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# Evidence on Informal Insurance in Rural Zimbabwe

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## Abstract<sup>2</sup>

The test on the presence of full insurance that is commonly employed does not take into account that households also rely on buffer stocks to shield their consumption from income shocks. In this paper a test is developed that deals with this omission. It is shown that in the presence of partial insurance, the common test on the degree of informal insurance underestimates the degree of protection offered by informal arrangements. This finding has policy implications because if the degree of informal insurance is partial, but high nonetheless, targeting of transfers (in case of drought for instance) is of less importance while transitory movement out of poverty is limited. In the empirical part the newly developed test is employed for data on rural Zimbabwe. The presence of full insurance is rejected.

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# Evidence on Informal Insurance in Rural Zimbabwe

## 1. Introduction

A distinctive feature of life in a developing country is the importance of risk. This is immediately apparent for those who depend for the generation of their income upon dryland farming. Differences in the timing, intensity and quantity of rainfall and other weather phenomena like storms, precipitation and cloud cover, the incidence of disease, pests, fire or attacks by wild animals cause yields to fluctuate unpredictably. Variations in the price of inputs and marketed output cause farm profits to vary, and illness at the moment of planting may seriously affect the household's income for that year.

In this paper it is explored to which degree rural households in Zimbabwe deal with high income variability. One way is through a buffer stock strategy. Another is by relying on insurance arrangements. Formal insurance arrangements are absent in Zimbabwe's rural areas but this does not mean that risks cannot be pooled at all. In fact, rural households are likely to have certain advantages in pooling risks themselves, especially if households know each other well (this reduces the scope for information problems) or if they have extra-legal means of contract enforcement.

The possibility to pool risk at the community level in rural Zimbabwe is illustrated by the coefficient of variation for crop income. It is 84 percent at the household level, but at the community level the coefficient of variation is much lower. For villages as a whole it is 43 percent and at the survey site, 36 percent. Pooling incomes at the village or survey site level would thus help to reduce income risk. In conversations with farmers it materialised that this is not only a theoretical possibility but that it is actively explored. Reciprocal exchanges are common (this even continued during the drought of 1992) and many

villagers participate in informal funeral arrangements and work parties or joined savings clubs (women especially).<sup>3</sup>

A way to explore the existence of mutual insurance at the community level without having to go into detail on each of the existing informal arrangements is to consider whether consumption of those living in the same community moves in the same direction over time. After all, if all incomes are pooled and each household received its predetermined share from the pool, then at times when aggregate resources are in abundance every household will have more to consume than at times when community resources are scarce. Comovement in consumption between group members is therefore in accordance with full insurance.

Comovement in consumption is a condition that will be met in the presence of full insurance, but evidence in support of it does not invalidate other explanations for the same phenomenon. From a permanent income model without insurance, a similar prediction can be derived if the community is confronted with a technology shock. Productivity increasing technological shocks probably did not take place in the survey areas since 1992. But to discard this possibility beforehand would be premature, if only because of the structural changes that occurred in the Zimbabwean economy since 1992 (liberalisation; high inflation and more recently a breakdown of the institutional infrastructure). In any case, the reverse does hold: if no, or partial comovement in consumption between villagers is found, then complete insurance through informal arrangements does not exist.

Evidence in support of full insurance, has implications for, for instance, the implementation of disaster relief efforts. In the presence of full insurance, targeting is of little importance because the transfer of resources to any member in a community with full insurance will be followed by a redistribution of this addition to aggregate resources amongst the members in the insurance pool. A rejection of the full insurance model implies that the distribution of household endowments is of importance for household consumption, implying for instance a means test to ensure that relief aid reaches the persons in need. Another implication of full insurance is that in its presence, poverty will be permanent and escape from it will depend on the availability of sufficient resources in the aggregate.

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<sup>3</sup> Saving clubs are not necessarily informal insurance arrangements, but many are organized in such a way that they allow their members to pool certain risks.

To find evidence in support of full insurance would be remarkable. One reason for this is that in its presence the incentive for shirking is large as the effort of any participant in the pool has only a marginal impact on his share of income. Another is that individuals will have less of an incentive to avoid risks. And finally, households have an incentive to join the insurance *ex ante*, but the lucky ones will want to renege on their promise to share when they have to make transfers to the unlucky members in the pool. For these reasons complete consumption insurance may be neither desirable nor possible. Nonetheless Townsend (1994) reports evidence in support of full insurance for households in the Indian ICRISAT villages. But as Ravallion and Chaudhuri (1997) have pointed out, Townsend's empirical analysis is biased toward the acceptance of the full insurance model. In a careful re-examination of his results, Ravallion and Chaudhuri only found indications for partial insurance. This is a result more commonly found. Cochrane (1991), Mace (1991), Grimard (1997), Deaton (1997) and Ravallion and Jalan (1999) report a certain degree of comovement in consumption across households, but not complete insurance.

The test of full insurance is based on the proposition that with perfect risk sharing, consumption at the household level is shielded from idiosyncratic risks and depends solely on the realisation of aggregate risk. Consumption should be independent of the realisation of household income and this is what is tested. The approach is reasonable if the main component of risk is idiosyncratic. But consider a situation in which risk is covariate. Suppose for instance that in a rural setting two subsequent harvests fail completely. Each household's income is zero but families do not starve as they rely on buffer stocks. In this case a test that considers whether household consumption is independent of household income would find this to be true. But to consider this a situation of full insurance would not be correct. It is not clear for instance whether idiosyncratic shocks are shared in years with positive income. And to label as full insurance a situation in which each household finances its consumption from the sale of its assets, is inappropriate. The illustration is extreme but comparable problems will arise in each instance where buffer stocks are used to deal with idiosyncratic shocks. It implies that the common test of full insurance is affected by an omitted variable problem, which, leads to biased coefficients in the case of partial informal insurance.

To deal with this issue, in this paper a test is developed that takes explicitly into account the accumulation of buffer stocks. It shows that in a situation of full insurance household consumption should not be independent of household income, but of household endowments (buffer stocks plus income).

Once the test is derived it is empirically tested. To this end use is made of a unique panel of Zimbabwean farm households comprising information on 400 land reform beneficiary households (resettled in the early 1980s) and 150 communal (ordinary) farm households. This information has been collected under the supervision of Bill Kinsey. For this paper use is made of information collected between 1997 and 1999 reflecting the seasons 1995-96 till 1997-98.

Additionally whether differences in the degree of insurance exist between land reform beneficiaries and communal households is explored as well. On the one hand, monitoring between land reform beneficiaries is easier because, unlike communal households, they live clustered in villages. On the other hand, resettled households started off as strangers. Though it seems plausible that any distrust that might have existed at the initial phase of land reform will have disappeared after almost 20 years, it cannot be excluded that the fact that households come from different regions (and have different ethnic backgrounds) still gives rise to social tensions. Both effects work in opposite directions so that a prior cannot be formulated. Nevertheless whether differences in informal insurance exist between both groups of households is interesting in itself.

Another factor of interest is whether insurance experienced by the poor differs from that of the better off. After all, as Fafchamps (1992) and Coate and Ravallion (1993) point out, wealthy households have an incentive to renege on their contribution to the informal insurance pool. Households that are fortunate in their income outcomes may collude against families experiencing negative income shocks and exclude them from the insurance in an attempt to limit the size of the transfers that have to be made. On the other hand marginal utility declines steeply if consumption lies close to the survival threshold. The poor therefore have a greater interest in the proper functioning of insurance arrangements and may for that reason participate more actively in them. In either case, there is reason to believe that differences in the degree of insurance exist between poor and non-poor households. Evidence in support of this has already been found. Jalan and Ravallion (1999) report for China that consumption insurance is considerably less for the asset poor. Whether this is also the case in Zimbabwe is considered as well. Finally it is considered what constitutes the relevant community for insurance.

The organisation of this paper is as follows. The next section presents the derivation of a test for income pooling that takes into account the fact that households accumulate buffer stocks to deal with aggregate shocks. Section 3 elaborates on data issues and seeks to empirically identify the presence of community level shocks. In section 4 regression results are presented. Another implication of the full insurance model is explored as well, namely whether a household's consumption rank remains unchanged over time. This is done graphically at the community level as this allows establishing whether differences exist in the degree of insurance between villages. Concluding remarks follow in section 5.

## 2. Income Pooling in the Presence of Buffer Stocks

In accordance with the common approach to derive a test for community level insurance, consider a social planner who maximises the weighted sum of expected household utilities  $u(\cdot)$  subject to a predetermined level of resources. Let there be  $N$  households in the community, who each earn an exogenously determined stochastic income,  $y_{it}$  ( $i$  indicates the household and  $t$  is a time subscript).  $\lambda_i$  indicates the time independent household specific Pareto weight satisfying:  $0 < \lambda_i < 1$  and  $\sum_{i=1}^N \lambda_i = 1$ . Households are risk averse. They share a common twice differentiable utility function,  $u$ , with consumption  $c_{it}$  as argument:  $u'(c_{it}) > 0$  and  $u''(c_{it}) < 0$ .

Since households are risk averse, they prefer to smooth consumption over time. And in the face of covariate shocks they accumulate buffer stocks to deal with them. To incorporate the accumulation of buffer stocks in the analysis a storage technology is introduced allowing the planner to transfer resources from one period to the next. Now resources available for consumption are no longer predetermined by exogenous income, but depend on the realisation of current income and the size of the buffer stocks carried over from the previous period. The planner not only has to take into account that households seek protection against idiosyncratic shocks (for which income pooling is an adequate remedy), she also has to decide on the accumulation of buffer stocks to deal with covariate shocks.

From the perspective of the planner it is of no concern whether buffer stocks are kept at the community level or by individual households (as is the case in rural Zimbabwe). The social planner is indifferent between a system where resources to deal with an aggregate

shock come from the liquidation of collectively held buffer stocks or where they are provided by wealthy community members with many assets. In either case the total endowment of assets has to be considered in the optimisation decision. Who keeps assets is only a matter of organisation.

Assets,  $a_{it}$ , are assumed to fetch a fixed return,  $r$ , which may be positive but which can also be negative. In each period the planner observes the amount of resources available (income plus assets). Using this information she decides on the amount of resources to be used for consumption in the current period, the amount to be carried over to the next period and the allocation of consumption between households.

Let an upper bar indicate a community aggregate. Community income, consumption and assets are then given by:

$$\bar{y}_t = \sum_{i=1}^N y_{it} \quad \bar{c}_t = \sum_{i=1}^N c_{it} \quad \bar{a}_t = \sum_{i=1}^N a_{it} \quad (1)$$

while the evolution of assets over time is given by:

$$\bar{a}_t = (1+r)\bar{a}_{t-1} + \bar{y}_t - \bar{c}_t . \quad (2)$$

Since future income is unknown the planner optimises given the available resources (cash on hand):

$$\bar{x}_t = (1+r)\bar{a}_{t-1} + \bar{y}_t \quad (3)$$

The optimisation problem can, for given  $\bar{x}_t$  be recursively formulated as:

$$V_t(\bar{x}_t) = \max_{c_{it} \dots c_{Nt}} \sum_{i=1}^N \mathbf{I}_i u(c_{it}) + \mathbf{r} E_t V_{t+1}(\bar{x}_{t+1})$$

subject to: (4)

$$\bar{x}_{t+1} = (1+r)\bar{a}_t + \bar{y}_{t+1}$$

where  $V$  is a value function,  $\mathbf{r}$  the common rate of time preference and  $E$  the expectations operator.

To arrive at a condition for the optimal allocation of resources over time, take the first order condition of (4) with respect to  $c_{it}$ :

$$\mathbf{I}_i u'(c_{it}) - \mathbf{r}(1+r) E_t V'_{t+1}(\bar{x}_{t+1}) = 0. \quad (5)$$

To transform this expression, use is made of the fact that

$$V'_t(\bar{x}_t) = \mathbf{I}_i u'(c_{it}) \quad (6)$$

should hold (see annex 1 for a derivation).

Now substitute (6) into (5) and divide by  $\mathbf{I}_i$  to arrive at the familiar Euler condition for the intertemporally optimal allocation of resources.

$$u'(c_{it}) = \mathbf{r}(1+r) E_t u'(c_{it+1}). \quad (7)$$

It states that for each household the marginal utility of current consumption should equal expected marginal utility of next period's consumption, adjusted for a factor representing the rate of return on assets and time preferences. Equation (7) does not contain any variables relevant for the distribution of consumption within a given period, suggesting that the planner can take the intertemporal decision (in response to aggregate risk) and the allocation of resources (to deal with the idiosyncratic component of risk) separately. She can solve the maximisation problem in two steps. First, when community income is known, she decides on aggregate savings or dissavings. Next she decides on the distribution of the available resources across community members.

So far a constraint on borrowing and lending was not included. Given the absence in rural Zimbabwe of formal lending institutions that are prepared to advance loans for consumption purposes, the community is assumed to be autarkic and subject to a borrowing constraint:

$$\bar{a}_i \geq 0. \quad (8)$$

This does not imply that households in the community do not informally borrow or lend to each other. The restriction only holds for the community as a whole.

If there is a borrowing constraint at the community level, equation (7) has to be adjusted. In some situations the planner will be constrained in her optimisation decision. Typically in these cases she would like to borrow but cannot. In these instances, she is no longer able to equate marginal utility to expected marginal utility (adjusted for a time factor). If the constraint becomes binding, the best thing to be done is consume all available resources so that the planner solves the problem:

$$\max_{c_{it} \dots c_{Nt}} \sum_{i=1}^N \mathbf{1}_i u(c_{it}) \text{ subject to } \bar{x}_t = \bar{c}_t. \quad (9)$$

If  $x_{it}$  denotes the value of  $c_{it}$  which solves (9) then the first order condition (7) changes to:

$$u'(c_{it}) = \max[ u'(x_{it}); \mathbf{r}(1+r) E_t u'(c_{it+1}) ] \quad (10)$$

which states that if the community borrowing constraint is not binding, the original Euler equation (7) remains satisfied, while if it is binding, marginal utility cannot be equated over time. The only thing that can be done in that case is to try to attain the desired level of marginal utility as close as possible and consume all available resources.

To operationalise equation (10) use is made of the fact that the information on which the decision on current consumption is based, consists solely of the available endowments, household preferences and the process determining income. An explicit functional form for the consumption rule as function of endowments, given the income process and preferences cannot be found. But in Deaton (1989 and 1991), Dercon (1992) and Hoogeveen (2000) consumption rules are derived numerically for a range of values for available endowments. Under different assumptions regarding the (in)dependence of income over time, the liquidity of assets, risk aversion, the covariance between asset values and income and the variability of income, consumption rules are derived suggesting to consume all resources if the borrowing constraint is binding. If it is not binding the consumption rule can be approximated by a linear function (see annex 2):

$$c_{it} = \mathbf{b}_t \bar{x}_t + \mathbf{h}_t \quad \text{for } \bar{x}_t \geq \mathbf{t}_v \quad (11)$$

where  $\mathbf{h}_t$  is a zero mean error term, subscript  $v$  indicates the community and  $\mathbf{t}_v$  is the community specific threshold level below which the members consume all available

resources. (This is the part where the consumption rule of annex 2 is the 45 degree line.)<sup>4</sup> The consumption rule is kinked, and  $\mathbf{t}_v$  is rarely much above mean community level income. Equation (11) shows that optimal *household* consumption can be written as function of the available *aggregate* resources. Since village resources matter for the consumption of household, aggregate consumption can be written as function of aggregate resources. Community consumption can therefore be written as:

$$\bar{c}_t = \mathbf{b}\bar{x}_t + \mathbf{h}_v \quad \text{for} \quad \bar{x}_t \geq \mathbf{t}_v . \quad (12)$$

Next turn to the allocation of consumption between households within a period. Taking the first order conditions corresponding to  $c_{it}$  and  $c_{jt}$  gives:

$$\mathbf{I}_i u'(c_{it}) = \mathbf{I}_j u'(c_{jt}) \quad (13)$$

indicating that within each period the aggregate endowment is redistributed in such a way that weighted marginal utilities are equated across households. An implication of (13) is that household consumption correlates positively with aggregate consumption. The latter obviously varies over time depending on aggregate income earned and the availability of buffer stocks.

To operationalise this equation, it is common to represent preferences by an exponential utility function (Mace, 1991; Townsend, 1994; Deaton, 1997; Ravallion and Chaudhuri, 1997; Jalan and Ravallion; 1999)

$$u_i(c_{it}) = \frac{-1}{\mathbf{a}} \text{Exp}(-\mathbf{a}c_{it}) . \quad (14)$$

After applying this to (13) and taking logs,  $c_{it}$  can be expressed as:

$$c_{it} = c_{jt} + \frac{\log(\mathbf{I}_i) - \log(\mathbf{I}_j)}{\mathbf{a}} \quad (15)$$

which upon aggregation over all households and after substitution gives:

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<sup>4</sup> In the empirical test a more flexible approach is adopted that does not rely on this linear approximation of

$$c_{it} = \bar{c}_t + \mathbf{m} \quad (16)$$

where

$$\mathbf{m} = \frac{\log(\mathbf{I}_i) - \sum_{j=1}^N \log(\mathbf{I}_j)}{\mathbf{a}}. \quad (17)$$

From (16) the implication that individual consumption varies positively with aggregate consumption is clear. Depending on the Pareto weights and the absolute degree of risk aversion,  $\alpha$ , household consumption equals average community consumption plus or minus a fixed amount.

To obtain an expression usable for estimation purposes, substitute (12) into (16). This gives:

$$c_{it} = \mathbf{b} \bar{x}_t + \mathbf{h}_{vt} + \mathbf{m} \quad \text{for} \quad \bar{x}_t \geq \mathbf{t}_v \quad (18)$$

Since  $\mu_i$  is a constant it disappears after taking first differences. If one does so, the change in household consumption over time after redistribution depends solely on the change in aggregate resources. The test of full insurance is then whether household consumption is solely explained by community endowments (income plus assets) and independent of household endowments. The test for absence of any insurance arrangement is exactly the opposite: whether household consumption is independent of community variables.

In addition to relying on consumption information, in section 4 the existence of full insurance is also tested using information on changes in savings collected in the surveys. To arrive at an expression to do so, subtract both sides of equation (18) from  $y_{it}$  to obtain:

$$y_{it} - c_{it} = y_{it} - \mathbf{b} \bar{x}_t - \mathbf{m} - \mathbf{h}_{vt} \quad \text{for} \quad \bar{x}_t \geq \mathbf{t}_v. \quad (19)$$

If (dis)savings are recorded as  $s_{it}$  and first differences of (19) are taken then one obtains:

$$\Delta s_{it} = \Delta y_{it} - \mathbf{b} \Delta \bar{x}_t - \Delta \mathbf{h}_{vt} \quad \text{for} \quad \bar{x}_t \geq \mathbf{t}_v. \quad (20)$$

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the consumption function.

Equation (20) now comprises the change in savings as dependent variable. It can also serve as basis for a test of the full insurance model. A way to do so is to include household level asset information in (20) and test whether its coefficient is equal to zero. Additionally one expects the coefficient on household income to be unity.

Alternatively one can test for complete absence of community level insurance. If community solidarity lacks and given the presence of aggregate risk, an optimising household will still follow a buffer stock strategy. If households are assumed additionally to face a borrowing constraint then equation (11) in combination with (16) can be used to provide the alternative hypothesis of no village insurance. After subtracting from  $y_{it}$  and taking first differences, one obtains:

$$\Delta s_{it} = (1 - \mathbf{b}) \Delta y_{it} - \mathbf{b} \Delta a_{it}^* - \Delta \mathbf{h}_{it} \quad \text{for } x_i \geq \mathbf{t}_i \quad (21)$$

where an asterix indicates assets carried forward from the previous year (i.e.  $(1+r)a_{t-1}$ ), but which can be observed in the current period as those assets available. The way to test for absence of insurance is similar to the test for presence of full insurance. In this case one would include aggregate endowments and test whether its coefficient is equal to zero. Additionally one expects the coefficient on household income to be less than unity. Note that the tests for complete or absent insurance require estimating an identical equation with the change in savings as dependent variable and household and aggregate assets and income as exogenous variables.

In the estimations, instead of including community level endowments, a community level time dummy  $D_{vt}$  is included. Such a dummy specification is also used by Deaton (1997) and Ravallion and Chaudhuri (1997) and is more convincing if there are aggregate resources that are not counted for in individual incomes and assets and if, as is the case with the available data, complete community censuses were not obtained. An additional advantage is that the linear approximation to the numerically determined consumption rule of equation (12) is no longer required. The community dummy coefficients can take different values each year and account for any non-linearities in the consumption rule. It is therefore no longer required to limit the estimations to those cases where aggregate endowments are above  $\mathbf{t}_v$ . The equations to be estimated are:

$$\Delta s_{it} = \mathbf{g}_0 \Delta y_{it} - \mathbf{b}_{vt} D_{vt} - \mathbf{g}_i \Delta a_{it}^* - \mathbf{e}_{it} \quad (22)$$

for the case with a change in savings and

$$\Delta c_{it} = \mathbf{g}_2 \Delta y_{it} + \mathbf{b}_{vt} D_{vt} + \mathbf{g}_3 \Delta a_{it}^* + \mathbf{x}_{it} \quad (23)$$

for the change in consumption where  $\mathbf{e}_{it}$  and  $\mathbf{x}_{it}$  are normally distributed error terms. The testable implication of the full insurance situation is that  $\gamma_0$  is equal to one and  $\gamma_1$ ,  $\gamma_2$  and  $\gamma_3$  equal to zero. Testable implication for completely absent insurance following from (22) is that  $\gamma_0$  lies between zero and one, that  $\gamma_1$  equals  $(1-\gamma_0)$  and that community-time dummies do not play a role in determining the change in household savings, respectively consumption. For (23) it follows that  $\gamma_2$  equals  $\gamma_3$  and that the community dummies are jointly insignificant.

Specification (23) also allows to identify what happens when (23) is the true model, but the test on full insurance is carried out without taking into account the presence of buffer stocks but employing:

$$\Delta c_{it} = \mathbf{g}_2 \Delta y_{it} - \mathbf{b}_{vt} D_{vt} + \mathbf{x}_{it} \quad (24)$$

If the null hypothesis is correct and  $\gamma_3$  is equal to zero, estimation of both (23) and (24) will yield a consistent estimate for  $\gamma_2$ . However if  $\gamma_3$  is larger than zero then specification (24) will yield an estimate for  $\gamma_2$  that is biased upward. To see this note that if the regression for (24) is run, the probability limit of the OLS estimate of  $\gamma_2$  is:

$$p \lim \hat{\mathbf{g}}_2 = \mathbf{g}_2 + \mathbf{g}_3 \frac{\text{cov}(y_{it}, a_{it})}{\text{var}(y_{it})} \quad (25)$$

If  $\gamma_3 > 0$  and household income and asset ownership are positively correlated (as is plausible), then the probability limit of  $\hat{\mathbf{g}}_2$  will be positive. Estimating (24) for a situation of partial insurance where households also rely on buffer stocks to smooth consumption results in a positive bias in the coefficient of household income explaining household consumption. This then suggests less complete insurance than takes place in practise. Of course if insurance is complete and  $\gamma_3 = 0$  there is no such bias.

### 3. Identifying Community Level Effects

To estimate equations (22) and (23) information on household income, expenditure, savings and assets is required. Income was obtained from the questionnaires by summing the components for crop income (gross), income from own enterprises, gross income from livestock products and herd size increases, income from public transfers, gross female income (usually from gardening), off-farm income and remittances for the different years. Values were then made real using Zimbabwe's (urban) price index adjusted for observed differences between urban and rural prices. An important component of income to be included in the income measure is private transfers, as they capture the insurance element we intend to estimate. This element has only been incorporated in Kinsey's surveys since 1996 (they have been held annually since 1992). So three years of observations (1997-1999) are usable. For communal households for each of the years for which their information was collected, questions on private transfers were posed. But for resettled households we have to limit ourselves to information collected in 1997 and thereafter. Because crop related information is collected only for the previous season two survey years are required to obtain complete information for one year's income. It follows that for communal households two years of complete information are available from which one first difference could be calculated. For land reform beneficiaries changes in the relevant variables could be obtained for two periods.

In determining savings, the interest is in assets that can be used for consumption purposes either by consuming them directly or by liquidating them and using the cash obtained to purchase consumption goods. Food stocks obviously qualify as savings. In addition cash savings and livestock may be considered. This can be inferred from table 1 which reproduces a table from Kinsey, Burger and Gunning (1998), and which presents the sources of cash used by households to buy food during the droughts of 1992 and 1995. Not all sources of cash in the table are savings. Several entries (taking a job, trading, the sale of garden vegetables and panning for gold) reflect responses to the failure to generate sufficient income from the main source of income, agriculture.<sup>5</sup> Of the assets, which potentially can be labelled as savings (gold, land, houses, livestock, personal effects, equipment, household effects and cash/savings), only livestock and cash/savings present

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<sup>5</sup> They are examples of the flexibility in income generation and illustrate that when the marginal utility of extra income is high (during adverse circumstances) less rewarding activities, such as gold panning, are explored.

themselves as sources of cash during adverse circumstances. They are therefore included in the measure of savings.<sup>6</sup>

Livestock savings were obtained by determining the balance between livestock bought and livestock sold. Advantage of this approach over taking the difference of changes in livestock values between different years is that by observing sales and purchases directly, the potential impact of measurement error is reduced as fewer observations are needed. An additional advantage is the reduced scope for spurious correlation while regressing changes in assets on changes in savings if the livestock component is determined on a different basis. The other components of savings, cash holdings and food stocks, were obtained by taking first differences of the annual changes in cash balances respectively changes in the value of food stores.<sup>7</sup>

From the way in which savings are determined, it follows that household assets also consist of food stocks, livestock possessions and cash balances.<sup>8</sup> In the presence of full insurance none of these savings instruments should have any effect on household expenditure. But if insurance is not complete, it is more likely to find different coefficients for livestock, grain and cash savings than identical ones. Livestock being indivisible can be expected to be used mostly in circumstances in which a large amount of savings is required. Cash on the other hand can be put to use on a more flexible basis and in an environment with high inflation, any cash balances are more likely to be a reflection of a transaction motive than savings. Grain, finally, is entirely different since the bulk of any grain storage will be consumed the same year. As such it may also be given a consumption interpretation instead of a savings interpretation. For these reasons, the different savings instruments are expected to have different effects on consumption and are therefore included separately.

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<sup>6</sup> It is unsurprising that assets such as gold, housing or land do not show up as liquid assets. In rural Zimbabwe households do not keep gold, while houses and land can generally not be sold. For the land reform beneficiaries the sale of land (and therefore of all buildings on that land) is prohibited for instance. For the communal households it is not prohibited but it is very difficult in practice because of the absence of a legally enforceable demarcation of land.

<sup>7</sup> The value of food stores is determined by multiplying the quantity stored with the sales price of the crop. If no sales price could be obtained, the quantity stored is multiplied with the median price. Food crops included are: maize, sorghum, nyimo, mhunga and rapoko.

<sup>8</sup> The value of livestock possessions is determined by multiplying livestock numbers with the median (sales) price for each type of animal. This procedure is preferred to the one used for food stocks where the household sales price was used, because, unlike crop sales, many households do not sell any livestock in a given year.

Table 1

Sources of cash used to buy food during serious droughts, 1992 and 1995

	1992		1995	
	Mean amount raised (Z\$)	Percent of Households doing this	Mean Amount raised (Z\$)	Percent of households doing this
Take a new loan	61	3.6	68	3.7
Use cash / savings	438	27.6	337	27.1
Take a job in this area	250	17.6	308	22.4
Take a job elsewhere	15	19.6	387	11.1
Sell livestock	648	63.1	1112	60.2
Sell personal effects	0	0.0	0	0.0
Sell farm equipment	0	0.0	0	0.0
Sell household effects	1	0.3	0	0.0
Sell firewood, wild fruit	0	0.0	0	0.0
Sell other items *	76	15.5	516	18.7
Pan for gold	32	6.2	93	11.4
Other actions	122	13.8	190	10.3
Total	1653		3011	

\* Chiefly hand-irrigated vegetables, second hand clothing and craft goods

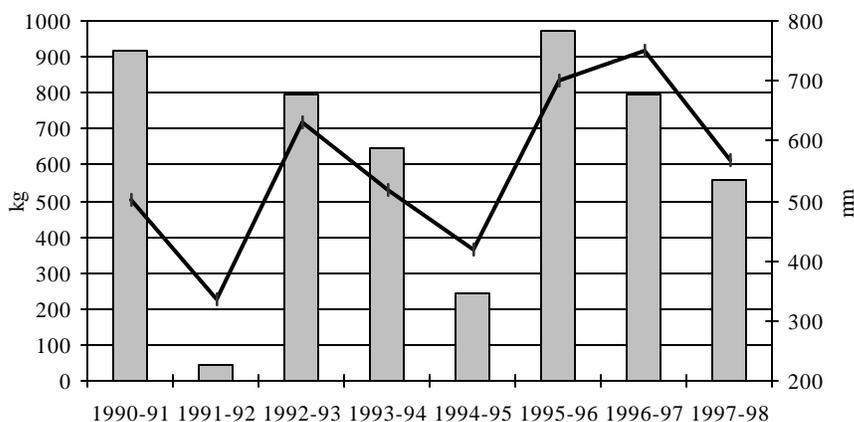
Source: Kinsey, Burger and Gunning (1998)

From the equality  $y_t - c_{it} = s_{it}$ , follows the existence of a straightforward relation between the equations (22) and (23). But the estimation results do not allow confirming this relation. The reason being that from the previous definition of savings it follows that expenses on food but also on housing, land, durable consumption goods and equipment are considered consumptive lay outs in estimating (22). After all,  $y_t - s_t = c_t$ , and the community time dummies capture this. But in estimating equation (23), the expenditure measure only comprises food expenditures and expenditures on durable consumption goods, for the simple reason that information on the other lay outs was not available. The community-time dummies in this equation therefore reflect this expenditure measure. There exists no straightforward relation between the coefficients obtained in estimating (22) and (23).

In rural Zimbabwe covariate risks are important. This can be derived from the high correlation between national rainfall and average yield of 0.89 for the most important crop grown, maize which is illustrated in figure 1.<sup>9</sup>

*Figure 1*

Average rainfall (bold line) and average maize yield per acre (columns)



Source: Rainfall, Department of Meteorological Services / FEWS based on records for 1200 stations<sup>10</sup>; maize yield per acre calculated using Kinsey's surveys.

Since income pooling can only smooth idiosyncratic variations in income, dealing with these covariate risks requires that households make use of buffer stocks. If rainfall is indeed a source of aggregate risk, then this should show up in the data as a community level clustering in crop incomes and, given the agricultural nature of the economy and the limited possibilities for diversification, in total income as well. To explore this, crop and total income were regressed on village and survey site, time interacted, dummies. Table 2 reports the results for those observations (843 in total) included in the regressions of the next section. Because a case can be made for insurance to take place between individuals instead of between households, the table presents information on a per adult equivalent basis in the first two columns and on a household basis in the columns three and four. Statistically significant values of the regression's F-test indicate that levels in (crop) income are more similar for those living in the same community than for those living in different communities.<sup>11</sup>

<sup>9</sup> For the other two most widely cultivated crops, cotton and groundnuts, this is 0.80 and 0.91 respectively.

<sup>10</sup> Rainfall for 1997/98 is estimated on the basis of information available for a selected number of weather stations.

<sup>11</sup> This F-test tests for the absence of a relationship between the endogenous variable and the community-time dummies.

Regressing crop income on village-time interacted dummies, reported in the top half of table 2, yields high F-statistics implying that crop outcomes are indeed covariate, and underscoring the need to accumulate buffer stocks. This holds both at the household level and per adult equivalent, though the effect is somewhat stronger at the household level. Village effects become weaker if non-crop income is taken into account (reported in the second row). This is unsurprising and may be concluded from Table 1 which shows that in the face of a bad harvest, households compensate the loss of income by exploiting unconventional means to generate earnings.

Where the F-statistics for incomes indicate the existence of covariate risks, our interest is in finding evidence for community level effects in consumption. Results are reported in the third row of table 2. There is no indication of greater similarities in consumption *within* villages than *between* villages. This may mean two things: little smoothing takes place within the village or the village is not the correct identity to define the insurance group.

The three types of liquid assets are reported in the row four till six in table 2. Again there is evidence of community effects but the effect is weak, especially for cash savings. Still the presence of village effects in asset ownership suggests that some communities are better endowed than others. A similarly (weak) effect is found for livestock savings. The absence of a strong effect in savings need not imply the absence of full insurance as it is possible that within a given village only few households save for the benefit of the whole village. If this is what happens then differences between those within a community may be just as large as differences in savings between those in separate villages.

Table 2

Changes in income, crop income, savings and assets

	<i>Per adult equivalent</i>		<i>Household</i>	
	F-stat	P-value	F-stat	P-value
Crop Income	5.87	0.0000	11.00	0.0000
Total Income	3.95	0.0000	7.99	0.0000
Consumption	1.34	0.0643	1.30	0.0877
Cash balances	1.34	0.0652	1.47	0.0223
Livestock possessions	1.97	0.0001	3.34	0.0000
Grain stores	3.25	0.0000	3.99	0.0000
Livestock savings	2.36	0.0000	1.58	0.0081
	F-stat	P-value	F-stat	P-value
Δ Crop Income	3.94	0.0000	5.49	0.0000
Δ Total Income	2.45	0.0000	2.72	0.0000
Δ Consumption	1.39	0.0444	1.22	0.1499
Δ Cash balances	1.01	0.4596	0.87	0.7159
Δ Livestock possessions	2.05	0.0000	1.59	0.0895
Δ Grain stores	3.05	0.0000	2.78	0.0000
Δ Livestock savings	2.05	0.0000	2.00	0.0001

Source: estimated using Kinsey's surveys.

The test for full insurance does not tests for comovement in levels but tests for comovement in first differences. These are reported in the bottom half of table 2. Clearly where village effects exist in levels, they are likely to appear in first differences as well. Measurement error may obscure these results however. Especially for variables whose levels change little over time, the variance of measured changes may easily be dominated by measurement error, even if the measurement of the levels is relatively accurate. Measurement error appears to play a role as the F-tests for the changes in (crop) income, consumption, savings and assets are lower than for those in levels. Otherwise, the patterns are much the same. There is evidence for comovement in (crop) income, asset ownership and savings but there is only a weak suggestion for comovement in consumption measured in adult equivalents. If one considers the differences in comovement between household level variables and variables expressed in adult equivalents then there is no reason to prefer one type of measure over the other.

## 4. Estimation Results

In the estimation 60 households were dropped because information on any of the variables was absent in any of the three years required to determine first differences. In total 139 communal households (out of a total of 150) and 351 resettled households (out of a total of 400) are included in the estimations. Not all reported private transfers were in cash and assigning a monetary value to these transfers turned out to be impossible. In order not to lose information it was decided to include additional variables in the estimations representing the quantity of items households received and provided.<sup>12</sup>

In the presence of full insurance, the inclusion of village dummies implies that endogeneity problems will not lead to biases in the estimates of the  $\gamma$ 's. To see why, suppose that an unobserved technology shock (e.g. draft animals have become stronger due to a new method of dipping) increases household income (draft animals are stronger). In the absence of full insurance this increase in income could affect the consumption decision in two ways. Through a direct effect (income is higher) and because less assets are required for precautionary reasons. The latter suggests a correlation between the error term and household income so that in the presence of partial insurance the income coefficient would be biased. However, in the presence of full insurance, the household's increase in income is captured in the dummy representing village endowments. If the household increases consumption it should be due to this increase in village endowments (and possibly the additional availability of endowments because the income process has become safer). Hence in the presence of full insurance the estimated  $\gamma$ 's will be unbiased (and equal to zero). Clearly this is not true if insurance is partial, in which case one would have to rely on instrumental variable techniques to deal with this kind of endogeneity.

Another source of bias might come from measurement error. The worst kind affects both endogenous and exogenous variables, for instance if values have to be imputed to income or assets which are also used to determine consumption. Fortunately it was possible to establish expenditure and income and asset information using different questionnaire modules to obtain price and quantity information. So values that had to be imputed to deal with missing price information for consumption respectively income and measures could be derived from different sources. However if the variables in the model are expressed in adult equivalent terms, a new bias affecting variables on both sides of the

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<sup>12</sup> Distinguished are agricultural inputs, maize, other food/home produce and other items, so that eight additional variables representing received respectively given were added to the regressions.

regression is introduced if there is measurement error in household composition. To avoid this problem, and since in the previous section no good reasons were found to rely on per adult equivalent measures, the regressions are carried out at the household level. Still, in annex 3 an expenditure regression is presented capturing variables on a per capita basis.<sup>13</sup>

Even in the absence of a simultaneous measurement error between dependent and independent variables, measurement error in the explanatory variables remains an issue as it will lead to attenuation bias. Relying on instrumental variable estimation can solve this problem, but finding suitable instruments proved to be difficult. Using lagged values was not possible because, for communal households, all three available years of information were already used to calculate the first differences. Other instruments were discarded on economic grounds. One potential solution is to create instruments following the Durbin method (Kennedy, 1990). To do so the independent variables are ranked by size after which instrumental variables are defined by the rank order. This method, however, does not solve the measurement problem since it is unlikely that the true values of the different values would have the same rank order as the measured values. Rank order is therefore not a good instrument to deal with measurement error.

In view of these problems and given the interest in testing for the presence of full insurance, it was decided to estimate equation (22) using OLS. The idea behind this approach is that if full insurance is rejected despite the presence of a downward attenuation bias, then it would certainly be rejected if the coefficients could have been estimated properly. The implication is however that if full insurance is rejected, the estimates for the coefficients are biased. Due to measurement error they will be biased toward zero, but endogeneity problems may lead to opposite effects. So in the case of partial insurance, the coefficients do not have an interpretation.

Table 3 presents the results for three estimations with village dummies. One for the sample as whole and two comprising interaction terms. In one estimation interaction terms for poor households are incorporated; in the other interaction terms for households from communal areas are included. The coefficients for the change in income and the change in livestock endowments are positive in all three regressions. This is in accordance with the consumption rule presented in annex 2, where it was found that after

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<sup>13</sup> The results in this regression are comparable to the ones presented in the main text. In the adult equivalent regression one additional variable, reflecting household composition, was included to capture the presence of economies of scale in household consumption (see Lanjouw and Ravallion (1995)).

a positive endowment shock (either assets or income) both consumption and savings increase. The coefficients for the different kinds of liquid assets are not identical, as we expected. Unlike livestock assets, cash balances enter the regression with a negative (and significant) sign. This underscores the earlier observation that in a highly inflationary environment, cash balances are kept for transaction reasons. And this is what the regression outcomes reflect. Grain stores are not significant.

The regressions show no support for the presence of full insurance. T-tests that the coefficient for the change in income is equal to zero are rejected in each of the three regressions. This does not hold for changes in livestock endowments, which is insignificant and thereby in accordance with the suggestion of full insurance. The lack of significance may be a reflection of the fact that, unlike income or cash, livestock endowments are pooled at the village level. Or, it may be attributed to the absence of substantial changes in the levels of livestock possession, leading in the presence of measurement error to a low signal to noise ratios when estimating in first differences. In any case not only do the estimation reject the hypothesis of full insurance, absent insurance is also rejected, following the rejection of the hypothesis that village dummies are jointly zero.

Next consider the differences in the degree of insurance between the poor and the non-poor. The estimation is also reported in table 3. As poor are considered those families owning less than half the median number of livestock in the year previous to the one for which complete information was obtained: 1996 (for land reform beneficiaries) and 1997 for communal households. The coefficients between both groups do not differ significantly so that the degree of insurance poor and the non-poor is identical. Given that the years for which these estimations were ran were characterised by relatively normal weather, this need not come as a surprise. After all, exclusion from existing insurance arrangements is most likely in situations with covariate shocks. Still, this evidence contradicts Jalan and Ravallion (1999) who find different degrees of insurance between poor and non-poor households.

No differences are found between communal and resettled households, implying either that the distrust effect is offset by the lack of privacy in the clustered villages or, and this seems more plausible, that after 20 years of resettlement the social cohesion (and possibilities for monitoring) between both groups of farmers has become comparable.

The evidence rejects full insurance and is in favour of partial insurance. One reason why full insurance may be rejected is that the insurance group was improperly defined. After all, why would the village be the entity that confines the insurance group. Why for instance not consider the survey site as a whole? Therefore the regressions in table 3 were repeated, but now including survey site dummies. The results were essentially the same and are not presented here. It follows however that *if full insurance exists nonetheless* that the insurance group is not defined by administrative units like the village or the survey site.

To further look into this issue it was considered who the providers and recipients of transfers are. Information to this end is presented in table 4. It shows the involvement of neighbours and friends in a quarter of all transfers. They are likely to be responsible for the evidence found for village level insurance. But most frequently mentioned as the recipient or provider of goods are family members. Some of them will live in the village itself but in many instances this will not be the case, explaining why insurance at the survey site level may work just as well as insurance at the village level. This suggests that if it had been possible to define as the relevant insurance group the village plus relatives living elsewhere, full insurance might not have been rejected. Unfortunately this could not be put to a test.<sup>14</sup>

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<sup>14</sup> Evidence of the importance of extra-village ties is presented by Grimard (1997) who reports for Côte d'Ivoire that people of same ethnic origin insure each other.

Table 3

OLS estimates of changes in household expenditures<sup>1, 2, 3, 4</sup>

	<i>Coefficien</i>	<i>P-value</i>	<i>Coefficient</i>	<i>P-value</i>	<i>Coefficient</i>	<i>P-value</i>
	<i>t</i>					
Δ income	0.2775	0.018	0.3107	0.022	0.2881	0.024
Δ livestock	0.1122	0.217	0.1182	0.279	0.1270	0.240
Δ cash savings	-0.4169	0.037	-0.3607	0.110	-0.4155	0.047
Δ grain stores	-0.3388	0.449	-0.4887	0.353	-0.3553	0.456
Δ income * D-poor			-0.1322	0.401		
Δ livestock * D-poor			-0.0361	0.822		
Δ cash savings * D-poor			-0.2205	0.601		
Δ grain stores * D-poor			0.7743	0.129		
Δ income * D-communal area					-0.0810	0.480
Δ livestock * D-communal area					-0.0410	0.881
Δ cash savings * D-communal area					0.2189	0.707
Δ grain stores * D-communal area					-0.0829	0.454
R <sup>2</sup>	0.09		0.09		0.09	
Wald Test: H <sub>0</sub> : village dummies are jointly zero	p-value	0.000	0.000		0.000	
F-test: H <sub>0</sub> : all coefficients are jointly zero	p-value	0.000	0.000		0.000	

<sup>1</sup> In all regressions the number of observations is 843.

<sup>2</sup> Stratification by natural region (3), clustering by village (28), no weighting.

<sup>3</sup> Income, livestock cash savings and grain stores are per adult equivalent.

<sup>4</sup> Village dummies are not reported

Source: estimated from Kinsey's surveys

Table 4

Recipients / providers of private transfers  
in 1997 and 1998

<i>Recipient / provider</i>	
Parent of member of household	7%
Child of member of household	27%
Other blood relative	24%
Relative related through marriage	13%
Neighbour or friend	25%
Other	4%
	100%

Source: calculated from Kinsey's surveys

In section 2 it was also shown that instead of explaining expenditure, a full insurance test can also be based on the change in savings. A difficulty in estimating equation (23) is the possibility of correlations in measurement error between right and left hand side variables. After all, cash savings are imputed for differences in cash balances in subsequent years, implying that any measurement error in cash balances (included as exogenous variable) will be correlated with the measure for household savings (which includes cash savings). Again, instrumental variable estimation allows one to solve this issue but the absence of reliable instruments for both cash savings and food grain savings prevented doing so. One fortunate aspect is however that savings in livestock were determined independently from the level of livestock possession. So where it is not possible for the given data to estimate a complete savings function, it is possible to estimate a limited one, based on changes in cattle savings. And as cattle represent 76 percent of average household savings (and 87 percent in value terms) this regression is thought to be informative at least. It is included in annex 3. The results of this regression are comparable to the ones reported on the basis of table 3. Full insurance is rejected and so is the absence of all informal insurance.<sup>15</sup>

Another implication of the model presented in section 2 is that in the presence of full insurance the rank order of the different households should remain unchanged over time. This implication is already suggested by Banerjee and Newman (1991) but has not

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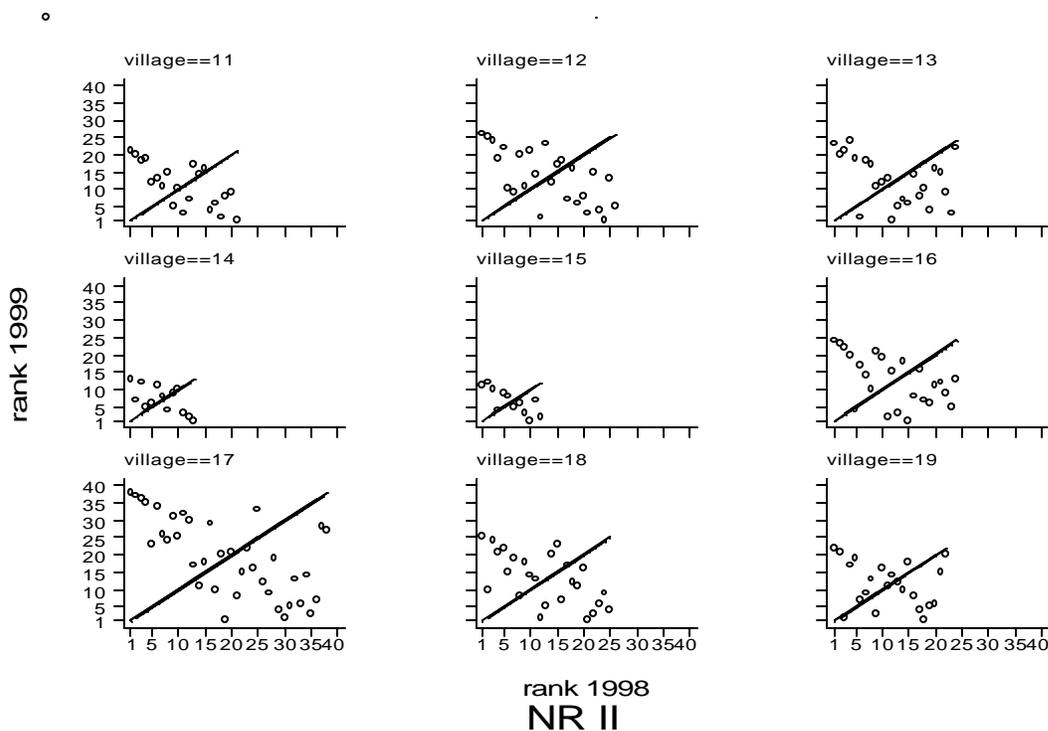
<sup>15</sup> Note that in this regression, the test on the presence of full insurance is whether the income coefficient is equal to one.

received much attention in the literature.<sup>16</sup> One way to explore this is graphically. Advantage of such an approach is that, if it is done at the village level, one can easily identify whether villages exist in which the degree of insurance differs from that of others. If the household consumption rank in the different years is put on the x and y-axes respectively, then full insurance suggests that all observations should lay on the 45-degree line. Clearly, measurement error will lead to deviations from this line, but still one expects to find a clustering of scatter points around the 45-degree line.

Figure 2 presents household consumption ranks for 1998 and 1999 for each of the villages. There are some villages for which indications of a high degree of insurance exist. This is the case for the villages 19 and 36 for instance. These villages appear to be exception however and the illustration mostly confirms what the regression estimates indicated already: there is little evidence in support of full insurance within villages.

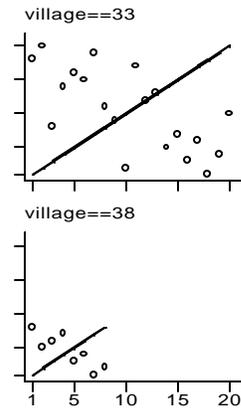
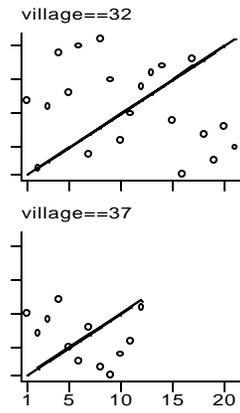
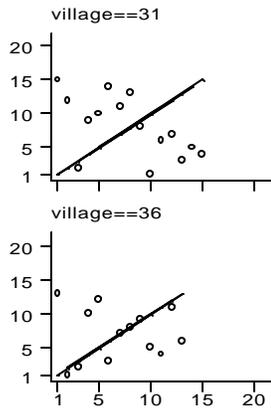
Figure 2

Household consumption rank in 1998 and 1999



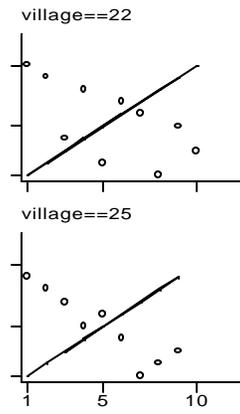
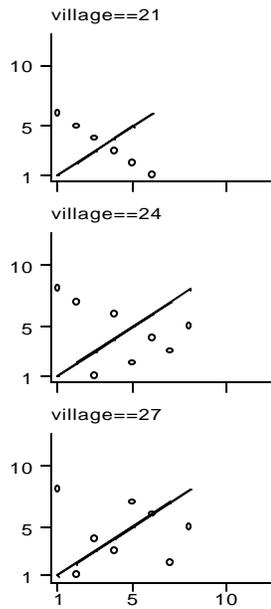
<sup>16</sup> In a study on consumption mobility, Jappelli and Pistaferri (1999) consider this implication of the insurance theory as well.

rank 1999

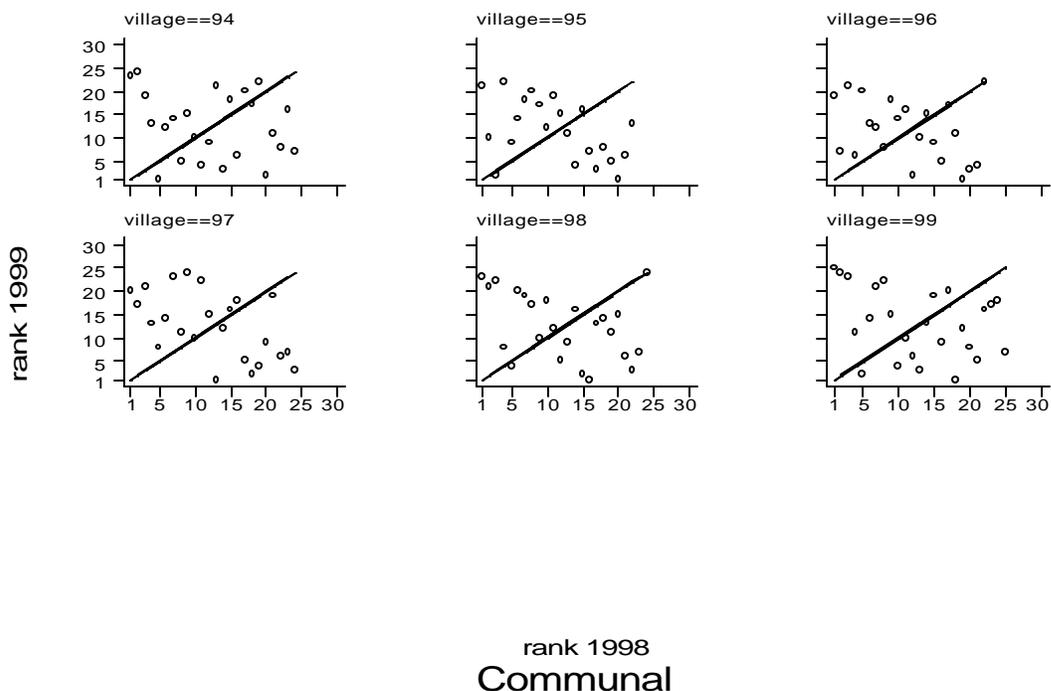


rank 1998  
NR III

rank 1999



rank 1998  
NR IV



Source: calculated using Kinsey's data

## 5. Conclusions

In the absence of opportunities to insure oneself formally, it may be expected that households explore the possibilities to enter informal insurance arrangements. After all, by pooling incomes within the community, households can shield themselves from idiosyncratic risks. Many different kinds of arrangements to do so can be thought of. But instead of exploring their functioning separately, in this paper it is tested whether the combination of all informal arrangements leads to a complete pooling of idiosyncratic income risks.

This paper is not the first to test for the presence of complete income pooling. It is the first however to take the use of buffer stocks explicitly into account. The common test on full insurance identifies whether there is comovement in consumption between households living in the same community. It tests whether changes in household consumption are independent of changes in household income and whether consumption depends only on village consumption. But in an environment where many risks are

covariant (and this paper provided evidence to this end) and where households rely on buffer stocks to deal with them, such a test is inconclusive. The independence of household consumption from household income could also be brought about by relying on buffer stocks to attain a smooth consumption profile. After all, buffer stocks can be used to deal with covariate shocks but also to deal with idiosyncratic risks. However if changes in household consumption do not comove with changes in household income *and* household asset levels then this may be considered evidence for the presence of community level insurance. This point is formally illustrated in the theoretical part of this paper.

In the empirical part the presence of full insurance is put to a test. Evidence in support of full insurance was not found. This is an altogether unsurprising finding given the presence of information and incentive problems which hinder the functioning of informal insurance arrangements. But evidence in support of the reverse, complete absence of informal insurance arrangements, was not found either. Changes in household consumption (and savings) were found to be dependent not only on changes in household income but also on the village-time dummies.

Two additional issues were explored: whether the poor are insured differently than the non-poor and whether differences in the degree of insurance exist between land reform beneficiaries and non-beneficiaries. With respect to the former, no support could be found for differences in the degree of insurance between poor and non-poor households. Also with respect to latter did the estimations not suggest the presence of differences between land reform beneficiaries and communal households.

Finally attention has been attributed to discovering what is the relevant insurance group. The degree of insurance was found to be similar, irrespective of whether village-time dummies or survey-site time dummies were included in the regressions. This is interesting as it shows that distance is not the major obstacle to deal with information and enforcement problems. A reason why this may be the case is that pooling not only takes place between villagers but also between family members, who are likely to have better possibilities to obtain reliable information and to deal with enforcement problems.

## Annex 1

To arrive at:

$$V_t'(\bar{x}_t) = \mathbf{I}_i u'(c_{it}) \quad (6)$$

write (5)

$$\mathbf{I}_i u'(c_{it}) - \mathbf{r}(1+r)E_t V_{t+1}'(\bar{x}_{t+1}) = 0 \quad (5)$$

as:

$$\mathbf{I}_i u'(c_{it}) = \mathbf{r}(1+r)E_t V_{t+1}' \left\{ (1+r)(\bar{x}_t - \sum_{i=1}^N c_{it}) + \bar{y}_{t+1} \right\} \quad (5^*)$$

This gives optimal consumption as implicit function of current wealth:  $c_{it} = c_{it}(\bar{x}_t)$ . If this implicit function is substituted in the Bellman equation one obtains:

$$V_t(\bar{x}_t) = \sum_{i=1}^N \mathbf{I}_i u(c_{it}(\bar{x}_t)) + \mathbf{r}E_t V_{t+1} \left\{ (1+r)(\bar{x}_t - \sum_{i=1}^N c_{it}(\bar{x}_t)) + \bar{y}_{t+1} \right\}.$$

Differentiate this function with respect to  $\bar{x}_t$ :

$$V_t'(\bar{x}_t) = \sum_{i=1}^N \mathbf{I}_i u'(c_{it}) c_{it}'(\bar{x}_t) + (1+r) \mathbf{r} E_t V_{t+1}' \left\{ (1+r)(\bar{x}_t - \sum_{i=1}^N c_{it}(\bar{x}_t)) + \bar{y}_{t+1} \right\} \left[ 1 - \sum_{i=1}^N c_{it}'(\bar{x}_t) \right]$$

Substitute (5) into this expression:

$$V_t'(\bar{x}_t) = (1+r) \mathbf{r} E_t V_{t+1}'(\bar{x}_{t+1}) \sum_{i=1}^N c_{it}'(\bar{x}_t) + (1+r) \mathbf{r} E_t V_{t+1}'(\bar{x}_{t+1}) \left[ 1 - \sum_{i=1}^N c_{it}'(\bar{x}_t) \right]$$

and rewrite:

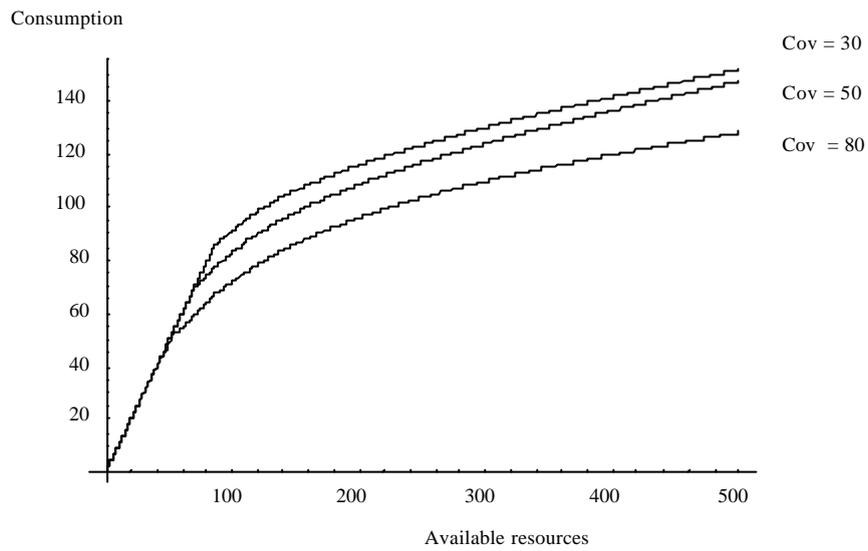
$$V_t'(\bar{x}_t) = (1+r) \mathbf{r} E_t V_{t+1}'(\bar{x}_{t+1}).$$

Substitute (5) into this expression to obtain:

$$V_t'(\bar{x}_t) = \mathbf{I}_i u'(c_{it}) \quad (6)$$

## Annex 2

Simulated consumption rules for liquidity constrained households with mean income of 100, coefficients of variation of 30, 50 and 80 respectively and a relative rate of risk aversion of 2



## Annex 3

OLS estimates of changes in household livestock savings<sup>1,2,3,4</sup>

	<i>Coefficient</i>	<i>P-value</i>	<i>Coefficient</i>	<i>P-value</i>	<i>Coefficient</i>	<i>P-value</i>
Δ income	-0.0014	0.903	-0.0023	0.867	-0.0107	0.280
Δ livestock	-0.0083	0.619	-0.0101	0.586	-0.0075	0.705
Δ cash savings	0.0378	0.285	0.0469	0.211	0.0489	0.169
Δ grain stores	-0.0155	0.821	-0.0071	0.928	0.0029	0.976
Δ income * D-poor			0.0092	0.671		
Δ livestock * D-poor			0.0149	0.630		
Δ cash savings * D-poor			-0.0547	0.283		
Δ grain stores * D-poor			-0.0656	0.425		
Δ income * D-communal area					0.0928	0.012
Δ livestock * D-communal area					-0.1609	0.082
Δ cash savings * D-communal area					-0.2139	0.136
Δ grain stores * D-communal area					-0.0101	0.695
R <sup>2</sup>	0.12		0.12		0.12	
Wald Test: H <sub>0</sub> : dummies are jointly zero p-value	0.000		0.000		0.000	
F-test: H <sub>0</sub> : all coefficients are jointly zero p-value	0.000		0.000		0.000	

<sup>1</sup> In all regressions the number of observations is 843.

<sup>2</sup> Stratification by natural region (3), clustering by village (28), no weighting.

<sup>3</sup> Income, livestock cash savings and grain stores are per adult equivalent.

<sup>4</sup> Village dummies are not reported

Source: estimated from Kinsey's surveys

OLS estimates of changes in per capita expenditures<sup>2,3,4</sup>

	<i>Coefficient</i>	<i>P-value</i>	<i>Coefficient</i>	<i>P-value</i>	<i>Coefficient</i>	<i>P-value</i>
Δ income	0.3019	0.003	0.3381	0.004	0.3375	0.003
Δ livestock	0.0604	0.136	0.0702	0.168	0.0863	0.070
Δ cash savings	-0.4561	0.029	-0.4633	0.048	-0.5213	0.077
Δ grain stores	-0.0613	0.863	-0.2526	0.514	-0.2161	0.600
Δ household size	-251.31	0.000	-216.89	0.001	-223.47	0.001
Δ income * D-poor			-0.1373	0.359		
Δ livestock * D-poor			-0.0287	0.645		
Δ cash savings * D-poor			0.0789	0.845		
Δ grain stores * D-poor			0.9289	0.148		
Δ household size * D-poor			-173.54	0.150		
Δ income * D-communal area					-0.1629	0.095
Δ livestock * D-communal area					0.2505	0.392
Δ cash savings * D-communal area					0.5283	0.316
Δ grain stores * D-communal area					-0.0742	0.347
Δ household size * D-communal area					-268.24	0.296
R <sup>2</sup>	0.15		0.15		0.15	
Wald Test: H <sub>0</sub> : dummies are jointly zero p-value	0.000		0.000		0.000	
F-test: H <sub>0</sub> : all coefficients are jointly zero p-value	0.000		0.000		0.000	

<sup>1</sup> In all regressions the number of observations is 841.

<sup>2</sup> Stratification by natural region (3), clustering by village (28), no weighting.

<sup>3</sup> Income, livestock cash savings and grain stores are per adult equivalent.

<sup>4</sup> Village dummies are not reported

Source: estimated from Kinsey's surveys

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