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GIFT-GIVING, QUASI-CREDIT AND RECIPROCITY

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Abstract

The fluctuations in incomes inherent in rural communities can be attenuated by reciprocal insurance. We develop a model of such insurance based on self-interested behaviour and voluntary participation. One individual assists another only if the costs of so doing are outweighed by the benefits from expected future reciprocation. A distinction is made between general reciprocity where the counter obligation is expected but not certain and balanced reciprocity where there is a firm counter obligation. This firm counter obligation is reflected by including a loan or quasi-credit element in any assistance. It is shown how this can increase the insurance provided and how it may explain the widespread use of quasi-credit in rural communities. Moreover it is shown that for a range of parameter values consistent with evidence from three villages in southern India, a simple scheme of gift-giving and quasi-credit can do almost as well as theoretically better but more complicated schemes.

JEL Classification: D89, O16, O17.

Keywords: implicit contract, gift-giving, reciprocity, quasi-credit.

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1 Three Villages

We will briefly describe three village communities, one from India, one from Africa and one from Asia. Purakkad is a small fishing village in Kerala state in southern India. The fishermen of the village have a choice either of beach-seining or going deep-sea fishing with lines on non-motorized boats. They fish when the weather permits and when there is evidence of fish which means that on average they fish every second or third day. When they fish, they land and market their catch on the beach. There are large day-to-day variations in the catch of any one fishing team and large variations in catches across different teams on any given day. Some teams will be lucky and happen upon good shoals of fish and land good catches and others will be less fortunate and net only a meagre haul. But the chances are that the luck will even itself out and those fortunate today may be less fortunate tomorrow. The response of the fishermen to the variability in their catch is documented by Platteau and Abraham (1987) and Platteau (1991). Those fishermen who have been unlucky enough to have a bad catch are able to borrow interest-free from those who have been more fortunate. This system of credit is very active with each fisherman undertaking a loan or borrowing or making a repayment on average every other day. It also appears to be very effective in reducing the variability of consumption relative to the variability in their income.

The Basarwa of northern Botswana are semi-nomadic subsistence farmers who grow mainly maize and sorghum. They own relatively few animals and borrow *mafisa* cattle from wealthier cattle owners. The Basarwa get the milk and draught power of the mafisa cattle (and possibly any calves) but must return the animal after the season. They stay in one place only for a few seasons and then move usually to a new employer or when the current employer no longer needs them. In addition they face important sources of variation in their crop yields from regional drought, crop disease and pests. The pests are clearly an important worry. As one of the Basarwa put it: the cattle eat and destroy the crops, the birds eat the sorghum, the monkeys eat the maize, the jackals eat the watermelon and duikers eat the beans. The Basarwa have been studied by the anthropologist Elizabeth Cashdan (see Cashdan, 1985) who finds that there is widespread evidence of food-sharing amongst the Basarwa with gifts mainly of meat but also grain and milk given to those in need. Small gifts are also given frequently "to reinforce the social relationships that can be called upon for more significant gifts should the need arise". This system of reciprocal giving helps stabilize food consumption and is a "cost-effective way of attaining security for this population".

The rice terraces in the Cordillera mountains of northern Luzon island in the Philippines are justifiably famous and the mountains are home to many isolated rice-farming villages. Lund and Fafchamps (1997) report on a survey of four villages in the area.[2] All

[2] This survey is probably unique as it was explicitly designed to gather information on gifts, loans and transfers.

206 households in the survey participated in gift-giving or receiving in the 9 months of the survey and the majority also participated in giving or receiving of loans. Over 80% of these transactions were between households within the same village and virtually all others were with adjacent villages. Nearly all expected to transact with the same partner again. Over half the households reversed their roles with their loan partner within the nine month survey period. So givers (lenders) became receivers (borrowers) and vice-versa. Most of the loans and gifts were for consumption purposes. None of the loans were written down explicitly, less than 3% specified a repayment schedule, only 1% required collateral and over 80% were interest-free. Of the loans repaid within the survey period nearly 20% were *not* repaid in full. In only one case did the lender claim that a default had taken place. In all other cases the lenders agreed to forgive part of the loan due to the borrowers' difficult circumstances.

2 Deductivist Approach

Nearly one-half of the world live in small rural communities like these villages. These three examples illustrate the social structure of a village economy and the informal insurance arrangements in which they engage. The gifts, loans and transfers between the villagers are predominately for consumption purposes;[3] they provide some insurance against a bad catch or a bad harvest but are informal as there are no written records, no legal procedures to enforce repayments, no collateral; and an understanding that debts may be delayed or forgiven if circumstances dictate. The loans and gift transactions are personalized rather than pure market transactions and are embedded in the social structure of the village.[4] Resources are allocated not by markets but by non-market institutions that act as partial and imperfect substitutes for the absent or missing markets.[5] The village economy is a relatively small, relatively closed, relatively cohesive, near subsistence, agricultural economy.

There has been considerable discussion of informal insurance arrangements in rural communities by economists, ethnographers, sociologists and social anthropologists (see, e.g., Bliss and Stern, 1982; Hoff, Braverman, and Stiglitz, 1994; Bardhan, 1989; Cashdan, 1990; Firth and Yamey, 1964; Sahlins, 1974; Schwatz, 1967). This literature emphasizes that life in village economies is aleatory. Risk is the predominant fact of life. Risk to crops from poor weather or disease or pests, the risk of losing ones animals and the risk of illness. James Scott starts his book on "The Moral Economy of the Peasant" with

[3] Informal arrangements are also used for the financing of productive investments and indivisible goods. A common approach is the use of rotating savings and credit associations (Roscas), see Besley, Coate, and Loury (1993).

[4] On the importance of embedding economic transactions within a social structure see Granovetter (1985).

[5] Absent complete markets, consumption and production decisions cannot be separated and rationality is decoupled from profit maximization (see Lipton (1968)).

a quote from R. Tawney: "the position of the rural population is like a man standing permanently up to the neck in water, so that even a ripple is sufficient to drown him". The current paper concerns itself with one of the ways in which people can respond to risk, namely by insuring each other. We depart, however, from the vast majority of the literature by adopting a highly deductivist methodology. That is, suppose we were in the situation faced by, say, the fisherman in Purakkad, knowing more or less what the risks are and knowing that if someone fails to repay there are no courts to enforce the payment, how would we best design an arrangement that provides as much insurance as possible in these circumstances? We then compare the features of this arrangement with existing institutions.

To be more precise, we shall construct a simple model of mutual insurance based on self-interested behaviour. The parameters of the model will be calibrated to reflect what is known about such factors as attitudes to risk and the degree of risk faced in typical village economies. We shall then compare the best mutual insurance arrangement in the model with some of the features of insurance arrangements that have been documented in the literature to see whether the approach taken here can plausibly explain these features. More precisely, we shall show that a stylized version of the documented arrangements can come close to the "ideal" arrangement according to the theory; in this sense our finding is that the theoretical approach advanced can explain general features of informal insurance arrangements.[6]

This deductivist approach may be contrasted with the inductive approach, or more functional approach, which *starts* with observations about what institutions or informal arrangements are used and then develops a model to explain the observations. One advantage of the deductivist approach is that it forces one to be very explicit about the economic environment. Another is that it is better suited to the evaluation of policy changes.[7] The disadvantage is that it does not provide an explanation of the evolution of the institutions as a response to a changing environment. Rather it assumes that the institution exists to solve a given problem.

[6] In a related paper, Ligon, Thomas, and Worrall (1997) fit a model of an efficient arangement to data from 3 Indian villages, and argue that this model provides a superior account of the data to a number of competing models.

[7] The ability to assess policy changes is especially important as previous policy interventions have often proved only moderately and patchily successful, such as the green revolution, and others have at best proved only partially successful and at worst have been counter-productive (Braverman and Guasch, 1986). Even the more recent and thoughtful interventions like the Grameen Bank in Bangladesh or the BKK in Java, which have been successful in their own terms of promoting savings, have been questioned as to whether they actually improved welfare (Townsend, 1996).

3 Gift-Giving and Reciprocity

Gift-giving and reciprocal exchange appears to be pervasive in rural communities. Sahlins (1974) provides numerous examples ranging from studies of the Eskimo to studies of the !Kung to studies of Australian Aboriginals. History also offers many examples of reciprocity, for example in medieval villages (Townsend, 1993) and also in archaic periods.[8] Sahlins (developing the ideas of Malinowski, 1978) identifies three types of reciprocal exchange, generalized, balanced and negative. Generalized and negative reciprocity are at two extremes with balanced reciprocity somewhere in the middle. *Generalized reciprocity* (also called weak or indefinite reciprocity) may take the form of a "*gift*" (see, e.g., Malinowski, 1978; Mauss, 1990). This is not to say that the gift does not imply a counter obligation. Rather the reckoning of the debt cannot be overt and the recipient has only a vague obligation to reciprocate. Reciprocation may be in full or may be in part; it may come soon or it may never come. The test of generalized reciprocity according to Sahlins is whether failure to reciprocate causes the giver to stop giving. *Balanced reciprocity* is applied to transaction which involve a more complete reckoning of the counter obligation. There must be a tangible quid pro quo. It may be contemporaneous as in normal exchange transaction but it need not be. There will however be a firm expectation that a counter gift of approximately equal worth will be offered within some reasonable time period. The test of balanced reciprocity is the inability to tolerate one-way flows. The relationship between the parties will be disrupted if there is a failure to reciprocate. At the other extreme is *negative reciprocity* (Gouldner, 1960). This is a situation where one party seeks to gain at the other's expense. Theft comes into this category as would dishonestly supplying inferior goods.

Platteau (1997) argues that, in the context of informal insurance, gift-giving when need arises is a form of generalized reciprocity, but that informal loans or credit (possibly combined with gifts) corresponds to balanced reciprocity. Gift-receiving in times of need does not create any extra obligation on the part of the recipient beyond what already existed. If one household unfortunately suffered a series of bad shocks, there will be a one-way flow of resources in its favor. The evidence from the villages of Kerala state, northern Botswana, the Philippines and elsewhere suggests, however, that informal loans, or a combination of informal loans and gifts, are much more common than simple gifts. That is, a transfer of resources today is balanced by a counter obligation of repayment at some point in the future. That credit can be, and is, used as insurance has long been recognized (see, e.g., Eswaren and Kotwal, 1989): borrow when times are bad and repay when times are good. These loans may however, be interpreted better as a type of *quasi-*

[8] The book by Gordon (1975) on economic analysis before Adam Smith begins with the writings of the greek didactic poet Hesiod who lived around 700BC. One of Hesiod's poems is *Work and Days* where he writes about a collection on independent farming households. The poem can be considered as a series of aphorisms on how best to keep the household wealthy (Millet, 1984). One part of the poem deals with reciprocity: "Take fair measure from your neighbour and pay him back fairly with the same or better if you can; so that if you are in need afterwards, you may find him sure." (*lines 359-361*)

credit as they have an implicit and flexible rather than an explicit and rigid repayment schedule.[9]

From the point of view of insurance, generalized reciprocity or gift-giving as need arises is the best arrangement. Balanced reciprocity, that corresponds (in this context) to credit or quasi-credit arrangements, is less effective. For example, a household facing one adverse shock may borrow to stabilize its consumption. Should it then immediately suffer another adverse shock, it is in a worse position than after the first shock as it has repayment obligations on the borrowing already made, and being less willing to accumulate even more debt, it will be forced to cut consumption. Had it received a gift without counter obligation after the first shock, it is in no worse position when the second shock hits, and provided another gift is made, it will be able to maintain its consumption. It may be quite puzzling, then, why these quasi-credit arrangements are used in place of or as a supplement to gifts, but we shall argue that quasi-credit components arise quite naturally when reciprocity is voluntary rather than enforced and is based on rational action: one makes a loan or a gift because the future benefits exceed the current cost. A gift or loan is made in the anticipation of being a recipient in the future. I give or lend to you because I anticipate the benefits exceed the cost and I know you will reciprocate at some point as you will have a similar calculation to make. The problem with a pure insurance/gift arrangement, where the only counter obligation on the receiver is the general obligation to respond likewise if the giver is in need in the future, is that this counter obligation may not be sufficient to induce the giver to part with resources today. This can be seen clearly if the giver is confident that he or she will not be in need of help in the immediate future, so that the general counter obligation has little value. On the other hand, if there is a credit element to the transaction, the giver will expect some future reward—repayment on the loan—over and above any reciprocal insurance promise, and this may provide sufficient incentive to induce the giver to part with resources today. An interesting example of a pure insurance arrangement which suffers from an incentive problem is described in Platteau (1997). He cites the case of Senegalese small-scale fishermen who band together in order to provide a rescue service for fellow fishermen who get into difficulty at sea. They also promise to help repair or replace damaged or lost equipment. However, Platteau finds that these informal rescue organizations often break down as those who contribute but do not receive any benefit become frustrated with the arrangement.[10] The argument presented here is that such ideal but potentially unstable arrangements can be made stable by adding a quasi-credit element.

[9] Udry (1994) finds evidence from northern Nigeria that repayments on loans are state contingent. On average a borrower with high income repays 20.4% more than he borrowed but a borrower who has another bad year repays 0.6% less than he borrowed. Moreover repayments are contingent on the *lender's* position. A lender with a good realization of income receives on average 5% less than he lent, but a lender with a bad realization receives on average 11.8% more. Thus repayments appear to contain a "gift" element tailored to the circumstances of either party. (See also the discussion of the rice terraces in Luzon in Section 1.)

[10] It may be argued that a good reason for pulling out of the arrangement is because one learns of negative characteristics of other fishermen. This does not, however, seem to be a problem here. Those rescued were not seen as being imprudent or bad fishermen, merely unlucky ones.

Implicit in the above is the idea that the consequence of failing to hold to one's side of an informal risk-sharing arrangement is exclusion from the arrangement in future.[11] The general idea that some insurance is possible in informal settings where the only incentive to sacrifice current resources is the threat of exclusion from the insurance institution in future can be found in Posner (1980) and Posner (1981) and more explicitly in the work on self-enforcing agreements by Telser (1980). It was applied to village economies by Kimball (1988) and Fafchamps (1992) who showed that it was possible for such a system to work and by Coate and Ravallion (1993) who examined a situation of reciprocal gift-giving but ignored the quasi-credit component. The approach we adopt is essentially game theoretic. What we do, in contrast to this literature which has concentrated on demonstrating that such arrangements are possible or has looked at properties of specific arrangements, is to find the *best* or "efficient" insurance arrangement given that any agent will renege on the arrangement if it is in their own self-interest so to do. We do this in such a way that the solution can be computed and a comparison made with existing institutions and insurance arrangements.[12]

The fear of exclusion from future insurance is of course not the only possible reason to reciprocate and there are certainly other possible answers which have been suggested. Other game theoretic models have been suggested by Camerer (1988) and Raub and Weesie (1990) and Goerlich (1996-97). Camerer (1988) treats gift-giving as a signalling game where the gift is a signal or symbol of one's intention to invest in a relationship.[13] He demonstrates how in the equilibrium of this game gift-giving can be mutual and inefficient (the recipient values the gift less than the giver). In a different but related vein Raub and Weesie (1990) study an extended version of the repeated prisoners' dilemma game.[14] They examine an infinite-horizon random matching model with a finite number of players. In any period a player either plays a prisoners' dilemma game against one of a subset of possible opponents or remains unmatched for that period. They study the incentives for players to play cooperatively under different informational assumptions about a players knowledge of the past play of their potential opponents. Goerlich (1996-97) looks at cooperative and non-cooperative models of ceremonial gift exchange and barter. But none of these papers address the insurance issue which is central to the explanations of gift-giving given by the anthropological literature and is the main concern of the present paper.

There are also a number of other possible explanations for reciprocity and gift-giving. It could be that the villagers are simply extremely moral and have a strong sense of

[11] The theory can be readily extended to incorporate additional costs of reneging on an arrangement such as shame, social sanctions, etc. The inclusion of such costs would however affect the exercise conducted in Sections 6 and 7.

[12] The general approach that agents will balance current loss against expected future gains will apply to any trading relation and is not specific to mutual insurance. Thus, e.g., borrowing to make productive investments which payoff in the future could be treated in a similar way. Other, non-economic transactions are also, in principle, amenable to this approach.

[13] See also Schwatz (1967).

[14] See also Nettle and Dunbar (1997).

social justice which involves raising the incomes of the poor. This is the view of Scott (1976) who stresses that "the obligation of reciprocity is a moral principle *par excellence*". For Scott the village notion of social justice includes the right to a subsistence level of income and the village is seen as the institution which guarantees this subsistence income through a system of reciprocities. Popkin (1979) and Popkin (1980) has severely criticized Scott and what he calls the moral economists. He questions whether a peasant society is any more moral than any other society and cites evidence of selfish behavior (see also Foster, 1965). He asks how these norms of reciprocities are derived, how subsistence is defined and how needs are assessed. One important criticism concerns the "safety-first" principle emphasized by the moral economists. The "safety-first" principle argues that villagers should and do avoid risk at all costs. Popkin argues that if villagers were so moral that they bailed-out anyone who fell below subsistence this would not be necessary.

A related possibility is that transfers are made for altruistic reasons. That is, the gift contributes to the giver's utility. It is well recognized that many transfers are between family and friends, the F-connection as Ben-Porath (1980) has called it. A number of authors have attempted to consider the role of altruism (see, e.g., Ravallion and Dearden, 1988; Foster and Rosenzweig, 1995; Rosenzweig, 1988; Stark, 1995). However, we feel that altruism cannot provide a complete explanation as altruism by itself cannot explain the use of loans rather than gifts alone, that is, balanced rather than generalized reciprocity, which seems a general feature of the evidence cited above.

In a similar vein, a recent game-theoretic literature takes reciprocity as a fundamental behavioral axiom, and either tests this axiom in laboratory experiments or explores its consequences (Fehr and Tyran, 1997; Falk and Fischbacher, 1998). Ruffle (1999) has applied psychological game theory (where beliefs enter directly into a player's payoff function) to gift giving; see also Dufwenberg and Kirchsteiger (1998). This work, however, does not concern itself with the specific question of informal insurance. In contrast with these models which assume either that people are altruistic or motivated to reciprocate, our work makes no such assumption, but derives reciprocal behavior as an *implication.* Of course, these two approaches need not necessarily be in conflict. If reciprocating is in an individual's self interest, then there may be an argument to suggest that a reciprocity norm might well evolve.

Other explanations have been offered in terms of *social exchange* or *tolerated theft*. The social exchange theorists (for an exposition, see, e.g., Heath, 1976) hypothesize that the act of giving creates a counter exchange in terms of an intangible like respect or prestige or status or avoidance of guilt. Blurton-Jones (1984) has also suggested that food-sharing is a form of tolerated theft: if the gifts were not given they would be stolen anyway. These however, can be criticized as giving no predictions about the size or nature of the gifts, nor can they easily explain the use of loans instead of gifts.

4 Examples and a result on quasi-credit

As an example of our approach consider the following. Suppose there are two households. Each has an income of either 1000 with probability $(1-p)$ or 500 with probability p. These draws are independent so the probability that both households get 500, for example, is p^2. Now consider a pure gift scheme where, if the incomes are different, the household with the high income gives an amount x, $250 \geq x \geq 0$, to the low income household. We can ask whether it is in the household's interest to make such a gift of the amount x given that it expects the other household to reciprocate. Suppose that within each period, a household's welfare or utility depends only upon consumption during that period. Specifically, suppose that each household (treated as a monolithic entity) has a utility of consumption function $u(c)$, where c is consumption, which has positive but diminishing marginal utility, so that $u'(c) > 0$ and $u''(c) < 0$ (where primes denote derivatives). Positive marginal utility simply means that the household prefers more to less. Diminishing marginal utility has the interpretation that the household is averse to risk (in the expected utility framework that we shall utilize). The short-run utility cost to making the transfer is

$$u(1000) - u(1000 - x).$$

Now suppose that both households live for an infinite number of periods (to justify this, consider them as dynasties), $t = 1, 2, \ldots$, but that each unit of utility next period is worth only $\delta < 1$ of a unit of today's utility (i.e., δ is the "discount factor", with higher values corresponding to increasing patience). Then total household utility is given by the discounted sum $\sum_{t=1}^{\infty} \delta^{t-1} u(c_t)$ where c_t is consumption in period t. Where consumption streams are uncertain, the expected value of the discounted sum is taken, in accordance with expected utility theory. Assuming that the process determining income is the same each period and does not depend on past realizations of income, then the potential long-term gain from such an arrangement is

$$\frac{\delta}{(1-\delta)}\{p(1-p)(u(500+x) - u(500))\} - \frac{\delta}{(1-\delta)}\{p(1-p)(u(1000-x) - u(1000))\}$$

where $u(500+x) - u(500))$ is the gain in any period when the household receives a transfer, while $u(1000) - u(1000-x))$ is the loss when a transfer is made to the other household. Since marginal utility is diminishing the utility gain from being a recipient exceeds the utility loss from being a giver,

$$u(500 + x) - u(500) > u(1000 - x) - u(1000)$$

and so the long-term gain in the equation above is positive. This simply reflects the fact that there are gains to risk-pooling. They will be larger the greater the curvature of the utility function—the more risk averse are the households. The long-term gains are also increasing in x (provided $x < 250$) and δ. The short-term loss is increasing in x.

Harvest	1's yield	2's yield	Transfer 1 to 2	1's share	2's share
418	1000	1000	0	0.5	0.5
419	1000	500	177.1	0.5486	0.4514
420	1000	1000	0	0.5	0.5
421	1000	500	177.1	0.5486	0.4514
422	1000	1000	0	0.5	0.5
423	1000	1000	0	0.5	0.5
424	500	1000	-177.1	0.5486	0.4514
425	500	500	0	0.5	0.5
426	1000	500	171.1	0.5486	0.4514
427	1000	1000	0	0.5	0.5

Table 1: Static Transfer

Ideally the outcome should be $x = 250$ where each household gets an equal share of aggregate income. This would mean full or "perfect" insurance with each household's share of aggregate income unchanging. (Note that perfect insurance doesn't entail all consumption variability being eliminated—in a small community this is impossible—but it means that risks should be shared appropriately between the members of the community; see Section 5.2.) Depending on the probabilities and the discount factor, however, the perfect insurance transfer/gift of 250 may not be *sustainable* as the short-term loss will exceed any long-term benefits. In other words, if the assumption is made that a household will participate in the arrangement only so long as it perceives a benefit from so doing, it may not pay a household to make a transfer as large as 250. As an example, suppose δ=20/21 which corresponds to a discount rate of 5%, $p = 0.1$, and that the utility function is logarithmic. Then the short-run loss is 0.2877 and the long-term gain is 0.2120. Thus it is not worthwhile making a transfer of 250. It may be worthwhile if x were smaller and a simple calculation shows that the long-term gains offset the short -term losses for x<177.1. The maximum risk-pooling that can be achieved given that the long-term benefits should exceed any short-term costs is x=177.1. This solution is what we shall call the *pure gift* solution and is that outlined in the paper by Coate and Ravallion (1993). It is a static solution because if the distribution of income is the same, then the same transfers or gifts are made. The results of a particular simulation is shown for a few periods in Table 1. The absence of commitment to a relationship (in, for example, a legal framework) implies that the relative shares of aggregate income are no longer constant over time as they would be with perfect insurance.

Note that the giving of a gift (making of a transfer) in this solution does not create a counter obligation beyond what already exists. Provided the gifts are large enough, such generalized reciprocity can achieve perfect insurance, so it is potentially the best arrangement. But, as argued above, if households participate only so long as it is in their interests to do so, then large gifts may not be sustainable. It is then not obvious that generalized reciprocity is the best arrangement.

Harvest	1's yield	2's yield	Transfer 1 to 2	1's share	2's share
418	1000	1000	-16.59	0.5083	0.4917
419	1000	500	237.56	0.4917	0.5083
420	1000	1000	-16.59	0.5083	0.4917
421	1000	500	237.56	0.4917	0.508
422	1000	1000	-16.59	0.5083	0.4917
423	1000	1000	-16.59	0.5083	0.4917
424	500	1000	-237.56	0.5083	0.4917
425	500	500	8.29	0.4917	0.5083
426	1000	500	237.56	0.4917	0.5083
427	1000	1000	16.59	0.4917	0.5083

Table 2: Dynamic Transfers

As already stated the evidence suggests widespread use of quasi-credit as a means of informal insurance. In the context of limited commitment the benefits of the quasi-credit element becomes clear. Start from a pure gift arrangement with $x < 250$ but also $x > 0$ (that is, positive, but less than perfect insurance, as explained above), and assume that this is sustainable, that is, so it is in the donor's long-term interests to make the transfer x. Suppose that the transfer is increased by a small amount, say Δ units, and in return there is a payment of $R\Delta$ next period if both households have 1000 (but not otherwise), so R is the gross interest rate, with the debt being written off if either household (or both) receives a low income. That is to say, add a small amount of quasi-credit to a system of gifts. The current marginal gain to the transferee is, using a first-order approximation, $u'(500+x)\cdot\Delta$ and the expected marginal loss from next period's repayment is $\delta(1-p)^2u'(1000)\cdot R\Delta$ where $(1-p)^2$ is the probability that both households have an income of 1000 so that the repayment is called for. The current marginal loss to the transferer is $u'(1000-x)\cdot\Delta$ and the expected marginal gain from next period's repayment is $\delta(1-p)^2u'(1000)R\cdot\Delta$, the same as the transferee's loss. As marginal utility is diminishing, $u'(1000-x) < u'(500+x)$ for $x<250$, so it is possible to choose R in such a way that both transferer and transferee gain, that is when R is chosen so that

$$\frac{u'(1000-x)}{\delta(1-p)^2u'(1000)} < R < \frac{u'(500+x)}{\delta(1-p)^2u'(1000)}.$$

Moreover, provided Δ is chosen small enough, the borrower will choose to repay when called upon to do so, because the cost of doing so, $\delta(1-p)^2u'(1000)\cdot R\Delta$, is proportional to Δ, while the cost of not doing so is the loss of future insurance, which is at least the value of insurance under the pure gift scheme x, and hence bounded below by a fixed positive number.[15] This argument works even when x is such that, in the pure gift scheme, the transferer is on the margin of not making the transfer, that is, indifferent. The intuition is simple. By demanding a repayment the transferer has an incentive to make a larger

[15] The argument does not imply that Δ is necessarily small, only that a small enough Δ is guaranteed to work. See Section 6 for illustrations of the optimal magnitude of loans.

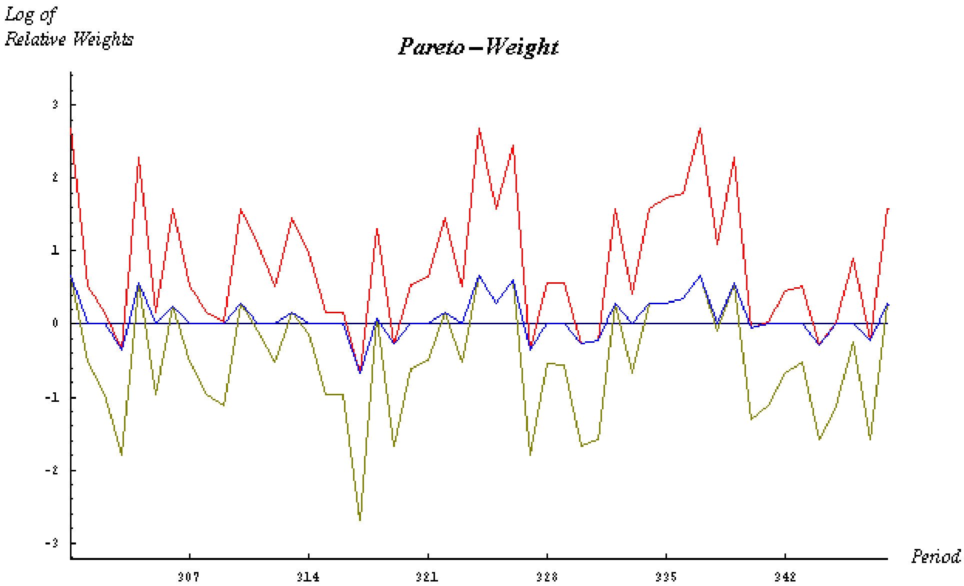

Figure 1: Relative Shares - Gifts Only

transfer and this helps risk-pooling which is to everyone's benefit. The cost of this is a move away from an equal share when both receive 1000—extra variability is introduced—but this cost is very small (formally, second-order) relative to the extra insurance when one household's income is 500 (which is first-order).

The above demonstrates that whenever the pure gift solution is unable to deliver perfect insurance (i.e., whenever $x < 250$), there is a superior arrangement involving some counter obligation. Moreover the argument just given does not depend on the specifics of the income distribution (it generalizes to arbitrary finite distributions). Exactly how the loans and repayments are optimally arranged is discussed later but the optimal solution—what we call the "dynamic limited commitment solution"— in the example with logarithmic utility and δ=20/21 and $p = 0.1$ is illustrated in Table 2. This solution is analysed more explicitly in Ligon, Thomas, and Worrall (1997). It can be seen from the table that the shares of income are less variable than in Table 1, so that more insurance is being provided. It should be stressed that this is the best conceivable arrangement given the constraint of voluntary participation, and in the remainder of the paper we shall investigate the extent to which a simple implementation of counter obligation using interest-free quasi credit measures up to this potentially complex ideal. Nevertheless, even in the best arrangement, the element of counter obligation can be clearly seen. For example in period 421, household 1 makes a large insurance transfer to 2 who has received a low yield; in the following two periods, yields return to parity, but 2 makes a small transfer to 1 (of 16.59). It is the anticipation of this "repayment" which helps to persuade 1 to make such a large initial transfer.

The variability in the shares indicate the extent of the insurance so it is worthwhile considering a slightly more complicated example to illustrate how shares change over time.[16] A random sample of nine incomes was drawn from a lognormal distribution with a mean and variance matching that in the data from the villages in rural India discussed below. It was assumed that the two households have identical and independent income draws, so there are a total of 81 states. The solutions were computed and income simulated over 600 periods. The results for 50 periods are displayed in Figure 1 and Figure 2. The vertical axis plots the logarithm of the relative shares of aggregate income of the two households. Thus a value of 0 represents equal shares (i.e., equal consumption levels) and positive values indicate that household 1 has the larger share. The middle line indicates the actual shares in an insurance arrangement and the top and bottom lines indicate the theoretical limits. These theoretical limits indicate *optimal* upper and lower bounds for the shares. In the pure gift case (Figure 1) the middle line returns to the horizontal axis when possible but is otherwise at one of its bounds. In the dynamic limited commitment case (Figure 2) two things are different. The theoretical bounds are smaller and the middle line does not revert to the horizontal axis but stays constant between the bounds if it can. Looking at Figure 2, it is easy to see the general rule for the relative shares: keep the relative share constant if doing so keeps it within the theoretical bounds, otherwise move it by the smallest possible amount to keep it within the theoretical bounds. The bounds themselves move in accordance with the income distribution: so if household 1, say, has a higher income than household 2, in the absence of a transfer it would receive a higher share (it just consumes its income); it may not be desirable to push the share down to one half as household 1 would not be prepared to sacrifice so much. Thus the lower bound on the logarithm of the relative share may be above 0. These upper and lower bounds depend only on the current income distribution. We will see how this rule is derived from a dynamic programming problem the Appendix.

5 Calibrating a model

In order to gauge whether this approach can help explain the type of arrangements that are observed, we adopt the following approach. First, an attempt is made to get an estimate of likely parameter values for the sort of simple example already considered. The extent and nature of the informal insurance will depend on three things: individuals' attitudes towards risk, the nature of the risk facing a community and the discount factor which measures how future income is treated relative to present income. Much of the evidence is based on detailed surveys conducted by the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT). Using these estimates, we investigate how a stylized version of observed arrangements performs, in terms of the amount of insurance it can provide, relative to both the pure gift and the dynamic limited commitment solution (outlined in

[16] Details of the computation and simulation procedure can be found in the Appendix; the utility function and discount factor are as before.

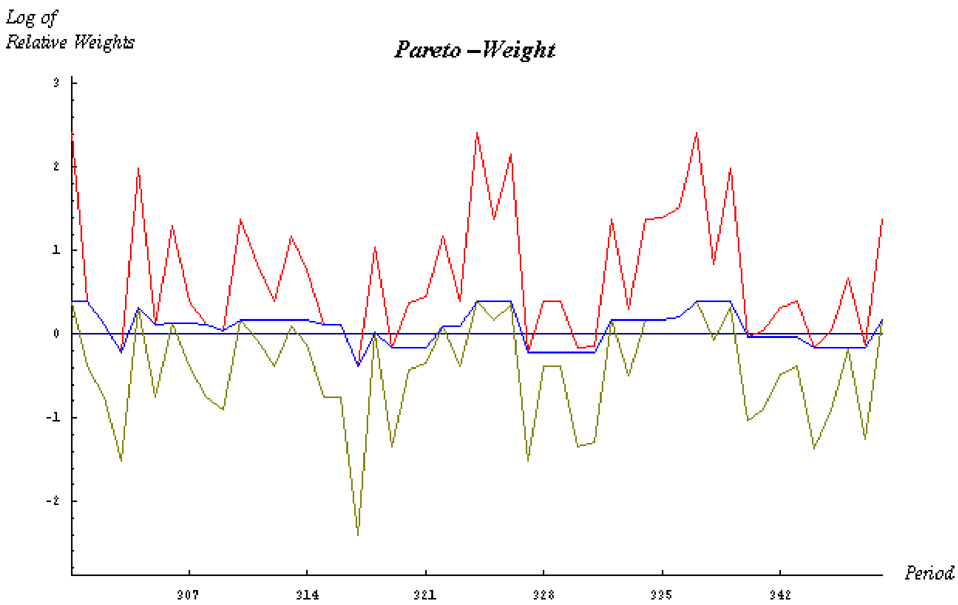

Figure 2: Relative Shares - Dynamic Limited Commitment

the Appendix). We have already seen that adding a small amount of credit or reciprocity to a pure gift (i.e., static) arrangement can lead to more insurance. On the other hand, the dynamic limited commitment solution gives an upper bound on what can be achieved. If the stylized arrangement performs significantly better than the pure gift solution, going some way towards the dynamic solution, then this can be taken as evidence that the approach taken here can explain key features of such arrangements. The dynamic limited commitment model itself has been tested against household data by Ligon, Thomas, and Worrall (1997), with generally positive results, and the current study should be viewed as complementary to this paper.

5.1 Attitudes towards risk

Attitudes towards risk are important because they determine the cost to an individual of variation in income and hence the value of insurance. The cost of the variation in income can be measured by the proportional risk premium. It measures the proportion of average income an individual would be prepared to give up to obtain a stable income level. It is given by the following simple formula:

$$\rho \approx \frac{1}{2} R v^2$$

where ρ is the proportional risk premium, $R = -cu''(c)/u'(c)$ is the "Arrow-Pratt" coefficient of relative risk aversion and v is the coefficient of variation, the standard deviation divided by the mean.

Thus to know the cost of the risk, an estimate of the coefficient of risk aversion is

Choice	Heads	Tails	Exp Value
1	5	5	5
2	9.5	4.5	7
3	12	4	8
4	16	2	9
5	19	1	10
6	20	0	10

Table 3: Binswanger's Experiment: The amounts are in Rs

needed. Binswanger (1980) and Binswanger (1981) conducted a series of experiments to try to gauge risk aversion amongst the households in the ICRISAT survey. He offered a series of gambles where players were invited to choose one of the alternative gambles outlined in Table 3. This was done repeatedly and with four different amounts of money (in Rupees): the amounts in Table 3 were also divided by a factor of 10 and multiplied by factors of 10 and 100. The first three of these games were played for real money; the other game (where gamble 1 was a sure gain of 500Rs, etc.) was hypothetical. Someone who consistently chooses gamble 1 is extremely risk averse and is prepared to give up a large expected return for the safety of a certain gain. Someone who consistently chooses gambles 5 or 6 is risk neutral and always goes for the highest expected returns no matter what the risk. The modal choice was 3 or 4 indicating a moderate but not extreme risk aversion. It corresponds to a coefficient of relative risk aversion of around 2. This means that a household which faces a coefficient of variation of income is 0.4 and has a coefficient of relative risk aversion of 2, would be prepared to pay 16% of its wealth in order to stabilize its income.

Statistical evidence from Antle (1987) also seems to support these results and evidence presented in Walker and Ryan (1990) also finds that using the experimental results on risk aversion helped explain actual choices of savings and investment in irrigation. That is, the more risk averse players adopted more cautious strategies for investment decisions.

5.2 Risk

As already stated, risk is perhaps the most dominant factor of life in subsistence economies. In the ICRISAT data the coefficient of variation of income ranged from 10% to 80% with the majority falling in the 20% – 40% range. Thirty-two of the 108 households surveyed in three of the ICRISAT villages Aurepalle, Kanzara and Shirapur, suffered one or more years where income was 50% or more below the median income. In the Indian fishing villages of Purakkad (mentioned above) and Poovar the coefficient of variation was even higher at over 100% (Platteau, 1997).

As we have seen a household which faces a coefficient of variation of 0.4 and has a coefficient of relative risk aversion of 2 is prepared to pay 16% of its wealth in order to stabilize this income. The question is whether there is anyone in the village who would be prepared to buy this risk. There are two possibilities: risk-sharing and risk-pooling.

A risk shared is a risk halved. Consider the following simple example with two households both with a constant coefficient of relative risk aversion of 2. One has a risky income of either 60 or 140 with equal probability (this gives an expected value of 100 and a coefficient of variation of 0.4). The other has a sure income of 100. Household 1 is prepared to pay 16 to eliminate its risk. Suppose however the two households share their income 50:50 so each gets either 80 or 120 with equal probability. The coefficient of variation is 0.2 for each so each would be prepared to pay 4 to eliminate the risk. The total cost of the risk is now 8 rather than 16, so the cost of the risk has been halved. It is also clear that there is a potential trade here. Household 1 would be prepared to pay 12 to reduce the variation from 0.4 to 0.2 and household 2 is willing to accept 4 to take on the extra risk, i.e. increase its variation from 0 to 0.2. Thus a situation where household 2 accepts a premium of say 8 and agrees to share the risk 50:50 should be beneficial to both.

Of course there may be no one in the village who does not face risk so it is important to know if it is still possible to trade risk when all face risks. This is known as risk pooling. The extent to which this is possible depends on how covariate are the risks. For example if household 2 also has an uncertain yield of 60 and 140 but when household 1 had 60 household 2 has 140 then the two risks are perfectly negatively correlated and by sharing 50:50 they could perfectly stabilize their incomes. If on the other hand the risks were perfectly positively correlated, then no sharing can reduce the risks. An informal insurance arrangement can only work if incomes are not perfectly correlated. The degree to which risks can be reduced will depend on the covariance or correlation between the risks.

The evidence suggest that the covariances are, perhaps surprisingly, very low. The covariances in the fishing villages of Poovar and Purakkad were very close to zero (see Platteau (1997)). In the ICRISAT villages the correlations with average village income were on average around 0.2 but varied from -0.7 to 0.9 (see Townsend (1994)). Thus there seems to be great scope for risk-pooling. In our calibrated model, we shall assume that the covariances are zero.

5.3 The discount rate

The rate at which villagers discount the future is also important. If they completely discounted the future ($\delta = 0$), then there would be no reason to make gifts or loans as the future reciprocation would not be valued. At the other extreme, if they were very patient ($\delta \approx 1$), then the best (pure gift) arrangement would be sustainable as any short-run cost from sacrificing current resources would always be outweighed by the long-term benefits

Choice	September 1990	September 1991	Implied Discount Rate
1	10 Kg	9 Kg	-10%
2	10 Kg	10 Kg	0%
3	10 Kg	11 Kg	10%
4	10 Kg	12 Kg	20%
5	10 Kg	13 Kg	30%
6	10 Kg	15 Kg	50%
7	10 Kg	17 Kg	70%
8	10 Kg	20 Kg	100%

Table 4: Pender's Experiment

of insurance.

Pender (1996) conducted a series of experiments to find out the discount rate amongst villagers in Aurepalle (one of the ICRISAT villages). Like the experiments of Binswanger, these were real rather than hypothetical experiments. Respondents were asked to state their preference over a series of choices between quantities of rice and the date they would be received like those in Table 4. The rightmost column shows the implied discount rate if the respondent was indifferent between the two alternatives. Thus if a respondent picked September 1990 (now) in choices 1–4 but September 1991 in choices 5–8, then the discount rate would be in the range 20%–30%. Each respondent answered three similar sets of choices with different base amounts and then one choice was randomly assigned as a reward. Thus if the respondent chose September 1991 in choice 8 in Table 4 and this was the choice assigned to him, then he would receive 20 Kg of rice in September 1991. There were two key features of the results. The discount rates were highly variable and the average rate was extremely high compared to the results from similar experiments conducted in industrialized societies. The median discount rate was above 50% implying that most respondents would prefer to have 10 Kg now rather than 15 Kg in one years time.

It is important to note that these experiments are designed to find the intertemporal marginal rate of substitution. That is how one person values consumption now against consumption in the future. In fact the discount rate that is needed for calibrating the model is *the rate of pure time preference*: that is, how a person values extra utility now against extra utility in the future, or equivalently how a person values extra consumption now against extra consumption in the future *with consumption the same in both periods.* If, however, average consumption is approximately constant and if marginal utility is a convex function of income ($u'''(c) \geq 0$, which is true of the logarithmic utility function), then Pender's estimates provide a lower bound for the rate of pure time preference. This implies an upper bound for the discount factor, which is one over one plus the rate of pure time preference, of about two-thirds.

6 Gifts and Loans

In this section we ask whether a scheme of gifts and loans can come close to achieving what can be achieved by the dynamic limited commitment solution. We use estimates for the discount factor, coefficient of variation and coefficient of risk aversion in the range discussed in the previous section. This is vital for the theory which we are proposing: for some parameter values the theory gives trivial answers. For example, holding the coefficient of variation and coefficient of risk aversion constant, if households are very impatient (δ near zero), putting little weight on the future, it turns out that *no* risk-pooling is possible because the (heavily discounted) future gains from insurance will never outweigh the loss from sacrificing current resources today. Similarly, if they are very patient (δ near 1) the future gains will always be so large relative to current losses that perfect insurance is possible, and consequently gifts alone are used in the gift/loan arrangement (which is then identical to the dynamic limited commitment solution), and there would be no balanced reciprocity.

The model is a general version of the example outlined in Section 4. There are two identical households who have an income of y and a probability p of a loss of size d. The risks are independent and hence the coefficient of variation is

$$v = \frac{\sqrt{(p(y-d-m)^2 + (1-p)(y-m)^2)}}{m}$$

where $m = p(y-d) + (1-p)y$ is average income. The gift/loan scheme we consider is as follows. When one household suffers a loss, the other gives it a gift of G and makes an interest-free loan of L. As we have seen in section 4 the addition of an interest-free loan can lead to improvements in risk sharing. Next period, if neither suffers a loss then the loan L is repaid. If the same household receives a loss the gift and loan are repeated (i.e., in this case the loan is written off). If both households suffer a loss then the loan repayment is reduced to L' in such a way that the loan repayment is reduced proportionally to the reduction in income (so that the loan is effectively written down; in the example of section 4 the write-down was 100).

$$L' = (\frac{y-d}{y})L.$$

If the other household suffers a loss then he receives the gift of G and loan of L and the previous loan is forgotten. This scheme has the virtue of being very simple and accords well with the evidence presented above that gifts and interest-free loans are both used and that sometimes loans are forgiven if circumstances dictate.

To see how this scheme works, consider the case where there are no loans outstanding. There are four possible situations. Both suffer no loss, which we label nn; both suffer a loss, which we label ll; or one suffers a loss and the other does not, which are labelled nl and ln. Let V denote the surplus over autarky (i.e., the difference between expected discounted utility under the scheme and under autarky) before the yields are known and let V_{nn}

denote the surplus when neither suffers a loss, V_{nl} denote the surplus of a household when only the other household suffers a loss, etc., assuming that there are no loans outstanding from the previous period. Then

$$V = (1-p)^2 V_{nn} + p^2 V_{ll} + p(1-p)V_{nl} + (1-p)pV_{ln}.$$

Since no payments are made in the situations where neither or both suffer a loss, then next period we start again from the same position of no outstanding loans. Thus

$$V_{nn} = \delta V$$

and

$$V_{ll} = \delta V.$$

If the second household suffers a loss, then he receives a gift of G and loan of L and so the surplus for the first household is

$$\begin{aligned} V_{nl} = {} & u(y-G-L) - u(y) \\ & + \delta(1-p)^2(u(y+L) - u(y) + \delta V) \\ & + \delta p^2(u(y-d+L') - u(y-d) + \delta V) \\ & + \delta p(1-p)V_{nl} + \delta(1-p)pV_{ln}. \end{aligned}$$

The first line is the loss in utility of giving G and loaning L; the second line is the discounted gain if neither suffers a loss so L is repaid and we start again from the situation of no outstanding loan; the third line is likewise the discounted gain from the loan repayment of L' if both suffer a loss and starting again from no outstanding loan; and the last line is the discounted surplus in states nl and ln, where V_{ln} is calculated similarly by the equation

$$\begin{aligned} V_{ln} = {} & u(y-d+G+L) - u(y-d) \\ & + \delta(1-p)^2(u(y-L) - u(y) + \delta V) \\ & + \delta p^2(u(y-d-L') - u(y-d) + \delta V) \\ & + \delta p(1-p)V_{nl} + \delta(1-p)pV_{ln}. \end{aligned}$$

It is possible to solve explicitly for V, V_{nl} and V_{ln} using these equations to give:

$$\begin{aligned} V &= \frac{\alpha(Y+Z)}{1-2\delta\alpha} \\ V_{nl} &= Y + \delta V = \frac{(1-\delta\alpha)Y + \delta\alpha Z}{1-2\delta\alpha} \\ V_{ln} &= Z + \delta V = \frac{\delta\alpha Y + (1-\delta\alpha)Z}{1-2\delta\alpha} \end{aligned}$$

where

$$\alpha = \frac{p(1-p)}{1-\delta(1-2p(1-p))}$$

$$
\begin{aligned}
Y &= u(y-G-L)-u(y) \\
&\quad +\delta(1-p)^2(u(y+L)-u(y))+\delta p^2(u(y-d+L')-u(y-d)) \\
Z &= u(y-d+G+L)-u(y-d) \\
&\quad +\delta(1-p)^2(u(y-L)-u(y))+\delta p^2(u(y-d-L')-u(y-d)).
\end{aligned}
$$

The objective is to choose G and L so as to maximize V. However, the household must always have an incentive to provide the gift and loan, so

$$V_{nl} = Y + \delta V \geq 0 \tag{1}$$

and must have an incentive to repay the loan[17]

$$u(y-L) - u(y) + \delta V \geq 0. \tag{2}$$

Given the estimates of Section 5, we choose $y = 100$ (for illustrative purposes; none of the comparisons depend on the level) and take as a base case the following values for the parameters: coefficient of variation $v = 0.45$ and the discount factor $\delta = 0.65$; the coefficient of relative risk aversion is $R = 2$ and we use the constant relative risk-aversion utility function $u(c) = c^{1-R}/(1-R)$ (or $\log c$ for $R = 1$). These parameter values are firmly in the middle of the ranges given in the last section.[18] With a coefficient of variation $v = 0.45$ and a probability of loss $p = 0.5$ the implied loss is $d =$\$62.07.[19] While it is not possible to obtain an analytical solution for the optimum gift and loan, it is possible to do so numerically. It is clear that either (1) or (2) holds as an equality unless perfect insurance is possible. Thus by gridding over 100 values for L and choosing the values of G which satisfy the constraints, it is then possible to find the combination of G and L which attains the highest value for V and simultaneously satisfy both constraints. The optimum is $G =$\$21.01 and $L =$\$5.90.[20] Thus when one household suffers a loss its income is $y-d+G+L =$\$64.84 and the other's net income is $y-G-L =$\$73.09. The repayment next period is either \$5.90 if neither suffers a loss and \$2.24 if both suffer a loss.

As a contrast we consider a situation of generalized reciprocity where only gifts are used and a system of pure credit where only interest-free loans are used. In the system of generalized reciprocity, the optimal gift is \$24.87 and in the case of pure credit, the optimal loan is \$1.06 with a repayment of \$0.41 if both households suffer a loss. We see that gifts alone do quite well but gifts and loans together provide a distinct improvement. Loans by themselves prove to be inadequate. The reason is that the loan payment improves risk-sharing but the loan repayment harms risk-sharing. The purpose of the loan repayment is

[17] For $R > 1$, $u(y-L)-u(y) > u(y-d-L')-u(y-d)$ as $u(y-L)-u(y)-(u(y-d-L')-u(y-d)) = ((1-(L/y))^{(1-R)}-1)(y^{(1-R)}-(y-d)^{(1-R)})/(1-R) \geq 0$.

[18] We have presumed that the covariance is zero.

[19] A value for the coefficient of variation and for y does not fix the distribution even if it is assumed to be two point, as here. Nevertheless simulations suggest that our result are not particularly sensitive to the way that this is broken up into p and d.

[20] A Mathematica package is available from the authors.

to encourage risk-sharing when incomes are different. But with loans alone, this is difficult and the loan cannot be raised much without running into the constraint (2). The reason that a higher value for L is possible in the combined gift/loan scheme is that the gift element allows much more insurance, so that higher loan repayments are sustainable due to the fact that there is more to lose, in terms of future insurance, if a repayment is not made.

A better comparison can be made by calculating the surpluses—the increase in utility over autarky—from each scheme. We do this relative to the most efficient (i.e., the dynamic limited commitment) scheme. The most efficient scheme involves more complicated gifts and loans and repayments over more than one period. The procedure for calculating the efficient contract is outlined in the Appendix. The purpose here is to show that a simple system of gifts and loans can do extremely well and do almost as well as the more complicated contract. The gift/loan scheme achieves 99.62% of the total possible surplus from the most efficient scheme. The generalized reciprocity scheme of gifts scores 98.40% and the pure credit scheme of loans only scores 8.37%. Thus some loan element is beneficial when combined with gifts, although for these parameter values only mildly so. In the next section it is shown that for parameter values close to these ones, the loan element can be much more valuable.

7 Sensitivity

In this section we examine how sensitive the estimates are to the parameter values. We first consider how gifts and loans in the combined gift/loan arrangement respond to different parameter values around the base case given in Section 6 with income in the no loss state $y = 100$, the coefficient of risk aversion $R = 2$, the discount factor $\delta = 0.65$ and the coefficient of variation $v = 0.45$. This is shown in Figure 7 for the three parameters; the coefficient of risk aversion; the discount factor and the coefficient of variation. We take the parameters to range within the values suggested in Section 5.

Thus the first panel shows values for the coefficient of risk aversion between 1 and 2.5 with the discount factor fixed at $\delta = 0.65$ and the coefficient of variation fixed at $v = 0.45$. As risk aversion increases, the (future) benefits from mutual insurance rise (relative to the current cost of making a transfer to the other party), and this allows more insurance to be provided. Thus, for a value of risk aversion close to one, no gift/loan combination is sustainable; for slightly higher values of risk aversion, some insurance is possible and loans are more important than gifts. Eventually as the coefficient of risk aversion increases, gifts dominate loans, and for a value of the coefficient of risk aversion above 2.35 complete insurance is possible and so no loan element is required. A similar picture obtains as the other two parameter values are varied. The second panel shows how the gifts and loans vary as the discount factor varies between 0.36 and 0.72 with the other parameters fixed at

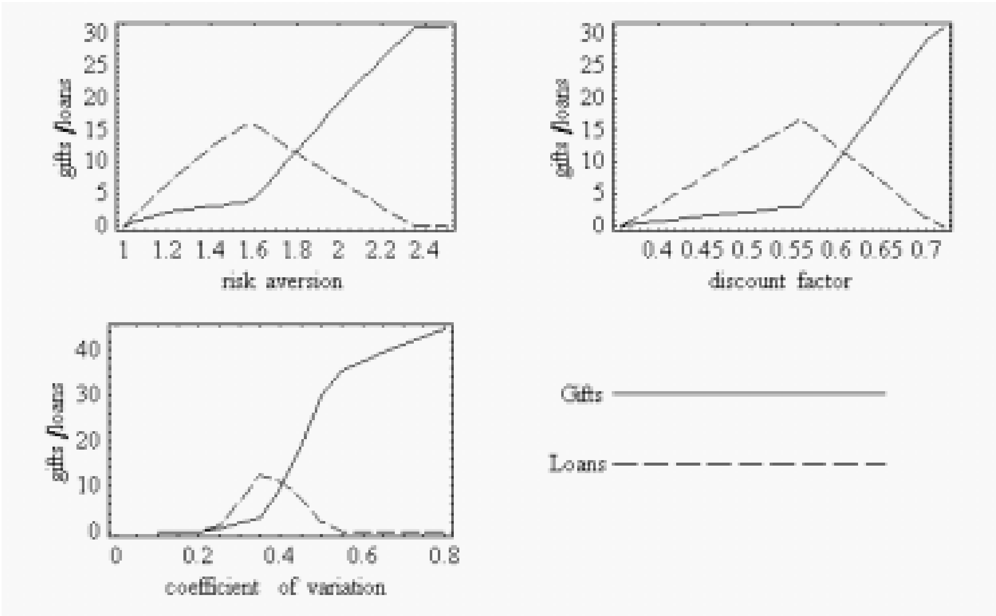

Figure 3: Gifts and Loans

their baseline values. At a discount factor of below 0.38, no insurance is possible and for a discount factor above 0.72, complete insurance is possible. In between, gifts increase and loans increase at first but become less important for higher discount factors. A similar pattern emerges from the third panel which plots gifts and loans as the coefficient of variation ranges between 0.1 and 0.8. For values of v above 0.55, full insurance is possible and for values below 0.2, no insurance is possible. At low values of v, both gifts and loans increase as v rises but eventually loans become less important.[21] The next figure, Figure 4, plots the surpluses relative to the dynamic limited commitment surplus for the same range of parameter values. The solid line is the percentage surplus from gifts and loans; the dotted line from gifts alone and the dashed line from loans alone. It shows how well each of these arrangements does. Since these surpluses are relative to the dynamic limited commitment surplus, a value of 100% is the theoretical maximum for all parameter values. As can be seen gifts easily dominates loans and gifts and loans together dominate either (as we know from the result in Section 4). From the first panel it can be seen that for a low value of the coefficient of risk aversion such as $R = 1.1$, the gift only arrangement attains 3% of the most possible whereas gifts and loans together achieve 91%. This dominance is preserved although diminished as R rises until it is possible to obtain complete risk sharing with gifts alone for $R > 2.35$. The second and third panels show a similar story as δ and v are varied. From each case it appears that the combination of gifts and loans can do considerably better than gifts alone provided that some but not complete insurance is possible.

[21] Gifts continue to rise for $v > 0.55$ as the loss of income in the bad state increases with v.

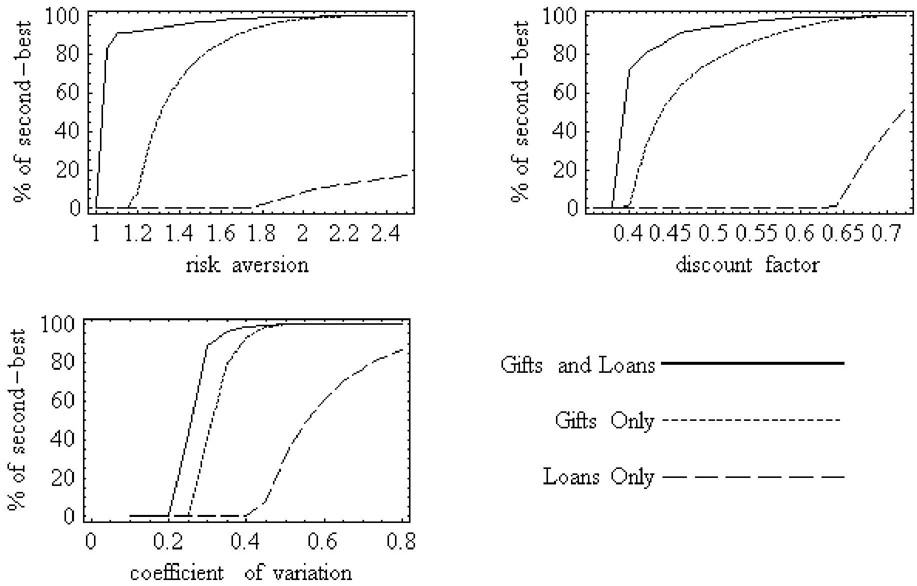

Figure 4: Relative Surpluses

8 Conclusion

A key feature of the informal insurance arrangements in rural communities discussed in the introduction is the use of gifts and informal loans which are uncollateralized and pay no interest. There is a presumption that gifts will be reciprocated and loans repaid unless adverse circumstances dictate otherwise. That is, mutual insurance takes the form of balanced *reciprocity* or *quasi-credit.*

We have shown that quasi-credit arrangements can be the outcome of a dynamic game when reciprocation is the voluntary action of rational agents rather than enforced. If reciprocation were obligatory, gift-giving alone as need arises would be the best arrangement. Quasi-credit is less effective as if a household borrows in the face of an adverse shock and then immediately suffers another adverse shock, it has repayment obligations on the borrowing already made, and unless it is willing to accumulate even more debt, it will be forced to cut consumption. Had it received a gift without counter obligation after the first shock, it would be in no worse position after the second shock, and provided another gift is made, it would be able to maintain its consumption. The problem with a pure gift arrangement in this case is that the counter obligation may not be sufficient to induce the giver to part with resources today. On the other hand, if there is a credit element to the transaction, the giver will expect some future reward—repayment on the loan—over and above any reciprocal insurance promise, and this may provide sufficient incentive to induce the giver to part with resources today.

The exact nature of the quasi-credit arrangement depends upon a few key parameters.

These are the size of the risk as measured by the coefficient of variation and the covariance of household incomes; the degree to which households are affected by risk as measured by the coefficient of risk aversion; and the rate at which households discount future as measured by the rate of pure time preference. The ICRISAT data on villages in southern India allows estimates for these parameters and we have calibrated the model using estimates from this literature. Using this calibration, we are able compute the best quasi-credit arrangements for some simple examples. In addition we are able to compare the outcome to the optimum dynamic limited commitment outcomes which are discussed in the Appendix. The latter arrangements are more complex because the loan repayments are spread over many periods and depend upon the sequence of shocks. Nevertheless it is shown that for a range of typical parameter values a very simple quasi-credit scheme does almost as well as the more complex dynamic limited commitment arrangement. This suggest that the advantage of the dynamic element can be adequately captured by a simple interest-free loan element and that the quasi-credit arrangements used in practice are very close to optimum when reciprocity is voluntary. Thus not only is balanced reciprocity a theoretical possibility in the model, for plausible parameter values, it can achieve something close the best insurance that can be attained.

Is the approach to reciprocity outlined in this paper applicable outside of the context of mutual insurance in rural communities? In principle, it is relevant to any situation in which risk is important and the need for informal insurance arises. An obvious example is within-family transfers even in economies where developed insurance markets, private or public, exist. Such markets suffer from a number of imperfections, especially because of the difficulties and cost of obtaining all relevant information, and thus there is a benefit to be had from insurance arrangements in the context where information flows more freely (the family) although participation cannot be enforced through legal means. Even outside of an insurance context the analysis is potentially applicable, for example in any continuing relation where each party can undertake costly actions, which may or may not involve monetary transfers, that have a benefit to the other party. Whenever these benefits fluctuate over time, either randomly or deterministically,[22] so that party A today benefits from an action taken by party B and there is a likelihood in the future that party B will benefit from an action taken by party A at that time, then the principle of balanced reciprocity can be used to help sustain higher levels of mutual cooperation.

9 Appendix

The Appendix outlines a general model with H households and shows how the optimum risk-pooling arrangement under dynamic limited commitment can be derived and solution numerically computed. It provides an upper bound to how well a simple arrangement of gifts and loans can do. This problem is similar in structure to that analyzed by Thomas and Worrall (1988), and we borrow heavily from that analysis and from Hayashi (1996).

Each period $t = 1, 2, \ldots$, household i ($i = 1, 2, \ldots, H$) receives an income $y^i(s) > 0$

[22] The model developed in the Appendix is general enough to cover *deterministic* fluctuations.

of a single perishable good, where s is the state of nature drawn from a finite set $s \in S$, and $S = \{1, 2, ..., S\}$. The state is a sufficient statistic for the income distribution at any particular date. It is assumed that the state of nature follows a Markov process with the probability of transition from state s to state r given by π_{sr}. This formalization includes as a special case an identical and independent distribution over the possible states of nature (π_{sr} is independent of s). The general specification of the dependence of incomes $y_i(s)$ on the state of nature allows for arbitrary correlation between the two incomes, although in the simulations we have assumed that incomes are independently and identically distributed.

Household i has a per-period ("von-Neumann-Morgernstern") utility of consumption function $u_i(c^i)$ which displays positive but diminishing marginal utility: $u_i'(c^i) > 0$, $u_i''(c^i) < 0$. Households are infinitely lived, discount the future with common discount factor δ, and are expected utility maximizers. We assume that at date 0, before any uncertainty is resolved, the households enter into an implicit risk-sharing arrangement. After an arrangement violation by any party (failure to make a transfer to another household when one is supposed to), all households consume at autarky levels (i.e., consume their own income) thereafter.

What we refer to below as *sustainable* arrangements can be shown to correspond precisely to the non-cooperative subgame-perfect equilibrium outcomes of the dynamic game; since reversion to autarky is the most severe subgame-perfect punishment, not only does a sustainable arrangement correspond to a subgame-perfect equilibrium outcome, but also there can be no other equilibrium outcomes other than those characterized by using reversion to autarky as a punishment.[23]

Let s_t be the state of the world occurring at date t. An arrangement will specify for every date t and for each *history* of states up to and including date t, $h_t = (s_1, s_2, ..., s_t)$, a consumption level $c^i(h_t)$. Define $U^i(h_t)$ to be the expected discounted utility gain over autarky or *surplus* of household i from the arrangement from period t onwards, discounted to period t, if history $h_t = (h_{t-1}, s_t)$ occurs up to period t:

$$U^i(h_t) = (1-\delta)(u_i(c^i(h_t)) - u_i(y^i(s_t))) + E \sum_{j=t+1}^{\infty} (1-\delta)\delta^{j-t}(u_i(c^i(h_j)) - u_i(y^i(s_j))),$$

where E denotes expectation, conditional on h_t, and per-period utility has been normalized by multiplying by $(1-\delta)$. The first term in the above equation is the short run gain from the arrangement and the second term is the long-run or continuation gain from the arrangement. This equation can be defined recursively as

$$U^i(h_t) = (1-\delta)(u_i(c^i(h_t)) - u_i(y^i(s_t))) + \delta \sum_{r=1}^{S} \pi_{sr} U^i(h_t, r).$$

Household i will have no incentive to break the arrangement if the following *sustainability constraint* holds at each date t after every history h_t:

$$U^i(h_t) \geq 0.$$

If these equations hold for all $i = 1, \ldots, H$, then we call the arrangement *sustainable.*

[23] The argument is simply that any equilibrium outcome supported by a less severe credible punishment, can also be supported by the more severe punishment considered here.

A sustainable arrangement is *efficient* if there is no other sustainable arrangement which Pareto dominates it. In the space of discounted utilities, the *Pareto frontier* is set of utilities corresponding to efficient arrangements. The Pareto frontier at any date t and given the current state s depends only on s and not on the past history which led to this state. This allows us to simplify and abuse notation slightly by letting U_r^i denote the continuation utility of household i when the state is r. Also let the Pareto frontier in state r be defined implicitly by the function $T_r(U_r^1, \ldots, U_r^H) = 0$. Similar arguments to those given in Thomas and Worrall (1988) show that the set defined by $0 \geq T_r(U_r^1, \ldots, U_r^H)$ is a convex set (i.e., all points lying on a straight line between any two points in the set also lie in the set).

To find the Pareto-efficient arrangement, first consider the following maximization problem.

$$\max_{(c_s^i)_{i=1}^H, ((U_r^i)_{r=1}^S)_{i=1}^H} \sum_{i=1}^H w_i\{(1-\delta)(u_i(c_s^i) - u_i(y_s^i)) + \delta \sum_{r=1}^S \pi_{sr} U_r^i\}$$

subject to

$$\begin{aligned} 0 &\geq T_r(U_r^1, \ldots, U_r^H) \qquad \forall r \in S \\ U_r^i \geq 0, \qquad \forall r &\in S \quad \forall i = 1, \ldots, H \\ \sum_{i=1}^H c_s^i &= Y_s \\ c_s^i \geq 0 \qquad \forall i &= 1, \ldots, H \end{aligned}$$

where w_i is the "Pareto-weight" and $Y_s = \sum_{i=1}^H y_s^i$ is aggregate income in state s. Following Hayashi (1996) this problem can be decomposed into a number of sub-problems. The first sub-problem is the efficient consumption at any date for a given set of Pareto-weights.

$$\max_{(c^i)_{i=1}^H} \sum_{i=1}^H w_i u_i(c_s^i) \qquad s.t. \qquad \sum_{i=1}^H c_s^i = Y_s \qquad \text{and} \qquad c_s^i \geq 0 \quad \forall i = 1, \ldots, H.$$

The first-order conditions are for any pair of households i and k

$$\frac{u_i'(c_s^i)}{u_k'(c_s^k)} = \frac{w_k}{w_i} + \frac{\psi^k - \psi^i}{w_i u_k'(c_s^k)}$$

where ψ^i is the "Lagrange" multiplier on the non-negativity constraint for household i consumption. We can write the solution as $c^i(w, Y_s)$ where $w = (w_1, \ldots, w_H)$ is the vector of Pareto-weights and an "indirect utility function" as $v_i(w, Y_s) = u_i(c^i(w, Y_s))$.

There are also S sub-problems of the form

$$\max_{(U_r^i)_{i=1}^H} \sum_{i=1}^H w_i U_r^i \quad s.t. \quad 0 \geq T_r(U_r^1, \ldots, U_r^H) \quad \text{and} \quad U_r^i \geq 0 \quad i = 1, \ldots, H.$$

The first-order conditions give for any pair of households i and k

$$\frac{w_k + \phi_r^k}{w_i + \phi_r^i} = \frac{\partial T_r / \partial U_r^k}{\partial T_r / \partial U_r^i},$$

where ϕ_r^i is the multiplier on the sustainability constraint for household i. It is clear as argued above that the solution involves $T_r(U_r^1, \ldots, U_r^H) = 0$, so that the continuation arrangement is itself efficient. Consider then the Pareto problem without the sustainability constraints where the weights are denoted $\tilde{w}$ to distinguish it from the former problem:

$$\max_{(U_r^i)_{i=1}^H} \sum_{i=1}^H \tilde{w}_i U_r^i \quad s.t. \quad 0 \geq T_r(U_r^1, \ldots, U_r^H).$$

The first-order conditions give

$$\frac{\tilde{w}_k}{\tilde{w}_i} = \frac{\partial T_r / \partial U_r^k}{\partial T_r / \partial U_r^i}.$$

Denote the solution $V^i(\tilde{w}, r) = U_r^i(\tilde{w})$ for each household i, as the conditional household value function (conditional on the state). These value functions map Pareto-weights to continuation utilities in a Pareto-efficient way. They obey the simple recursive relationship

$$V^i(w, s) = (1 - \delta)(v_i(w, Y_s) - u_i(y_s^i)) + \delta \sum_{s=1}^S \pi_{sr} V^i(\tilde{w}, r).$$

Then the S sub-problems can be replaced by

$$\max_{(\tilde{w}_i)_{i=1}^H} \sum_{i=1}^H w_i V^i(\tilde{w}, r) \quad s.t. \quad V^i(\tilde{w}, r) \geq \underline{U}_r^i \quad \forall i = 1, \ldots, H,$$

where the value functions are used so that the next period Pareto-weights $\tilde{w}$ become the maximand instead of the continuation utilities. It is clear from differentiating the first-order conditions for this problem that

$$\sum_{i=1}^H \tilde{w}_i \frac{\partial V^i(\tilde{w}, r)}{\partial \tilde{w}_k} = 0 \qquad \forall k = 1, \ldots, H,$$

so that in the absence of the sustainability constraint, the solution is $\tilde{w} = w$ and the Pareto-weights change only in response to binding sustainability constraints.

The relationship between $\tilde{w}$ and w when there are binding sustainability constraints can be described by combining the first-order conditions for the two problems defined above:

$$\frac{\tilde{w}_k}{\tilde{w}_i} = \frac{w_k / w_i + \phi_r^k / w_i}{1 + \phi_r^i / w_i}.$$

This gives an updating rule for the ratio of the Pareto-weights. Thus given an initial set of weights the arrangement can be computed recursively by updating the weights as determined by the actual state and the equation given above.

To solve the above problem it is necessary to determine the conditional value functions $V^i(w, r)$. These can be calculated using an iterative procedure starting with the first-best value functions (where the sustainability constraints are ignored). We will outline this procedure for the case considered in the main text, of two households where the states are identically and independently distributed over time ($\pi_{sr} = \pi_r$). It is computationally simpler to work with the unconditional value functions

$$W^i(w) = \sum_{r=1}^S \pi_r V^i(w, r).$$

In the *i.i.d.* case with two households there are just two unconditional value functions, one for each household.[24] The Pareto-weights can be normalized so $\sum_{i=1}^{H} w_i = 1$, so with two households it is only necessary to calculate one weight. To distinguish this case, let θ be the Pareto-weight for household 1 and let $1 - \theta$ be the Pareto-weight for household 2.

There is then a simple procedure for calculating the two unconditional value functions, $W^i(\theta)$. First calculate the indirect utility functions $v_i(\theta, Y_s)$ and compute an initial unconditional first-best value function as follows:

$$W_0^i(\theta) = \sum_{s=1}^{S} \pi_s (v_i(\theta, Y_s) - u_i(y_s^i)).$$

Next compute $\underline{U}_s^i$ and solve the $2S$ equations

$$(1 - \delta)(v_i(\theta, Y_s) - u_i(y_s^i)) + \delta W_0^i(\theta) = \underline{U}_s^i$$

for θ. This gives S intervals $[\underline{\theta}_s, \bar{\theta}_s]$ where $\underline{\theta}_s$ is computed from the equations for household 1 and $\bar{\theta}_s$ is computed from the equations for household 2. These intervals correspond to the theoretical bounds drawn in the figures in Section 4. New values of θ, say $\tilde{\theta}$, can be computed by the rule that θ is kept constant if it falls within the interval or moves to the nearest endpoint if it does not. [25] This gives $\tilde{\theta}$ as a function of θ in state s, say $\tilde{\theta}_s(\theta)$. Two new value functions can then be computed according to

$$W_1^i(\theta) = \sum_{s=1}^{S} \pi_s ((1 - \delta)(v_i(\tilde{\theta}_s(\theta), Y_s) - u_i(y_s^i)) + \delta W_0^i(\tilde{\theta}_s(\theta)))$$

and the process repeated until the difference between the value functions $W_{j+1}^i(\theta)$ and $W_j^i(\theta)$ or the difference between the interval endpoints $[\underline{\theta}_s, \bar{\theta}_s]$ at successive iterations is arbitrarily small.[26] This computation procedure and the simulation of predicted consumptions can be implemented with a Mathematica package.[27]

[24] In general there are HS value functions to compute.

[25] For a proof see Ligon, Thomas, and Worrall (1997).

[26] It can be shown that starting with the first-best value functions as described above, convergence is assured.

[27] The package is available upon request. The package solves the two identical household problem with constant relative risk aversion. It computes the solution to the perfect insurance, pure gift and dynamic limited commitment problems and simulates predicted consumptions for each model.

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