, that borrowers are more impatient than lenders (this is why they bid more and win early),

[13] Of course, p is not a continuous variable for a finite N, given that p is the fraction of high types. However, for the remainder of the discussion we will treat p (and N) as continuous variables. This is without loss of generality as it is easily verified that the properties of the derivatives can be replicated using differences.

and so even a single-period delay can be costly for them. This delay, together with the fact that there are now more borrowers (pN), increases the competition for the pot in the early periods, lowering the payoff for the borrowers and increasing it for the lenders. The delay-effect and the competition-effect described above work in opposite directions: When participants (particularly borrowers) are sufficiently impatient (δ is low), the competition-effect dominates and an increase in N will lower ΔW. When borrowers and lenders are both very patient (δ tends to one), the delay-effect dominates and ΔW will be increasing in N.

Lemma 2. *Fixing the proportion of high types p, the difference in the (normalized) expected payoff between borrowers and lenders is decreasing in the duration of the chit fund N, for sufficiently impatient participants.*

3.3 The First Stage: Endogenous Matching

We now proceed to describe the process by which participants sort themselves into chit fund groups. Each group is characterized by the number of participants N and the (correctly) anticipated belief about the proportion of high types that will decide to join that group $p(N)$. A potential participant choosing between alternative chit fund groups will compare the normalized payoff W from each group.

Suppose that a menu of groups is offered to potential participants. Then for each group N_i there will be associated an equilibrium belief $p(N_i)$ denoted by p_i. A *matching equilibrium* requires every participant to choose the group duration N that maximizes the normalized value function $W(\gamma, N_i, p_i)$. Note that we suppress the fixed per period contribution v in the W function, and in all the discussion that follows, to simplify the exposition. If different types of chit funds are to coexist, then the utility maximization requires $N \in \arg\max_N W(\gamma, N, p(N))$. In the case of a symmetric equilibrium with two types, a solution to this problem is interior[14], and implies

$$W(\gamma, N_i, p_i) = W(\gamma, N_j, p_j), \forall \gamma, \forall i \neq j. \tag{2}$$

It follows immediately that if condition (2) is satisfied for both $\underline{\gamma}$ and $\overline{\gamma}$, then the difference in the normalized value $\triangle W(N, p)$ will also be equalized across the chit funds:

$$\triangle W(N_i, p_i) = \triangle W(N_j, p_j), \forall i \neq j. \tag{3}$$

In addition, the condition must be satisfied that requires the proportion of high types p_i in each group be consistent with the proportion μ of high types in the entire market. Consider the case of

[14]Consider first the case where $p = 0$. Then there are no gains from trade to the low types (i.e. they will receive the same utility as under autarky), while the high types do benefit from funds where $p = 0$. As a results, high types will join the fund. On the other hand, from Lemma 1, the high types are relatively worse off as more high types enter (and the low types are better off). A similar argument applies to the case where $p = 1$.

two types $\overline{\gamma}, \underline{\gamma}$ with fractions $\mu, 1-\mu$ out of a total of n participants. Let the measure of groups of type i in equilibrium be n_i. Then the consistency condition requires

$$\sum_i n_i p\left(N_i\right) N_i = \mu \sum_i n_i N_i \tag{4}$$

where the total measure of participants is $\sum_i n_i N_i = n$.

We can now derive the main property of a matching equilibrium. Consider any two groups i, j with $N_i < N_j$. From Lemma 2, it follows that for sufficiently impatient participants

$$\triangle W\left(N_i, p\right) > \triangle W\left(N_j, p\right), \forall p$$

since $N_i < N_j$. Evaluated at $p = p_i$, this implies $\triangle W\left(N_i, p_i\right) > \triangle W\left(N_j, p_i\right)$. In equilibrium, $\triangle W\left(N_i, p_i\right) = \triangle W\left(N_j, p_j\right)$ from equation (3), so that

$$\triangle W\left(N_j, p_j\right) > \triangle W\left(N_j, p_i\right)$$

This implies, from Lemma 1, that $p_i > p_j$.

The intuition for this result is very simple. We know from Lemma 2 that $\triangle W$ is greater in short duration groups, for a given p. Thus p must be larger in the short duration groups, from Lemma 1, to equalize $\triangle W$ across groups of different durations.

Proposition 1. *The proportion of high types is declining in the duration of the group, for sufficiently impatient participants.*

This first result characterizes the properties of different matching allocations. It is worth observing that there exists a continuum[15] of pairs (p, N) that generate a constant normalized expected payoff for each type, and therefore a constant ΔW (setting the expression for ΔW equal to a constant, it is immediate that there is a locus of pairs p and N that satisfy this equation). Observe that the per capita surplus of the matching allocation is increasing in N when p is held constant. The intuition for this is that for higher N, there are more borrowers who are competing to win early. As a result, there exist a locus of combinations of p and N that generate the same payoff to each type. Therefore, if we can freely determine W for each type, there will be a continuum of possible allocations, each with a constant payoff.[16]

3.4 The Policy Experiment and the Change in Endogenous Matching

The law that came into force in September 1993 caps the bids at 30% of the auction value Nv. We now proceed to study the effect of this restriction on the matching equilibrium. We begin by showing that

[15] Remember that we are treating p and N as continuous variables.

[16] A proof of existence in the case of W determined in the chit fund auction needs to rely on the explicit expressions of $\overline{W}$ and $\underline{W}$. Unfortunately, while W can be computed recursively, we could not derive an analytical expression.

for a given p and N, the effect of capping the bids in 1993 is to increase $\overline{W}$ and decrease $\underline{W}$. Intuitively, capping reduces competition among the high types, increasing their payoffs at the expense of the low types. This change in payoffs in the capped groups leads to a re-sorting of low types and high types across the matching market, with the proportion of high types increasing disproportionately in the capped groups, to bring the market back into equilibrium.

Let $\overline{W}^c$, $\underline{W}^c$ be the payoffs for high and low types when the group is capped, $\triangle W^c = \overline{W}^c - \underline{W}^c$. Prior to the capping, the payoff to the high types is

$$\overline{W} = \frac{\overline{V}_1}{1-\delta^N} = \frac{\overline{V}_N - \overline{b}_1}{1-\delta^N}$$

and for the low types

$$\underline{W} = \frac{\underline{V}_1}{1-\delta^N} = \frac{1}{1-\delta^N}\left[\delta \underline{V}_2 + \frac{1}{N-1}\overline{b}_1\right].$$

Consider now the case in which the high bid in the first period is constrained, while the low bid is not (let b^c denote the constraint on the bid): $\underline{b}_1 \leq b^c \leq \overline{b}_1$. Then it immediately follows that $\overline{W}^c > \frac{\overline{V}_N - \overline{b}_1}{1-\delta^N} = \overline{W}$. Likewise, $\underline{W}^c < \frac{1}{1-\delta^N}\left[\delta \underline{V}_2 + \frac{1}{N-1}\overline{b}_1\right] = \underline{W}$, because the low types are not constrained and $\underline{V}_2$ is not affected by the constraint in the first period. It then also follows that $\triangle W^c \geq \triangle W$.

Lemma 3. *Consider the case in which high bids are constrained, while low bids are not. Then the difference in (normalized) payoffs between high types and low types increases under the constraint, for a fixed p and N.*

The increase in ΔW in the capped groups shifts the matching market out of equilibrium and we next proceed to study how the proportion of high types adjusts in both capped and uncapped groups to bring the market to its new equilibrium configuration. We will assume that there are only two types of groups, N_i and N_j, where group N_j is capped while N_i is unconstrained. Let $\Delta W'$ denote the difference in the payoffs for high and low types in the new equilibrium, and let p_i', p_j' be the new equilibrium proportions of high types.

Since N_i is unconstrained, $\triangle W'(p_i) = \triangle W(p_i)$. On the other hand, N_j is constrained, which implies from Lemma 3 that $\triangle W'(p_j) > \triangle W(p_j)$. Equilibrium prior to the capping requires that

$$\triangle W(p_i) = \triangle W(p_j),$$

which in turn implies, from the equations above, that

$$\triangle W'(p_i) < \triangle W'(p_j).$$

Now equilibrium after the capping requires

$$\triangle W'(p_i') = \triangle W'(p_j'),$$

so p_i, p_j must adjust to p_i', p_j' to restore this equilibrium condition. Assuming that the proportion of high types in the market μ, and the mix of groups n_i/n_j are fixed, and since there are only two types of groups, the consistency condition, equation (4), tells us that p_i, p_j must shift in opposite directions. This follows immediately from the observation that μ is a weighted average of p_i, p_j before the capping and p_i', p_j' after the capping.

¿From Lemma 1, $\triangle W$ is decreasing in p. As a result, p_i must decrease and p_j must increase to restore equilibrium after the capping:

$$p_i' - p_i < 0 < p_j' - p_j.$$

Proposition 2. *The proportion of high types will increase more in the constrained groups than in the unconstrained groups.*

The preceding result was derived under the condition that the proportion of high types in the market μ and the mix of groups n_i/n_j were fixed. In practice, μ not surprisingly increases after the capping. This "entry" effect shifts both p_i' and p_j' upward, but as long as the sorting across groups described above is strong enough, we would still expect the proportion of high types to increase more in the constrained groups.

3.5 The Policy Experiment and the Change in the Mix of Groups

The cap on the bids was seen to increase the proportion of high types more in the capped groups than in the unconstrained groups to bring the matching market back into equilibrium. We next proceed to study how the mix of *groups* adjusts to the regulatory change.

Continuing with the simple case with two types of groups, of duration N_i, N_j, where N_j is capped and N_i is unconstrained, the consistency condition, equation (4), requires that

$$p_i n_i N_i + p_j n_j N_j = \mu \left(n_i N_i + n_j N_j \right),$$

where n_i, n_j denote the measure (number) of groups of each type. Then

$$\frac{n_i}{n_j} = \frac{N_j}{N_i} \frac{\mu - p_j}{p_i - \mu}.$$

We will see below that long duration groups are capped, while short duration groups remain essentially unconstrained: $N_j > N_i$. Further, Proposition 1, which is also empirically verified below, tells us that the proportion of high types is decreasing in the duration of the group. With two types of groups, this implies that $p_i > \mu > p_j$.

Treating p_i, p_j as fixed, it is easy to verify from the equation above that the increase in μ that will be seen to accompany the capping must lead in turn to an increase in n_i/n_j.

Proposition 3. *Capping the bids in the long duration groups results in an increase in the proportion of short duration groups in the matching market.*

4 Testing the Theory

We now proceed to test the implications of the theory. Section 4.1 describes the various data sources used in the empirical analysis. Section 4.2 discusses the empirical specification used for testing the theory. Section 4.3 classifies groups for the empirical analysis and Section 4.4 studies the characteristics of the participants in the chit fund auctions. Section 4.5 tests propositions 1 and 2 and Section 4.6 tests proposition 3. Section 4.7 concludes with implicit interest rate calculations.

4.1 The Data

We use three sources of data in this paper. First, we obtained a complete record of *all* winning bids in *all* the groups operated by Shriram Chits and Investments Pvt. Ltd. that commenced between October 1, 1992 and September 30, 1994 in the city of Chennai. The sample period covers exactly one year before and one year after the imposition of the 30% cap on September 30, 1993. When we refer to the years 1993 and 1994 henceforth in the paper, we will actually be referring to the October 1 to September 30 period just before and just after the capping. Chennai is the largest commercial city in South India, and Shriram Chits, which is the largest chit fund company in the state of Tamil Nadu, has its headquarters, and 20 neighborhood branches, in the city. In total, 78,000 individuals participated in the chit fund groups that commenced in the city during the sample period.

Our second source of data provides income information for a limited number of subscribers in the sample. While the winning bids and the group characteristics are computerized and readily available, this additional subscriber information can only be obtained from the application forms which are filled in at the time of entry. These application forms are subsequently stacked in back rooms in each branch office, located all over the city. We picked a random sample of groups and then attempted to obtain income information on all their participants, from the respective branches. Ultimately, this information was collected for 21,906 subscribers (roughly 25% of the full sample). We appear to have been more successful in collecting this additional information for individuals belonging to groups that commenced in 1994, and thus there is some concern that this restricted sample may not be randomly selected. We should emphasize, however, that income data will only be used in a few exploratory regressions and to report some basic statistics; in particular, it is not required to test Propositions 1-3.

And finally, our third source of data is an aggregate break down of groups, based on the size of the pot auctioned in each month and the duration, in each year over the 1992-2001 period. Extensions

to the analysis that we report later in Section 4.6 will use these aggregate data to study long-term changes in the mix of groups.

4.2 The Empirical Specification

Proposition 1 describes the relationship between the proportion of borrowers and group duration in the unconstrained equilibrium prior to the capping. To test this proposition we estimate regressions of the form,

$$p_i = \alpha + \beta N_i + \epsilon_i, \tag{5}$$

where p_i is the proportion of borrowers in group i, N_i is the duration of group i, and ϵ_i is a mean-zero disturbance term. $\beta < 0$ from Proposition 1.

As noted in the Introduction, a particularly convenient feature of this institution is that we can identify *ex ante* borrowers; there is a separate field in the records that flags "finance companies." These corporate subscribers account for approximately 20% of all the observations in our data. The proprietors of these select companies appear to be trusted by the chit fund organizers, and most likely have social ties to them. While the individual subscribers must provide information on their income, assets, and occupation to the chit fund organizers, and also furnish the names and addresses of three guarantors, the corporate subscribers face none of these requirements. The money collected from the auction is invested elsewhere by these companies, who clearly have access to superior investment opportunities than the individual subscribers who are for the most part salaried employees. p_i is thus computed as the proportion of corporate subscribers in each group, and the regression above is estimated at the group level using data from 1993 only (prior to the bid cap).

We use two measures of group duration in the empirical analysis. The first measure treats duration N_i as a continuous variable, while the second measure divides the sample into *long* and *short* duration groups. As noted, long duration groups were affected most by the bid cap. For the second measure, we construct a long duration dummy that takes a value one if the group runs for 40 months or longer, zero otherwise.[17] Replacing N_i with the long duration dummy in equation (5) above, Proposition 1 predicts that the coefficient on the long duration dummy will continue to be negative.

Proposition 2 predicts that the proportion of borrowers will increase more in groups that are capped. We will see later that the long duration groups are capped severely, while the short duration groups remain essentially unconstrained. Equation (5) can be augmented to test these predicted changes using data from 1993 and 1994:

$$p_i = \alpha + \beta N_i + \gamma 1994_i + \theta N_i \cdot 1994_i + \varepsilon_i, \tag{6}$$

[17] The 40-month cut off that we choose is motivated by a similar classification that the organizing company introduced recently, many years after the bid cap was imposed. In an effort to reduce the effect of the regulation, the chit fund company changed the design of the auction, as of October 2000. These changes were restricted to groups with durations 40 months or longer, which are classified by the company as "long duration groups."

where 1994_i is a binary variable that takes the value one if the group commenced after the cap in 1994, zero if it commenced in 1993.[18] ε_i is a mean-zero disturbance term, and the remaining variables were defined above. As above, α, β continue to measure the $p_i - N_i$ correlation in 1993, and so have the same interpretation. The theory has no prediction for the secular change in p_i following the capping, and hence for γ. But Proposition 2 tells us that p_i should increase more in long duration groups, which are capped, than in short duration groups: $\theta > 0$. As before, regression (6) will be estimated at the group level, treating duration either as a continuous variable (N_i) or as a binary variable (with the long duration dummy).

4.3 Classification of Groups

All the results in Section 3 were derived for a given monthly contribution v. Appendix B derives the same properties of the chit fund auction under an alternative interpretation, where participants save for a target, i.e. a given chit value Nv. Since both interpretations predict the same results, equation (5) and equation (6) will be estimated for a specific v or Nv. Chit values range from Rs.10,000 to over Rs.100,000, and monthly contributions range from Rs.200 to over Rs.1000. There are thus many values of v and Nv reported in the data, making estimation of these equations for each value infeasible. What we do instead in the empirical analysis is to partition the sample of groups into aggregate categories, along the v or the Nv dimension.

By treating v as parametric in Section 3, we implicitly assume that subscribers save a fixed fraction of their income to invest in the chit fund each period. When treating Nv as parametric in Appendix B we assume instead that subscribers save for a fixed target, which we would expect depends once more on their income. Low (high) v or Nv groups will tend to be chosen by low (high) income subscribers. We thus proceed to classify groups based on how their choice (exogenously) depends on subscribers' incomes.

To implement this classification scheme we regress the choice of chit value or monthly contribution on subscribers' incomes. Appendix Table A1 reports multinomial logit and linear probability estimates of these regressions. The chit value regressions restrict attention to six values that together account for over 90% of all the observations in the sample. The monthly contribution regressions restrict attention to four contribution levels that account for nearly 85% of the sample. The variation in the income coefficient across these chit values or contributions then allows us to partition the full sample of groups into aggregate categories. We classify low (high) Nv or v groups as those groups whose choice is decreasing (increasing) in subscriber income. Medium value groups are defined to be those intermediate groups whose choice is unrelated to income. Based on this classification scheme, Rs.10,000 and Rs.50,000 are designated as the cut offs separating low, medium, and high chit values. The corresponding cut offs for low, medium, and high monthly contributions are Rs.500 and

[18] Recall that our data cover a period exactly one year before and one year after the policy experiment.

Rs.1000.[19]

By partitioning groups along the Nv or the v dimension we are essentially studying the relationship between p_i and N_i, and the change in this relationship, *within* each aggregate chit value or monthly contribution category. While group durations N_i range from 20 months to 100 months in the data, Table 1 verifies that there is sufficient variation in the duration variable within each category as well, particularly when groups are partitioned by chit value.

Insert Table 1 here.

4.4 Description of the Participants

Each neighborhood branch of the chit fund company posts a menu of available groups, characterized by duration and chit value, at each point in time. Prospective participants choose a group from this menu and once a group is filled, it is allowed to commence after the necessary information from the Registrar of Chit Funds has been obtained. While new groups form throughout the year, the company helps coordinate the formation of these groups by organizing two major subscription campaigns, in April and in October, each year.

The change in the proportion of borrowers across groups of different durations, as predicted in Proposition 2, is based on the assumption that the pool of participants in the matching market is fixed over time. We test Proposition 2 using data on groups that commenced one year before and one year after the imposition of the bid ceiling in September 1993. Groups run for at least 20 months, and so individuals who joined groups in the year prior to the bid cap are clearly distinct from individuals who joined in the following year. Even if we observed the same individuals making repeated participation decisions, incomes could well have changed over a two year period in this growing economy. To rule out compositional change in the pool of participants over time, we proceed to verify that the income distribution among the subscribers was essentially unchanged from 1993 to 1994.

Table 2, Panel A compares the income distribution in 1993 and 1994, separately for low, medium, and high chit values and monthly contributions. Incomes are very similar at all quantile levels in the two years, within each chit value and monthly contribution category, indicating that the underlying income distribution among the participants was roughly unchanged.

Insert Table 2 here.

As noted, participants in the chit fund can be classified as private subscribers and corporate subscribers. Private subscribers reveal their income to the organizing company and supply the names of three guarantors, whereas the corporate subscribers provide no such information. The income

[19]The cut off separating medium and high monthly contributions is shifted slightly to balance the mix of short and long duration groups in the medium category (see Appendix Table A2). This adjustment in the cut off does not affect the estimated coefficients in equation (5) or equation (6).

statistics described above are thus based on the private subscribers alone. The corporate subscribers play an important role in the chit fund institution, accounting for roughly 20% of all participants in Table 2, Panel B. But while the increase in the proportion of corporate subscribers from 1993 to 1994, following the bid cap, is consistent with the view that they are effectively borrowers, we have not up to this point provided direct evidence supporting the *ex ante* classification of borrowers and lenders.

Table 3 verifies the classification of types by comparing the time period in which private subscribers and corporate subscribers win the auction. The timing variable is defined as the month in which the subscriber wins the auction divided by the total duration of the group, and so is bounded between zero and one. The corporate subscriber variable equals one for the finance companies, zero otherwise. The constant term in the (linear) timing regression thus measures the average timing for the private subscribers, while the coefficient on the corporate subscriber dummy measures how much earlier on average the corporate subscribers win. High types win early, and as expected, the coefficient on the corporate subscriber dummy is negative, large in absolute magnitude, and very precisely estimated. The same result is obtained, without exception, in 1993 and 1994, for low, medium, and high chit values and monthly contributions.

Insert Table 3 here.

4.5 Matching into Groups

The analysis of endogenous matching begins by testing Proposition 1, which states that the proportion of borrowers is declining in the duration of the group. Restricting attention to groups that commenced in the unregulated regime, one year prior to September 1993, equation (5) is estimated within each of the aggregate chit value and monthly contribution categories in Table 4. Panel A of Table 4 measures duration as a binary variable (the long duration dummy), while Panel B measures duration as a continuous variable (in years). As predicted, the coefficient on the duration variable is negative and significant (with a few exceptions) across all the specifications that we experiment with in Table 4.[20]

Insert Table 4 here.

Next, we study the change in endogenous matching following the policy experiment. Proposition 2 tells us that the proportion of borrowers should increase more in capped groups, and we mentioned

[20] One outlying group-type - Rs.30,000 chit value running for 60 months - is dropped from the regressions reported in Table 4, and later in Table 5 where we study changes in matching over time, which explains the decline in the number of observations (groups) in the medium value category from Table 1 to Table 5. The coefficient on the duration variable actually reverses sign in Table 4, Column 2 and Column 5 when the outlying groups are included. Note, however, that the *change* in the matching that we report in Table 5 is completely unaffected by the inclusion or the omission of these outlying groups.

earlier that long duration groups were capped more severely than short duration groups. Figures 1-3 present nonparametric plots of the pattern of bids over the course of the group, in 1993 and 1994, for long and short duration groups. The bid amount is divided by the chit value to provide a normalized bid value on the Y-axis that was exogenously capped at 0.3 in 1994. Since we are presenting groups with different durations on the same graph, the time period on the X-axis is measured as the fraction of the group duration, running from zero to one. Bids for long and short duration groups are not directly comparable with this normalization; for example, the average of the bids in the first and second month of a 20-month group would now be aligned vertically with the first bid in a 10-month group. But the effect of the capping on groups with the same duration is easy to visualize. Groups are partitioned into low, medium, and high monthly contributions in Figures 1-3.[21]

Insert Figures 1-3 here.

The normalized bid declines over the course of the group, without exception, in Figures 1-3, bottoming out at 0.06 in 1993 and 0.05 in 1994 (this is the organizing company's legally determined commission in each period, which is paid out of the winning bid). Normalized bids are also increasing in the monthly contribution across the Figures, for both short and long duration groups. And, finally, the cap constrains 1994 bids in the early periods only. This cap is clearly more severe in the long duration groups, across all three monthly contribution categories, simply because the unconstrained 1993 bids are much higher than 0.3 in the early periods in those groups.[22]

Having established that bids in the long duration groups are capped more severely, we can now estimate equation (6). The prediction from Proposition 2 is that the coefficient on the group duration interacted with the 1994 dummy should be positive. Table 5 reports the results of this regression, with groups partitioned as usual by chit value and monthly contribution. Table 5, Panel A measures group duration with a long duration dummy, whereas duration is measured as a continuous variable (in years) in Panel B.

Insert Table 5 here.

[21] A previous version of the paper divided groups by chit value and reported bid patterns that are very similar to those presented in Figures 1-3. We also verified that the same patterns were obtained when we restricted attention to a single v and single durations, e.g. $v = 500$ and durations of 30 months and 60 months, $v = 1000$ and durations of 25 months and 50 months.

[22] Alternative spline regressions, reported in Appendix Table A3, divide the group into five equal time periods and estimate a dummy for each period. These dummies interacted with a 1994 year-dummy allow us to estimate the change in the pattern of bids, and hence the impact of the capping, over time. The time period dummies, which measure the 1993 bid pattern once the interaction terms are included, and the changes over time, match what we see in Figures 1-3 and are very precisely estimated.

The coefficient on the duration-1994 interaction term is positive and significant (with a couple of exceptions) across all the specifications that we experiment with in Table 5.[23] Thus the proportion of borrowers increases more in groups that are more severely capped, as predicted. The coefficient on the 1994 dummy in Panel A measures the change in the proportion of borrowers in the short duration groups following the capping. The coefficient on the duration-1994 interaction term measures the *additional* change in the long duration groups. Looking across columns in Panel A, group compositions clearly change dramatically from one year to the next, particularly in the long duration groups. The proportion of high types in long duration groups increases from 0.18 to 0.24 in the low chit value groups, from 0.13 to 0.19 in the medium chit value groups and from 0.11 to 0.24 in the high chit value groups.[24] Adding the duration and the duration-1994 coefficients, which gives us the duration coefficient in 1994, it is apparent that the decline in the proportion of borrowers with group duration that we observed in 1993 is largely reversed by 1994.

4.6 Change in the Mix of Groups

Proposition 3 tells us that the increase in the proportion of borrowers in the matching market following the bid-cap should result in an increase in the proportion of short duration groups. We see in Table 6, Panel A that the number of private subscribers (lenders) declines from 1993 to 1994 within all chit value and monthly contribution categories. In contrast, participation by the corporate subscribers (borrowers) increases across all categories except for the low chit values and monthly contributions. This explains the increase in borrowers across all categories that we observed previously in Table 2, Panel B; the overall proportion of borrowers (μ) increases from 16% to 22%. Participation levels also decline across all categories, and the total number of subscribers declines from 43,267 in 1993 to 34,797 in 1994 (a 20% decline).

Insert Table 6 here.

Next, we see in Table 6, Panel B that the increase in the overall proportion of borrowers (μ) noted above leads to an increase in the proportion of short duration groups, as predicted.[25] To verify the robustness of this result, group durations are disaggregated in Table 6, Panel C. We see an increase in the popularity of groups running for less than 40 months, almost without exception, whereas this pattern is reversed for groups running 40 months or longer. The increase in the proportion of short duration groups in Panel B is driven by underlying changes across all group durations in the data.

[23] As noted, the coefficient on the duration variable and the constant term are numerically identical to the corresponding coefficients in Table 4, by construction.

[24] To compute the proportion of borrowers in the long duration groups in 1993, add the coefficient on the long duration dummy to the constant term. To compute the corresponding statistic in 1994, add up all the coefficients in panel A (including the constant).

[25] This increase is significant at the 5% level, except for columns 9 to 10.

While the change in the proportion of borrowers within groups and the change in the mix of groups suggest that this matching market is making its way to a new equilibrium, we cannot tell by studying behavior at two points in time whether this change is complete. The equilibrium conditions are derived in terms of the normalized payoff W, which is unobserved. But we can gain a rough sense of how quickly this market settled into its new equilibrium by using aggregate group level data to study changes in the mix of groups over a longer ten-year period 1992-2001. The proportion of short duration groups that commenced in each year over this period is computed, separately for low, medium, and high chit values and monthly contributions. These proportions are plotted, without smoothing, in Figure 4 and Figure 5.

Insert Figure 4 and Figure 5 here.

The proportion of short duration groups increases sharply from 1993 to 1994, for low, medium, and high chit values and monthly contributions, just as we saw in Table 6. But this increase continues for one more year, 1994-95, after which the proportion of short duration groups flattens out.[26] The proportion of short duration groups in low and high chit values in Figure 4 increases from about 0.2 in 1993 to over 0.4 by 1995. The medium chit values begin with a much higher proportion of short duration groups, above 0.5 in 1993, yet this proportion increases even further to 0.7 by 1995. The term structure in this market clearly responds quite dramatically to the change in the economic environment.

There seems to be some overshooting in 1995, and some shaking out thereafter, judging from the minor oscillations in the Figures, but the basic shift from the pre-cap to the post-cap equilibrium is completed in two years. The institutional response to this exogenous shock is extremely rapid, given that this is a decentralized equilibrium. A fresh set of individuals joins the chit fund each period, which makes the rapid response in this matching market even more remarkable.

4.7 Implicit Interest Rates

There is no explicit price for money – interest rate – in this matching market. But based on the actual bids we can still calculate the interest rate implicit in a given group. Let $D \equiv \frac{1}{1+r_m} \in [0,1]$ be the monthly interest factor (where r_m is the monthly interest rate) and let c_t denote the funds

[26] Additional support for the view that the market was out of equilibrium in 1994 can also be obtained from Figure 1, which describes the bid pattern for the low monthly contribution groups. The bid schedule for the short duration groups is essentially the same in 1993 and 1994. In contrast, the 1994 bids are substantially lower than the 1993 bids for the long duration groups in that Figure. Participants who were indifferent between the long and short duration low value groups in 1993 evidently would not remain that way in 1994. While the proportion of borrowers within groups might have adjusted in the right direction to move the market to the new equilibrium, this change does not appear to have been totally completed by 1994. Interest rate calculations that we report below will support this interpretation of the data as well.

received in period t. The participant contributes an amount v each month over a period of N months (the duration of the group). Hence, the internal rate of return for any participant must satisfy the condition

$$\sum_{t=1}^{N} D^{t-1}\left(c_t - v\right) = 0. \tag{7}$$

The net present value of monthly contributions must equal the net present value of funds received. The inflow of funds in any period t in which a participant does not win the auction is given by $c_t = \frac{1}{N}b_t$: she gets her equal share of the bid. In one period, say τ, the participant wins the chit fund, in which case she collects $c_\tau = Nv - b_\tau + \frac{1}{N}b_\tau$, i.e. the total pot minus her bid $Nv - b_\tau$ in addition to her share of the bid. We can now rewrite the internal rate of return in equation (7) for a participant who wins the auction in period τ as:

$$D^{\tau-1}\left(Nv - b_\tau\right) + \sum_{t=1}^{N} D^{t-1}\left(\frac{1}{N}b_t - v\right) = 0.$$

It follows immediately that the expressions for different agents only differ in the first term. Therefore, we can calculate the interest factor D from any two agents' rate of return equations, i.e. agents who win the bids in two different periods τ and τ' as

$$D = \left(\frac{Nv - b_\tau}{Nv - b_{\tau'}}\right)^{\frac{1}{\tau' - \tau}}.$$

Using the relationship between D and the monthly interest rate r_m provided earlier, and converting r_m to the corresponding annual rate, we obtain:

$$r = \left(\frac{Nv - b_{\tau'}}{Nv - b_\tau}\right)^{\frac{12}{\tau' - \tau}} - 1. \tag{8}$$

Table 7 reports the within-group interest rates in each chit value and monthly contribution category, for short and long duration groups, in 1993 and 1994. The interest rate is computed for $\tau = 2$ and $\tau' = N$ in Panel A and for $\tau = 0.2N$ and $\tau' = N$ in Panel B.[27]

Insert Table 7 here

The 1989 Report on *Urban Informal Credit Markets in India* (Dasgupta 1989) tells us that the interest rate paid by non-banking finance companies, which include chit funds, was 18%. The unconstrained interest rates that we compute for 1993 match very well with this statistic, ranging from 14% to 24%. The same Report tells us that the interest rate paid by nationalized banks on term deposits was 9%, so the popularity of the chit funds is easy to understand and indicates that these institutions are capturing substantial gains from trade. The capping of the bids in turn, imposed

[27]The chit fund organizer is legally entitled to collect the first pot without bidding, $b_1 = 0$, and so competitive bidding only commences in period 2.

restrictions on those gains from trade. Consistent with this interpretation, the interest rates came down dramatically, and they range from 8% to 19% in 1994, which is much closer to the bank rate. The sharp decline in participation by the private subscribers that we saw in Table 6, Panel A, is consequently easy to understand.

Notice also, from Table 7, that interest rates for short and long duration groups within a chit value or monthly contribution category are roughly comparable in 1993. In contrast, we see that the interest rates on the long duration groups are significantly lower than the corresponding rates in the short duration groups, within the same category, in 1994. While we cannot map the computed interest rates directly into normalized payoffs W, the wide discrepancy in interest rates between long and short duration groups in 1994 suggests that the market was yet to reach its post-cap equilibrium, consistent with the long-term changes in the mix of groups reported earlier in Figure 4 and Figure 5.

5 Conclusion

Many institutions that economists are concerned with, such as firms, professional partnerships, and financial intermediaries, bring heterogeneous agents together to exploit gains from trade. This paper presents a general framework for analyzing decentralized matching into such economic institutions, and the equilibrium composition of participants that consequently arises. The predictions from the theory are tested with data from financial intermediaries in South India that bring borrowers and lenders together in small groups. We find that heterogeneous participants match together endogenously across groups of different sizes (durations) exactly as our theory would predict. The change in the composition of groups of different sizes and the change in the mix of groups, following an unexpected regulatory change, also matches precisely with the predictions from the theory. The payoff from choosing a particular group is not observed *ex ante* in this matching market, and will in general depend on the choices made by other participants. It is therefore all the more surprising that participants sort themselves so well across competing institutions in the application that we consider.

Apart from characterizing the mechanism underlying the matching into chit fund groups, our analysis also indicates that these financial institutions captured substantial gains from trade. Chit funds generated an implicit interest rate that was considerably higher than what could be obtained in the monopolistic banking system prior to the regulation. Moreover, after the imposition of the bid-cap, there was a sharp decline in the interest rate in the constrained groups, and a decline in overall participation. This suggests that the impact of the regulation had non-negligible welfare consequences on participants in this matching market.

6 Appendix A

Equilibrium bids in the chit fund auction

We establish the following proposition:

Proposition A1. *For any chit fund auction, the difference between the payoff for borrowers and lenders satisfies:*

$$\Delta V_1(N,p,v) = \delta^{pN-1}\Delta V_N$$

where $\triangle V_N(N,p,v) = Nv\left[\overline{\gamma} - \underline{\gamma}\right] = Nv \triangle \gamma$.

Proof. V_t denotes the expected continuation payoff in period t for a participant who has not won the auction yet. Because p is assumed known to all players, this is effectively an auction of public information. There are pN high types in the group, so first consider periods in which more than one high type remains among the bidders, $t = 1, ..., pN-1$. The payoff to the high type i can be written as

$$\begin{aligned}\overline{V}_t &= \Pr\left\{\overline{b}_t^i > \max\left\{\overline{b}_t^{-i}\right\}\right\}\left(\overline{V}_N - \max\left\{\overline{b}_t^{-i}\right\}\right) \\ &\quad + \left(1 - \Pr\left\{\overline{b}_t^i > \max\left\{\overline{b}_t^{-i}\right\}\right\}\right)\left(\delta\overline{V}_{t+1} + \frac{1}{N-t}\max_{\overline{b}_t \setminus \max\left\{\overline{b}_t\right\}}\left\{\overline{b}_t\right\}\right),\end{aligned}$$

where $\overline{b}_t^i$ denotes the bid by a high type player i (as usual, the notation $-i$ refers to any other player different from i, so $\overline{b}_t = \left\{\overline{b}_t^i, \overline{b}_t^{-i}\right\}$). Consider (type-contingent) symmetric bidding functions $\overline{b}_t^i = \frac{N-t}{N-t+1}\left(\overline{V}_N - \delta\overline{V}_{t+1}\right)$ and $\underline{b}_t^i = \frac{N-t}{N-t+1}\left(\underline{V}_N - \delta\underline{V}_{t+1}\right)$ and verify that bidding $\overline{b}_t = \frac{N-t}{N-t+1}\left(\overline{V}_N - \delta\overline{V}_{t+1}\right)$ is an equilibrium strategy. We assume that in the case of a tie in the bids, the winner is allocated at random, with uniform probability. Given the symmetric bid function for the high types, there will always be ties for $t \leq pN-1$. and as a result, the second price is equal to the winning bid. The expected payoff V_t is then

$$\begin{aligned}\overline{V}_t &= \Pr\left\{\overline{b}_t^i > \max\left\{\overline{b}_t^{-i}\right\}\right\}\left(\overline{V}_N - \frac{N-t}{N-t+1}\left(\overline{V}_N - \delta\overline{V}_{t+1}\right)\right) \\ &\quad + \left(1 - \Pr\left\{\overline{b}_t^i > \max\left\{\overline{b}_t^{-i}\right\}\right\}\right)\left(\delta\overline{V}_{t+1} + \frac{1}{N-t}\frac{N-t}{N-t+1}\left(\overline{V}_N - \delta\overline{V}_{t+1}\right)\right) \\ &= \frac{1}{pN-t+1}\left(\frac{1}{N-t+1}\left(\overline{V}_N + (N-t)\,\delta\overline{V}_{t+1}\right)\right) \\ &\quad + \left(1 - \frac{1}{pN-t+1}\right)\left(\frac{1}{N-t+1}\left(\overline{V}_N + (N-t)\,\delta\overline{V}_{t+1}\right)\right) \\ &= \frac{1}{N-t+1}\left(\overline{V}_N + (N-t)\,\delta\overline{V}_{t+1}\right)\end{aligned}$$

where $\Pr\left\{\overline{b}_t^i > \max\left\{\overline{b}_t^{-i}\right\}\right\} = \frac{1}{pN-t+1}$. Note that there is no incentive to deviate either way. Over-bidding – say $\overline{b}_t^i + d$ – implies winning the auction with certainty; however the expected utility is

strictly lower: $\overline{V}_N - \frac{N-t}{N-t+1}\left(\overline{V}_N - \delta\overline{V}_{t+1}\right) - d < \frac{1}{N-t+1}\left(\overline{V}_N + (N-t)\,\delta\overline{V}_{t+1}\right)$, and underbidding is weakly dominated. It is easy to verify that this bidding strategy leaves the high types indifferent between winning and losing the current auction: $\overline{V}_t = \overline{V}_N - \overline{b}_t = \delta\overline{V}_{t+1} + \frac{1}{N-t}\overline{b}_t$.

Similarly, there is no incentive to deviate for the low type, whose payoff is

$$\begin{aligned}\underline{V}_t &= \delta\underline{V}_{t+1} + \frac{1}{N-t}\overline{b}_t \\ &= \delta\underline{V}_{t+1} + \frac{1}{N-t+1}\left(\underline{V}_N - \delta\underline{V}_{t+1}\right).\end{aligned}$$

Now calculating $\Delta V_t = \overline{V}_t - \underline{V}_t$ is straightforward: $\Delta V_t = \delta\Delta V_{t+1}$. Solving recursively, $\Delta V_1 = \delta^{pN-1}\Delta V_{pN}$.

In period $t = pN$, only one high type is left. Now consider the following bids: $\underline{b}_{pN} = \frac{N-pN}{N-pN+1}\left(\underline{V}_N - \delta\underline{V}_{pN+1}\right)$ and $\overline{b}_{pN} = \frac{N-pN}{N-pN+1}\left(\underline{V}_N - \delta\underline{V}_{pN+1}\right) + \varepsilon > \underline{b}_{pN}$ (well known existence problems arise with discrete types and public information, which are typically resolved with the introduction of trembles or by assuming that the strategy space is a fine discrete grid; assume therefore that ε is one unit in the grid, say a penny). The low type bids lower than the high type, and as a result, the high type always wins the auction for sure, paying the low type's bid. The high type has therefore no incentive to deviate. The low type has no incentive to deviate either. Bidding lower than $\underline{b}_{pN}$ is weakly dominated, while bidding higher than $\overline{b}_{pN}$, say $\overline{b}_{pN} + d$, implies a payoff

$$\begin{aligned}\underline{V}_{pN} &= \underline{V}_N - \overline{b}_{pN} - d \\ &< \frac{1}{N-pN+1}\left[\underline{V}_N + (N-pN)\,\delta\underline{V}_{pN+1}\right] - d.\end{aligned}$$

On the other hand, bidding the equilibrium bid $\underline{b}_{pN}$ assures a payoff

$$\begin{aligned}\underline{V}_{pN} &= \delta\underline{V}_{pN+1} + \frac{1}{N-pN}\underline{b}_{pN} \\ &= \frac{1}{N-pN+1}\left[\underline{V}_N + (N-pN)\,\delta\underline{V}_{pN+1}\right],\end{aligned}$$

which is strictly larger. It is easy to verify that the equilibrium bidding strategy leaves the low type indifferent between winning and losing the current auction,

$$\begin{aligned}\overline{V}_{pN} &= \overline{V}_N - \underline{b}_{pN} \\ \underline{V}_{pN} &= \delta\underline{V}_{pN+1} + \frac{1}{N-pN}\underline{b}_{pN} = \underline{V}_N - \underline{b}_{pN}.\end{aligned}$$

As a result, $\Delta V_{pN} = \Delta V_N$. From the fact that $\Delta V_1 = \delta^{pN-1}\Delta V_{pN}$, it now follows that $\Delta V_1 = \delta^{pN-1}\Delta V_N = \delta^{pN-1}N\Delta\gamma$.

Note that for any subsequent period $t = pN+1, ..., N$, the bids are $\underline{b}_t = \frac{N-t}{N-t+1}\left(\underline{V}_N - \delta\underline{V}_{t+1}\right)$ – all the high types have already won and no longer bid – and as a result

$$\begin{aligned}\underline{V}_t &= \delta\underline{V}_{t+1} + \frac{1}{N-t}\underline{b}_t = \underline{V}_N - \underline{b}_t \\ &= \frac{1}{N-t+1}\left(\underline{V}_N + (N-t)\,\delta\underline{V}_{t+1}\right)\end{aligned}$$

■

Proof of Lemma 1

Lemma 1. *Fixing the group duration N, the difference in the (normalized) expected payoff between borrowers and lenders is decreasing in the proportion of borrowers p.*

Proof. Differentiating $\triangle W(N,p)$ with respect to p, we get

$$\frac{d\Delta W}{dp} = \frac{Nv\Delta\gamma}{1-\delta^N} N \ln\delta < 0$$

since $\ln\delta < 0$. ■

Proof of Lemma 2

Lemma 2. *Fixing the proportion of high types p, the difference in the (normalized) expected payoff between borrowers and lenders is decreasing in the duration of the chit fund N, for sufficiently impatient participants.*

Proof. Again, from equation (1) it follows that

$$\frac{d\Delta W}{dN} = v\Delta\gamma \frac{\delta^{pN-1}}{\left(1-\delta^N\right)^2}\left[(\ln\delta\cdot pN+1)\left(1-\delta^N\right)+N\delta^N\ln\delta\right]$$

Observe that as δ approaches 1, $\frac{d\Delta W}{dN}=0$ and as δ approaches 0, $\frac{d\Delta W}{dN}$ goes to $-\infty$. Thus, even if $\frac{d\Delta W}{dN}$ is positive for some values of δ, it must be negative for δ sufficiently small (close to zero). A sufficient condition for $\frac{d\Delta W}{dN}<0$ is that $\ln\delta\cdot pN+1<0$, since $\ln\delta<0$, which implies $\delta < e^{-\frac{1}{pN}} \in [0,1]$. As a result, there exists a $\delta^* \geq e^{-\frac{1}{pN}}$ such that for all $\delta<\delta^*$, $\frac{d\Delta W}{dN}<0$. ■

7 Appendix B

Normalization of Expected Chit Fund Values: Saving for a Target

We calculate the expected normalized payoff of a class of chit funds $\left\langle kv, \frac{N}{k}\right\rangle$ with $k>1$ that are equivalent to an N period fund $\langle v, N\rangle$ .By construction, each of these chit funds has a constant pot of vN. To make these choices comparable for an infinitely lived agent, the $\left\langle kv, \frac{N}{k}\right\rangle$ chit fund will be joined not every period N/k but every period N, and the savings pattern will be to save kv for the first N/k periods and zero between N/k and N. That is, the savings pattern is kv for periods $1,...,\frac{N}{k}$ and $N+1,...,N+\frac{N}{k}$ and $2N+1,...,2N+\frac{N}{k}$ etc., and zero in all other period ($\frac{N}{k}+1,...,N$ and $N+\frac{N}{k}+1,...,2N$ etc.). The $\left\langle kv, \frac{N}{k}\right\rangle$ chit fund is joined in periods $1,N,2N,...,$ each time with an expected value of $V_1\left(kv,\frac{N}{k}\right)$ and therefore with life time expected value W^T of

$V_1\left(kv, \frac{N}{k}\right) \cdot \left[1 + \delta^N + \delta^{2N} + ...\right] = V_1\left(kv, \frac{N}{k}\right)/(1-\delta^N)$, where the superscript T stands for target. It therefore immediately follows from Proposition 1 that

$$\Delta W^T\left(kv, \frac{N}{k}, p\right) = \frac{\delta^{p\frac{N}{k}-1} vN\Delta\gamma}{1-\delta^N}.$$

This normalization differs only in a constant factor k in the power of δ from the normalization in the text, and therefore both Lemma 1 and Lemma 2 are immediately extended.

Derivation of the Total Surplus

We derive the per capita surplus (normalized for different length) from any chit fund $\langle p, N, v\rangle$. Observe that autarky for the indefinite future generates a per capita of $A = \frac{v}{1-\delta}(1+\gamma)$. The per capita surplus of the chit fund, net of the value of autarky, is

$$S = \frac{v}{1-\delta}\left[(1+\overline{\gamma})\left(\frac{1-\delta^{pN}}{1-\delta^N} - p\right) + \left(1+\underline{\gamma}\right)\left(\delta^{pN}\frac{1-\delta^{(1-p)N}}{1-\delta^N} - (1-p)\right)\right]$$

To see this, observe that the gross surplus for all N participants is $Nv(1+\overline{\gamma})$ for the first pN periods, which is equal to $Nv(1+\overline{\gamma})\frac{1-\delta^{pN}}{1-\delta}$ and $Nv\left(1+\underline{\gamma}\right)$ for the periods $pN+1$ up to N, which is equal to $Nv\left(1+\underline{\gamma}\right)\delta^{pN}\frac{1-\delta^{(1-p)N}}{1-\delta}$. Then normalizing for the infinitely repeated N period fund (i.e. dividing by $1-\delta^N$) and subtracting the surplus from autarky, the surplus per capita (i.e. the total surplus divided by N) is given by S in the equation above. It can easily be verified that the surplus is concave in p ($S = 0$ for $p = 0$ and $p = 1$) and that S is increasing in N. Observe further that $S = p(\overline{W} - \overline{A}) + (1-p)(\underline{W} - \underline{A})$.

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Figure 1: Bids - Low Monthly Contribution

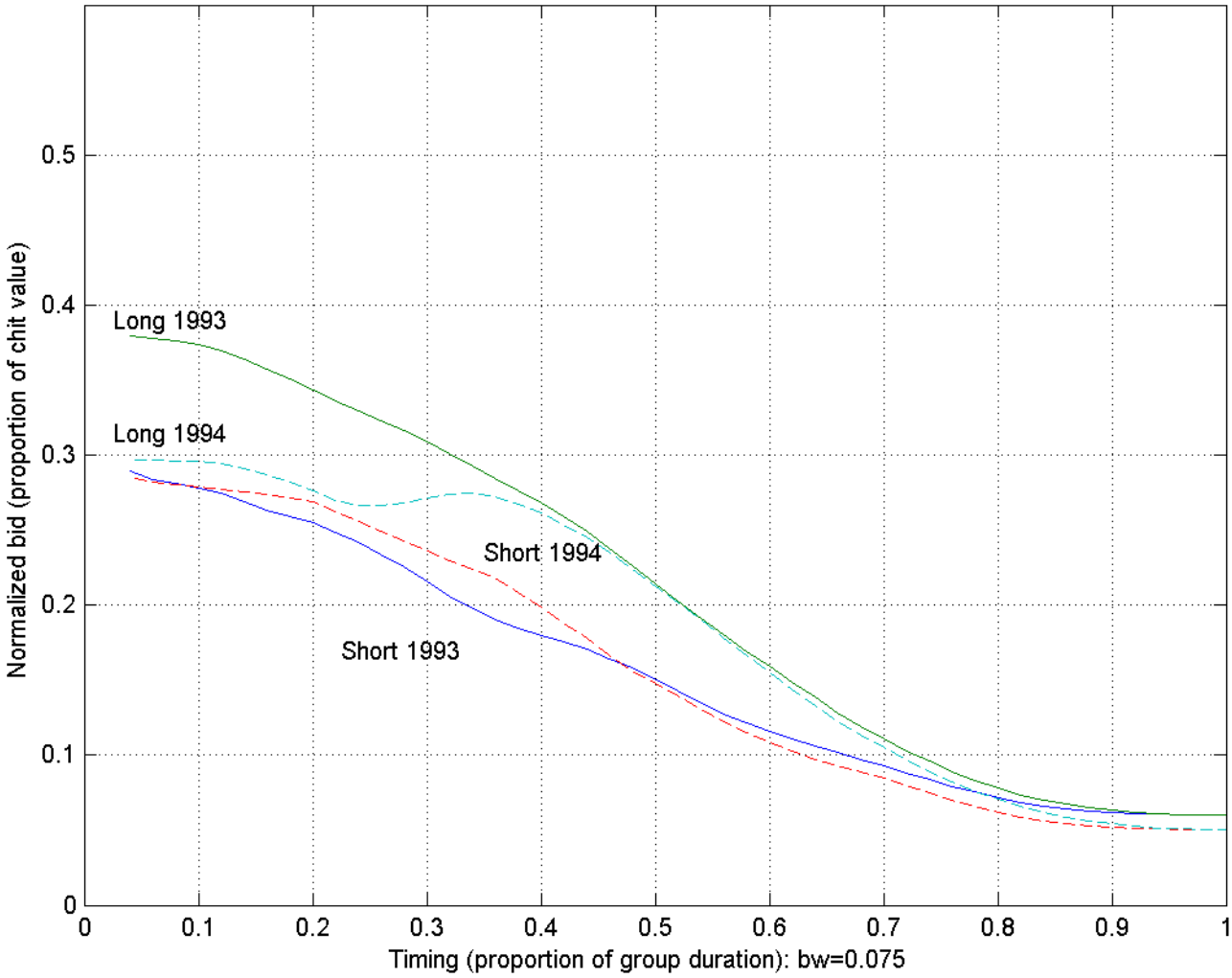

Figure 2: Bids - Medium Monthly Contribution

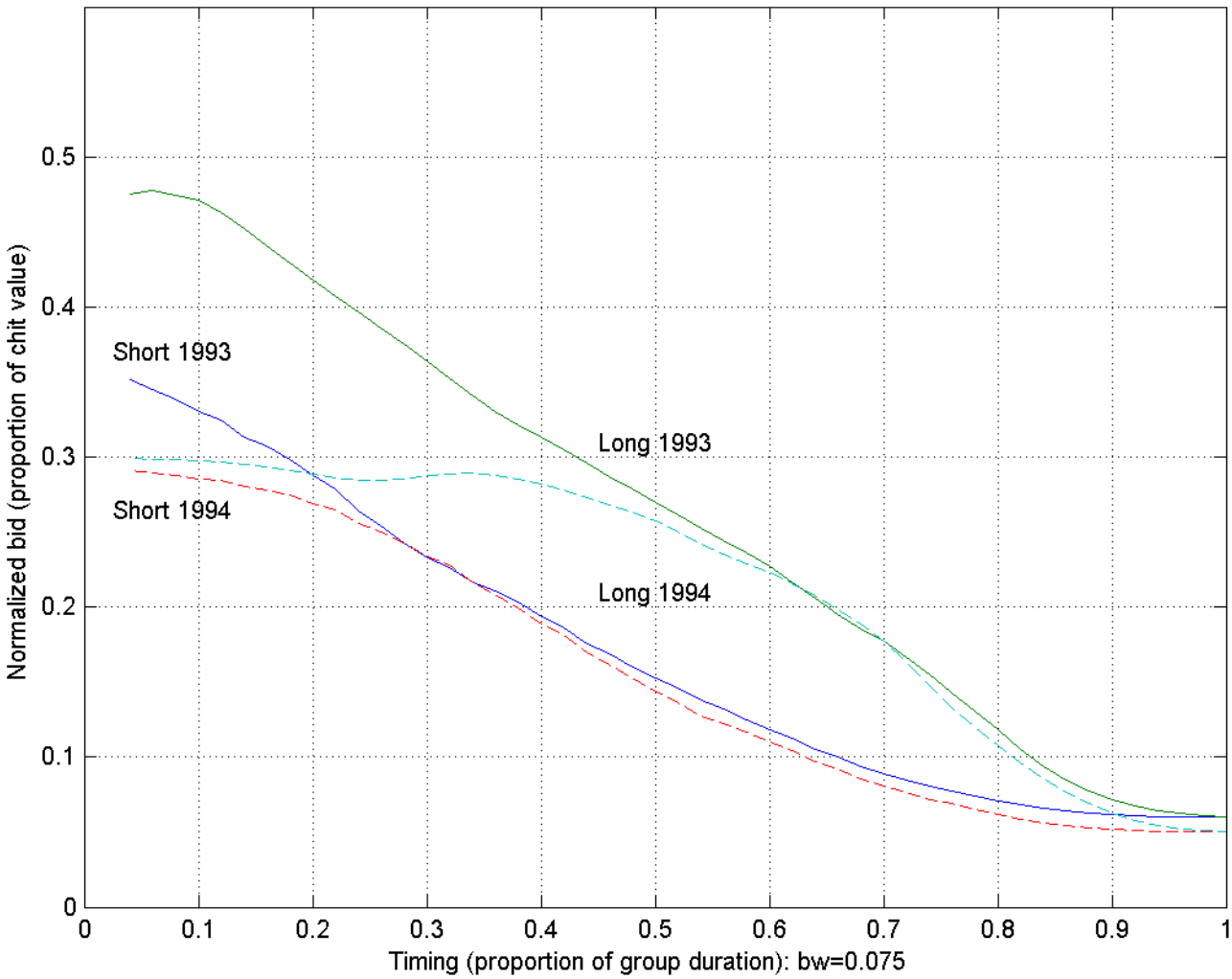

Figure 3: Bids - High Monthly Contribution

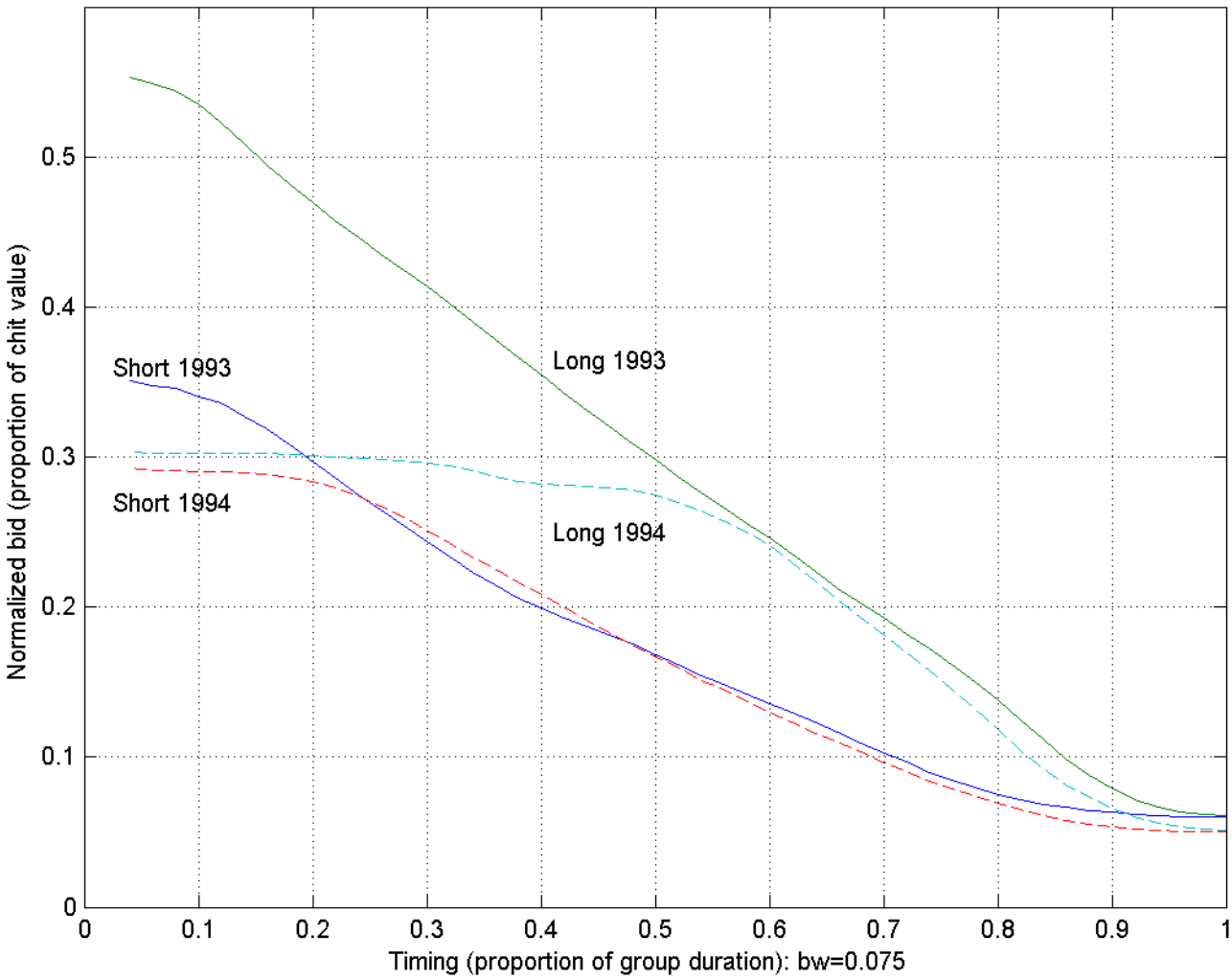

Figure 4: Proportion of Short Duration Groups - Partitioning Groups by Chit Value

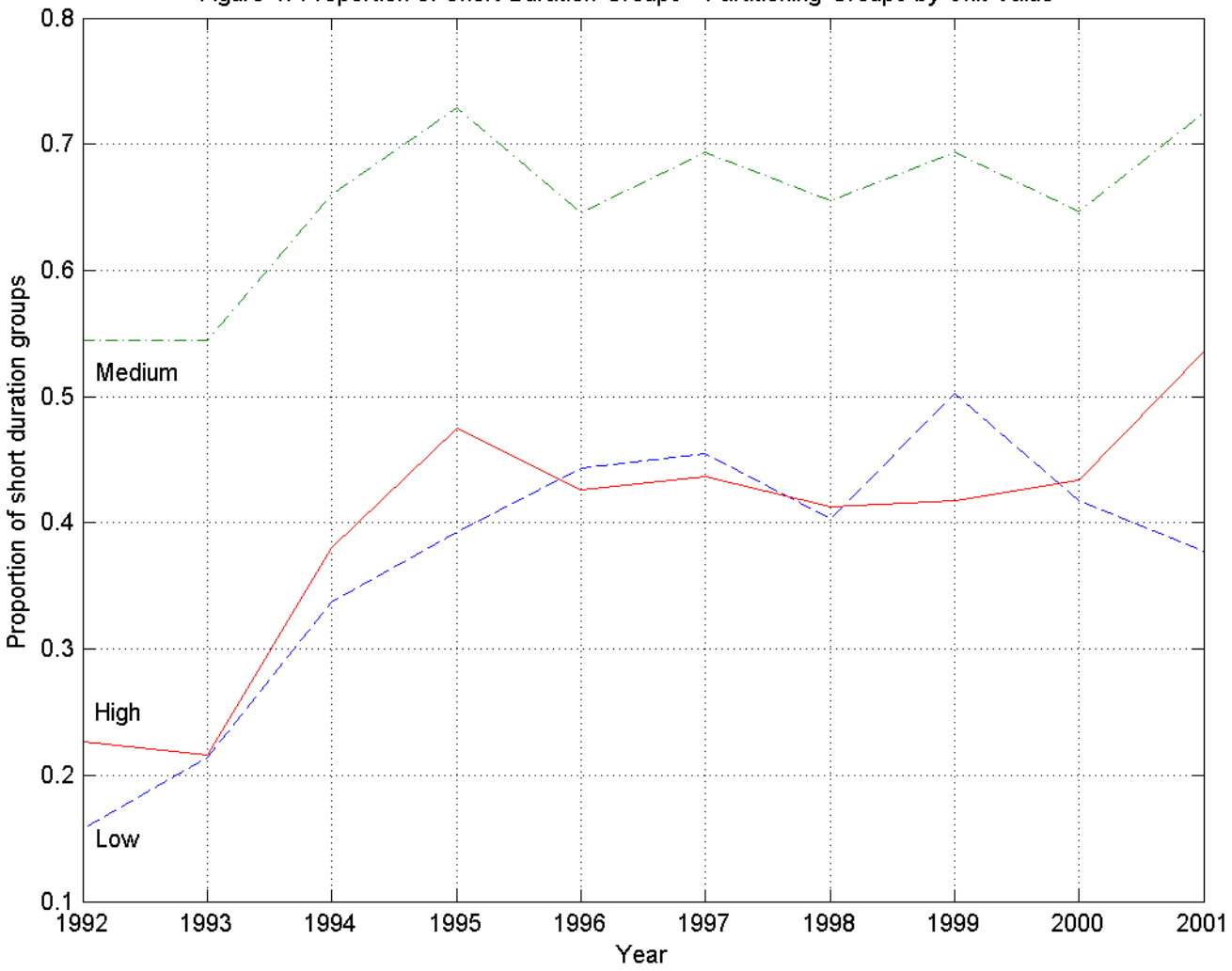

Figure 5: Proportion of Short Duration Groups - Partitioning Groups by Monthly Contribution

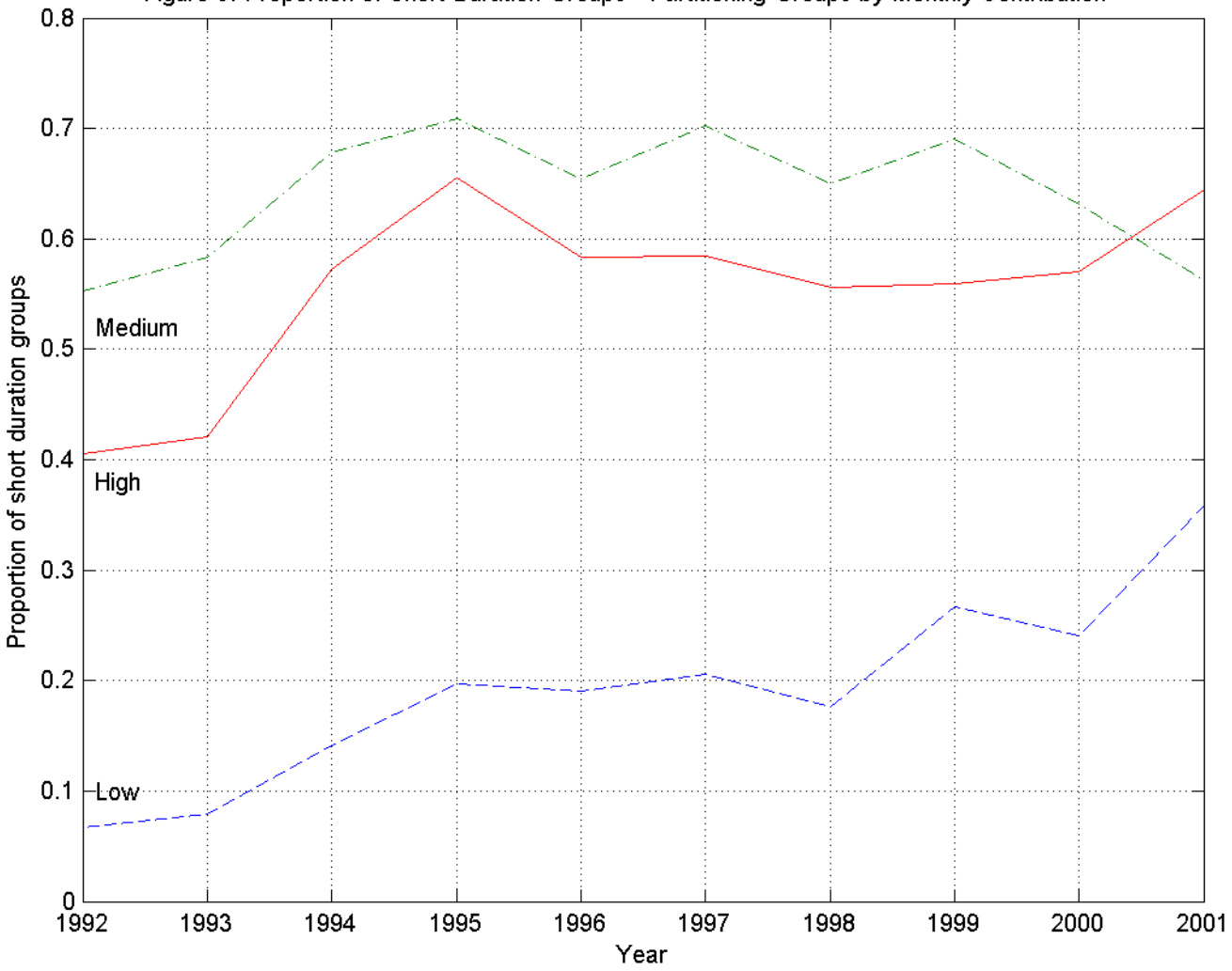

Table 1: Classification of Groups

Groups divided by:		chit value			monthly contribution		
Chit value/contribution:		Low	Medium	High	Low	Medium	High
		(1)	(2)	(3)	(4)	(5)	(6)
Duration							
20 months		17.42	3.35	5.79	--	23.29	7.02
25 months	SHORT	8.51	8.77	17.38	10.25	--	27.41
30 months		--	49.29	5.79	--	40.85	14.47
40 months		73.87	24.77	18.90	88.93	23.41	13.60
50 months	LONG	0.20	0.90	38.11	0.82	0.24	27.41
60 months		--	12.90	10.67	--	12.20	7.68
100 months		--	--	3.35	--	--	2.41
Total		100.00	100.00	100.00	100.00	100.00	100.00
Total no. of groups		1022	775	328	849	820	456

Note: Chit value is the product of the monthly contribution and the group duration (in months).
Chit value: Low if chit value=10000, Medium if chit value 10000-50000, High if chit value>=50000.
Contribution: Low if contribution<500/month, Medium if contribution 500-1000, High if contribution>1000.
Duration: Long >=40 months.

Table 2: Description of Participants

Groups partitioned by:	chit value						monthly contribution					
Chit value/ contribution:	Low		Medium		High		Low		Medium		High	
Year:	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Income Distribution (private subscribers)												
Mean	2.90	2.98	3.66	3.66	4.84	7.59	2.88	2.96	3.60	3.53	4.76	7.05
(standard deviation)	(2.70)	(3.06)	(4.79)	(3.00)	(9.12)	(35.94)	(2.75)	(2.98)	(4.70)	(2.54)	(8.80)	(32.92)
0.10 quantile	1.14	1.12	1.52	1.55	1.86	1.94	1.15	1.10	1.50	1.50	1.87	1.90
0.25 quantile	1.63	1.70	2.23	2.24	2.58	2.71	1.62	1.66	2.20	2.16	2.52	2.66
0.50 quantile	2.47	2.50	3.00	3.03	3.55	3.83	2.44	2.48	3.00	3.00	3.52	3.74
0.75 quantile	3.50	3.50	4.10	4.33	5.00	5.25	3.47	3.46	4.05	4.21	5.00	5.14
0.90 quantile	4.90	5.00	5.79	6.00	7.35	8.00	4.85	5.00	5.68	5.93	7.05	7.90
B. Proportion of corporate subscribers												
	0.17	0.23	0.15	0.20	0.12	0.24	0.17	0.23	0.15	0.20	0.13	0.23

Note: Chit value is the product of the monthly contribution and group duration (in months).
Income is measured in thousands of Rs. per month.
Statistics in Panel A are computed for private subscribers only.
Chit value: Low if chit value=10000, Medium if chit value 10000-50000, High if chit value>=50000.
Contribution: Low if contribution<500/month, Medium if contribution 500-1000, High if contribution>1000.

Table 3: Timing of Winning Bids by Type of Participant

Dependent variable:	Timing					
Chit value:	Low		Medium		High	
Year:	1993	1994	1993	1994	1993	1994
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Groups partitioned by chit value						
Corporate subscriber	-0.124	-0.124	-0.105	-0.144	-0.151	-0.118
	(0.005)	(0.006)	(0.007)	(0.006)	(0.010)	(0.008)
Constant	0.535	0.543	0.530	0.543	0.529	0.541
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Number of observations	21,400	14,635	14,300	13,411	7,555	6,750
Panel B: Groups partitioned by contribution						
Corporate subscriber	-0.122	-0.117	-0.114	-0.147	-0.134	-0.126
	(0.005)	(0.006)	(0.007)	(0.006)	(0.009)	(0.007)
Constant	0.534	0.540	0.532	0.544	0.529	0.543
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Number of observations	19,910	12,815	14,330	13,321	9,015	8,660

Note: Timing is measured as the winning month divided by the total duration of the group.
Corporate subscriber equals one if finance company, zero otherwise.
Chit value: Low if chit value=10000, Medium if 10000<chit value<50000, High if chit value>=50000.
Contribution: Low if contribution<500, Medium if 500<=contribution<1000, High if contribution>=1000.
The individual subscriber is the unit of observation.
Standard errors in parentheses.

Table 4: Matching into Groups (1993)

Dependent variable:	Proportion of corporate subscribers					
Groups partitioned by:	chit value			monthly contribution		
Chit value/ contribution:	Low	Medium	High	Low	Medium	High
	(1)	(2)	(3)	(4)	(5)	(6)
A. Duration measured by a binary variable						
Long duration dummy	-0.007	-0.014	-0.098	-0.018	-0.024	-0.063
	(0.008)	(0.009)	(0.014)	(0.012)	(0.010)	(0.011)
Constant	0.179	0.141	0.208	0.190	0.150	0.173
	(0.007)	(0.005)	(0.013)	(0.012)	(0.006)	(0.009)
Number of observations	594	337	161	512	363	217
B. Duration measured as a continuous variable (in years)						
Group duration	-0.004	-0.014	-0.015	-0.016	-0.026	-0.014
	(0.005)	(0.009)	(0.004)	(0.010)	(0.008)	(0.004)
Constant	0.185	0.173	0.191	0.227	0.210	0.185
	(0.017)	(0.024)	(0.018)	(0.031)	(0.020)	(0.014)
Number of observations	594	337	161	512	363	217

Note: Long duration dummy equals one if the group runs for at least 40 months, zero otherwise.
Chit value: Low if chit value=10000, Medium if chit value 10000-50000, High if chit value>=50000.
Contribution: Low if contribution<500/month, Medium if contribution 500-1000, High if contribution>1000.
Regressions use 1993 data only and the group is the unit of observation.
Standard errors in parentheses.

Table 5: Matching into Groups (from 1993 to 1994)

Dependent variable:	Proportion of corporate subscribers					
Groups partitioned by:	chit value			monthly contribution		
Chit value/contribution:	Low	Medium	High	Low	Medium	High
	(1)	(2)	(3)	(4)	(5)	(6)
A. Duration measured by a binary variable						
Long duration dummy - 1994 dummy	0.059	0.030	0.088	0.073	0.039	0.086
	(0.013)	(0.015)	(0.024)	(0.019)	(0.016)	(0.019)
Long duration dummy	-0.007	-0.014	-0.098	-0.018	-0.024	-0.063
	(0.009)	(0.010)	(0.018)	(0.013)	(0.011)	(0.014)
1994 dummy	0.004	0.031	0.040	-0.009	0.022	0.042
	(0.011)	(0.008)	(0.020)	(0.018)	(0.008)	(0.014)
Constant	0.179	0.141	0.208	0.190	0.150	0.173
	(0.008)	(0.006)	(0.016)	(0.013)	(0.006)	(0.010)
Number of observations	1,022	675	328	849	720	456
B. Duration measured as a continuous variable (in years)						
Group duration -1994 dummy	0.038	0.007	0.019	0.063	0.021	0.028
	(0.008)	(0.014)	(0.009)	(0.015)	(0.012)	(0.008)
Group duration	-0.004	-0.014	-0.015	-0.016	-0.026	-0.014
	(0.006)	(0.010)	(0.005)	(0.010)	(0.008)	(0.005)
1994 dummy	-0.063	0.020	0.037	-0.147	-0.020	-0.002
	(0.024)	(0.039)	(0.033)	(0.047)	(0.030)	(0.026)
Constant	0.185	0.173	0.191	0.227	0.210	0.185
	(0.017)	(0.027)	(0.022)	(0.033)	(0.021)	(0.017)
Number of observations	1,022	675	328	849	720	456

Note: Long duration dummy equals one if the group runs for at least 40 months, zero otherwise.
1994 dummy equals one if the group commenced in 1994, zero otherwise.
Chit value: Low if chit value=10000, Medium if chit value 10000-50000, High if chit value>=50000.
Contribution: Low if contribution<500/month, Medium if contribution 500-1000, High if contribution>1000.
The group is the unit of observation.
Standard errors in parentheses.

Table 6: Change in the Mix of Groups

Groups partitioned by:		chit value						monthly contribution					
Chit value/ contribution:		Low		Medium		High		Low		Medium		High	
Year:		1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A : Subscriber participation													
Private subscribers		17,688	11,331	12,133	10,772	6,637	5,108	16,468	9,848	12,113	10,700	7,877	6,663
Corporate subscribers		3,713	3,304	2,167	2,639	929	1,643	3,443	2,967	2,217	2,621	1,149	1,998
B : Proportion of short duration groups													
		0.217	0.318	0.573	0.656	0.217	0.359	0.082	0.134	0.612	0.672	0.419	0.552
		(0.017)	(0.023)	(0.025)	(0.024)	(0.033)	(0.037)	(0.012)	(0.019)	(0.024)	(0.023)	(0.034)	(0.032)
C : Distribution of group durations													
Duration:													
20 months		14.65	21.26	2.05	4.69	6.83	4.79	--	--	21.58	25.06	7.37	6.69
25 months	SHORT	7.07	10.51	8.70	8.85	11.80	22.75	8.20	13.35	--	--	24.42	30.13
30 months		--	--	46.55	52.08	3.11	8.38	--	--	39.57	42.18	10.14	18.41
40 months		78.11	67.99	27.11	22.40	16.77	20.96	90.63	86.35	25.42	21.34	12.44	14.64
50 months	LONG	0.17	0.23	1.79	--	44.10	32.34	1.17	0.30	0.48	--	32.72	22.59
60 months		--	--	13.81	11.98	11.18	10.18	--	--	12.95	11.41	8.29	7.11
100 months		--	--	--	--	6.21	0.60	--	--	--	--	4.61	0.42
Total (%)		100	100	100	100	100	100	100	100	100	100	100	100

Note: Short duration groups run for less than 40 months.
Chit value: Low if chit value=10000, Medium if chit value 10000-50000, High if chit value>=50000.
Contribution: Low if contribution<500/month, Medium if contribution 500-1000, High if contribution>=1000.
Proportion of short duration groups in 1994 is significantly higher at the 5 percent level than in 1993, within each category in Panel B, except for Columns 9-10.
Standard errors in parentheses.

Table 7: Implicit Interest Rates

Groups partitioned by:	chit value						contribution					
Chit value/contribution:	Low		Medium		High		Low		Medium		High	
Duration:	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Interest rate computed using first and last month												
1993	16.48	14.15	18.92	18.17	24.18	20.88	15.76	14.20	18.33	18.15	20.60	20.88
	(0.36)	(0.12)	(0.32)	(0.63)	(1.02)	(0.56)	(0.38)	(0.12)	(0.28)	(0.64)	(0.69)	(0.56)
1994	17.00	9.95	14.52	8.77	16.58	8.38	16.09	9.95	15.30	8.77	15.88	8.38
	(0.42)	(0.04)	(0.15)	(0.16)	(0.37)	(0.13)	(0.36)	(0.04)	(0.24)	(0.16)	(0.25)	(0.13)
B: Interest rate computed using 0.20*duration and last month												
1993	15.53	14.01	17.71	16.40	20.50	17.94	15.04	14.11	17.04	16.18	18.81	17.94
	(0.44)	(0.12)	(0.32)	(0.56)	(0.97)	(0.49)	(0.72)	(0.12)	(0.32)	(0.57)	(0.53)	(0.49)
1994	16.88	10.80	16.39	9.98	18.98	10.00	17.36	10.80	16.28	9.98	17.97	10.00
	(0.55)	(0.11)	(0.20)	(0.18)	(0.39)	(0.15)	(0.58)	(0.11)	(0.29)	(0.18)	(0.32)	(0.15)

Note: Short duration groups run for less than 40 months, Long duration groups run for at least 40 months.
Chit value: Low if chit value=10000, Medium if chit value 10000-50000, High if chit value>=50000.
Contribution: Low if contribution<500/month, Medium if contribution 500-1000, High if contribution>=1000.
Mean interest rate (in percentage) with standard errors in parentheses.
Interest rates are computed at the group level.

Table A1: Group Choice-Income Relationship

Panel A:						
Dependent variable:	chit value					
Chit value (thousands of Rs.):	10	15	25	30	50	100
B. Linear probability model						
Income	-0.003	-0.0001	0.00006	-0.0003	0.001	0.003
	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0001)
Constant	0.409	0.083	0.175	0.137	0.158	0.038
	(0.004)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
A. Multinomial logit model						
Income	-0.156	0.009	0.030	--	0.058	0.071
	(0.010)	(0.012)	(0.009)		(0.008)	(0.009)
Constant	1.574	-0.528	0.147	--	-0.040	-1.345
	(0.041)	(0.051)	(0.041)		(0.040)	(0.050)

Panel B:					
Dependent variable:	monthly contribution				
Contribution (Rs.):	250	500	625	1000	
A. Linear probability model					
Income	-0.011	-0.001	0.002	0.010	
	(0.001)	(0.001)	(0.001)	(0.001)	
Constant	0.419	0.266	0.155	0.160	
	(0.005)	(0.004)	(0.003)	(0.004)	
B. Multinomial logit model					
Income	-0.139	--	0.036	0.058	
	(0.010)		(0.008)	(0.007)	
Constant	0.803	--	-0.608	-0.518	
	(0.036)		(0.036)	(0.034)	

Note: chit value is the product of the monthly contribution and the group duration (in months).
Chit value and income are measured in thousands of Rs.
Monthly contribution is measured in Rs.
Multinomial logit model estimated with chit value=30 as base value in Panel A and contribution=500 in Panel B.
Linear probability model is estimated independently for each chit value or monthly contribution.
Number of observations in all regressions is 20,885 in Panel A and and 18,877 in Panel B.
Standard errors in parentheses.

Table A2: Distribution of Groups by Chit Value and Contribution

Breakdown of groups by:		chit value						monthly contribution			
Chit value/contribution:		10	15	25	30	50	100	250	500	625	1000
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Duration		LOW		MEDIUM		HIGH		LOW	MEDIUM		HIGH
20 months		18.88	3.74	2.02	4.85	3.31	12.04	--	28.53	--	--
25 months	SHORT	9.23	--	27.42	--	24.86	11.11	--	--	--	28.81
30 months		--	96.26	--	28.48	--	12.04	--	53.69	--	19.92
40 months		71.69	--	69.76	6.06	11.05	38.89	100.00	1.44	100.00	--
50 months	LONG	0.21	--	0.81	--	60.77	13.89	--	0.32	--	46.61
60 months		--	--	--	60.61	--	1.85	--	16.03	--	--
100 months		--	--	--	--	--	10.19	--	--	--	4.66
Total (%)		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total no. of groups		943	348	248	165	181	108	676	624	173	236

Note: Chit value is the product of the monthly contribution and the group duration (in months).
Chit value is measured in thousands of Rs., monthly contribution is measured in Rs.
The 6 chit values in the Table account for over 90% of all observations, the 4 monthly contributions account for nearly 85% of the observations.

Table A3: Bids within the Group

Dependent variable:	Normalized bid					
Contribution:	Low		Medium		High	
Duration:	Short	Long	Short	Long	Short	Long
	(1)	(2)	(3)	(4)	(5)	(6)
Period 1	0.275	**0.370**	**0.328**	**0.464**	**0.337**	**0.527**
	(0.004)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)
Period 2	0.223	0.312	0.246	**0.368**	0.254	**0.418**
	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Period 3	0.156	0.221	0.161	0.275	0.174	0.304
	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Period 4	0.097	0.118	0.095	0.181	0.110	0.197
	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Period 5	0.063	0.065	0.063	0.077	0.065	0.085
	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Period 1 * 1994 dummy	0.003	**-0.077**	**-0.043**	**-0.167**	**-0.046**	**-0.224**
	(0.005)	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)
Period 2 * 1994 dummy	0.020	-0.041	-0.005	**-0.081**	0.003	**-0.123**
	(0.004)	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)
Period 3 * 1994 dummy	0.003	-0.002	-0.008	-0.016	0.002	-0.031
	(0.004)	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)
Period 4 * 1994 dummy	-0.009	0.006	-0.008	-0.002	-0.007	-0.009
	(0.004)	(0.001)	(0.002)	(0.003)	(0.003)	(0.003)
Period 5 * 1994 dummy	-0.010	-0.009	-0.010	-0.009	-0.009	-0.014
	(0.004)	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
Number of observations	2088	29788	13344	13487	5522	11697

Note: Normalized bid is measured as the bid amount divided by the chit value.
Short duration groups last for less than 40 months, Long duration groups last for 40 months or more.
Each group is divided into 5 equal periods: Period 1- Period 5, covering its entire duration in sequence.
Contribution: Low if contribution<500/month, Medium if contribution 500-1000, High if contribution>=1000.
Bold face coefficients highlight bids greater than 0.3 in Rows 1-5 and the change in those bids in Rows 6-10.
Standard errors in parentheses.