Consumption Insurance with Preferences Heterogeneity. May the Sharecropping Institution Help Completing Markets?

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Abstract

Empirical tests of the complete markets hypothesis generally reject full insurance and stimulated the study of optimal risk sharing. However, most of the empirical tests of the complete markets hypothesis make strong assumptions concerning the specification of preferences. In particular, the usual rejection of full insurance may be affected by the incapacity to account for heterogeneity of risk aversion of households. Underlining the methodological problems on the identification of preferences, the direction of the tests and their power, we study the risk sharing and consumption insurance achieved by rural households from three provinces of Pakistan. We show how to deal with these methodological problems in studying consumption smoothing and implement some non directional and directional tests of market completeness. We actually find that markets are incomplete in Pakistan even at the village level and look for a possible explanation of how households try to complete markets. The risk sharing property of sharecropping is actually often called upon, but its effect on consumption smoothing has never been tested directly. We therefore present a reduced form evidence that, in Pakistan, the sharecropping institution allows to complete markets. Households able to use this contractual choice, which permits to share production risk, are better insured against idiosyncratic shocks. It seems that sharecropping provides a contingent claim that other accessible markets do not allow to replicate. This empirical fact shows that agricultural contracts play an important role sharing production risk but also through informal insurance mechanisms when markets are incomplete.

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1. Introduction

Several empirical and theoretical questions have been recently raised on risk sharing issues in particular in developing countries (Alderman and Paxson, 1994, Townsend, 1994). The interest in these questions is both theoretical and empirical. The Permanent Income Hypothesis (Hall, 1978, Pischke, 1995) and Complete Markets Hypothesis (Mace, 1991, Cochrane, 1991, Hayashi, Altonji and Kotlikoff, 1996) are generally rejected on data both of industrialized and developing countries. Liquidity constraints (Zeldes, 1989), non separability (Browning and Meghir, 1991, Attanasio and Davis, 1996) and other misspecification issues as well as informational asymmetries (Ligon, 1998) and limited commitment problems (Coate and Ravallion, 1993, Ligon, Thomas et Worrall, 1997) have been introduced to help rationalize the observed empirical facts (see Dubois 1999 for a survey of the theoretical and empirical literature). However, the full insurance tests implemented empirically generally rely on strong homogeneity assumptions. We argue that they should take into account the heterogeneity of risk aversion of households since excess sensitivity of consumption to income could result from the fact that there is some heterogeneity in households preferences with respect to the desire of smoothing idiosyncratic shocks (heterogeneity in risk aversion). Using data from Pakistan, we then try to address the following general questions. Which degree of consumption smoothing is reached by rural households? Which insurance markets (Arrow-Debreu securities) allow them to smooth idiosyncratic shocks, to insure themselves fully or partially? After finding that the within village complete markets hypothesis is globally rejected, we propose to test a conjecture that some kind of institutions may help households to complete markets. In particular, the risk sharing properties of sharecropping are often invoked in the literature on agricultural contracts. We say that this institution may allow to complete the market portfolio of households by providing state contingent securities that no other combination of other available and accessible contingent securities would be able to replicate. Consumption smoothing studies in developing countries has already shown that markets are in general incomplete and has tried to advance some evidence on the imperfect risk sharing mechanisms used and the extent of insurance achieved. Townsend (1994) showed with Indian data that landless people where less well insured than others. Foster and Rosenzweig (1996, 1997, 1998) showed, with data from Pakistan, the importance of altruistic links between households in the use of informal solidarity transfers as a risk sharing device, the role of individual savings and financial intermediation. Grimard (1997) studied the within-ethnic groups risk sharing in Côte d'Ivoire. Jalan and Ravallion (1999) tested the consumption full insurance according to wealth groups in China showing that wealthier groups were better insured. Kochar (1999) showed the role of labor supply response to income shocks in consumption smoothing in India. However, one of the widespread agricultural risk sharing institution, which has been the focus of a huge theoretical and empirical literature in development economics (see Otsuka, Chuma and Hayami, 1992), has never been considered in the consumption smoothing literature and in tests of the complete markets hypothesis. Here, we try to fill this gap between the literature on agrarian structure and that on consumption insurance. Hence, we try to test the full insurance predictions and the conjecture that sharecropping allows to complete markets taking into account the heterogeneity of risk aversion. We also deal with methodological problems of testing the complete markets hypothesis.

More precisely, the complete markets hypothesis generally rely on some strong homogeneity assumptions on the preferences of households, we allow the utility function of households to depend on household's characteristics by parameterizing both the marginal utility and the relative risk aversion (Blundell, Browning and Meghir, 1994 or Hayashi, Altonji, Kotlikoff, 1996 already used the same kind of method by parameterizing marginal utility only). Usual tests of full insurance consist in testing if some idiosyncratic shocks influence the marginal utility of consumption. This kind of test are directional because they test whether households are fully insured against some given shocks by looking at the effect of idiosyncratic shocks on marginal utility of consumption. If there is no significant effect, then full insurance is accepted. However, this does not mean that full insurance would be accepted if tested against some other alternative for example against some other idiosyncratic shocks not observed in the data. A simple inference method is used to test the complete markets hypothesis against any direction. A test of overidentifying restrictions with variables that are theoretically valid instruments under the null hypothesis provides a "non directional" test of the null hypothesis of complete markets. The test is said "non directional" because no other directions of model or alternative hypothesis are used as when we test if some income shock affect marginal utility of consumption. We study the risk sharing and consumption insurance achieved by rural households from three provinces of Pakistan: Sind, Punjab and the North West Frontier Province, implementing these tests. With instrumental variables techniques, we estimate the parameters of households' preferences and test different assumptions on the range of the complete markets hypothesis (for example within and between villages or within village only). The results show that heterogeneity of preferences is important. Both kinds of empirical tests show that full insurance is rejected within Pakistan, between provinces and between villages. Then, the within village full insurance is tested and rejected by directional tests while non directional tests appear not to be sufficiently powerful in this case. Then, we show that, in Pakistan, the sharecropping institution allows to complete markets because households able to use this contractual choice, which permits to share production risks, are better insured against idiosyncratic agricultural shocks than others. It seems that sharecropping provides a state contingent security that other accessible markets do not allow to replicate. This empirical fact shows that agricultural contracts play an important role in risk sharing when markets are incomplete and that it should be cared about for policy reform of institutions in rural developing areas.

The section **??** presents the econometric model used to test the complete markets hypothesis. Section 3 presents the data from Pakistan and the results of empirical tests. Section 4 concludes and gives some research directions suggested by this paper. The appendix is in section 5.

2. Econometric model and Inference Method

Under the complete markets hypothesis, the marginal utility of consumption is equal to the product of a household effect and a time effect (Debreu, 1959, Arrow, 1964, Altug and Miller, 1991). The household factor is a time invariant characteristic corresponding to the Lagrange multiplier of the intertemporal budget constraint. The common time effect is the Lagrange multiplier associated to the aggregate resource constraint at each period. Several methods can be used to test the complete markets hypothesis. The usual tests generally check that the marginal utility of consumption of an agent is not affected by idiosyncratic shocks but only by aggregate shocks. It generally consists in showing that the evolution of consumption (or its logarithm) is determined by the aggregate shock undergone by the economy for which we want to test the complete markets hypothesis (for example the village economy as in Townsend, 1994) and not by idiosyncratic shocks undergone by the household as for example unexpected income changes.

Here, we propose a method allowing to identify preferences heterogeneity while testing the complete markets hypothesis. In particular we take into account the risk aversion heterogeneity of agents that may have biased previous econometric studies that considered it as homogeneous. Assuming erroneously that risk aversion is homogeneous among households could actually lead to an apparent excess sensitivity of household consumption to idiosyncratic shocks if idiosyncratic shocks are correlated to aggregate shocks, because full insurance theory predicts that consumption changes should be more responsive to aggregate shocks for less risk averse people than for more risk averse people.

From an econometric point of view, it is also necessary to choose the specification of the utility function. The two most prevalent parametric forms used are the exponential (Constant Absolute Risk Aversion) and isoelastic (Constant Relative Risk Aversion) forms. The choice between these two forms can give very different results (Mace, 1991). Then, we have to define the empirical counterparts of economic theoretical variables which are not generally directly observed with for example consumption as the aggregation of several expenditures, idiosyncratic shocks due to uncertainty (income). It needs panel data which generally provide information on household consumption, income and characteristics. Measurement error on variables also cause some problems (Nelson, 1994). In addition to this econometric difficulty which can be addressed with instrumental variables techniques, we face the problem of defining consumption (food, non durable), of specifying the utility function (separability assumptions) and measuring unanticipated idiosyncratic shocks. Several questions that we will address.

2.1. Full insurance with preferences heterogeneity

Most of the tests of the complete markets hypothesis assume homogeneity of preferences with respect to risk. Some kind of heterogeneity is sometimes taken into account by parameterizing the marginal utility of consumption (Mace, 1991, Cochrane, 1991) but never in the degree of risk aversion. Only Townsend (1994) provides a test of full insurance with risk aversion heterogeneity using household level time series, but the power of the test is then very weak. Full insurance (see for example Wilson, 1968) predicts that household consumption must be a linear function of aggregate consumption with a slope equal to the ratio of household to community average absolute risk tolerance (the inverse of absolute risk aversion). Townsend (1994) regress household by household their consumption on aggregate consumption at the village level including successively proxy variables for household idiosyncratic shocks. Townsend tests, for each household, if the coefficient of the idiosyncratic variable is equal to zero or not and if the aggregate consumption coefficient is equal to one. But the power of these tests is very weak given the short time dimension of panel data on consumption (ten periods in Townsend, 1994). Moreover, in the case where households would have a constant absolute risk aversion equal to σ_i for household i, full risk sharing (complete markets) predicts that the coefficient of aggregate consumption must be equal to the ratio of household to average absolute risk tolerance i.e. $\beta_i = \frac{1/\sigma_i}{\frac{1}{\#village}\sum_{i\in village} 1/\sigma_j}$. Consequently, the right way to test the complete markets hypothesis with these time series results is not to test $\widehat{\beta_i} = 1$ but rather $\frac{1}{\#village}\sum_{i\in village}\widehat{\beta_i} = 1$ i.e. that the average of estimated coefficients should be equal to one. However, this test will probably remain weak and measurement errors on consumption data will turn it even more unreliable (Ravallion and Chaudhuri, 1997).

Another method of testing the full insurance property used also by Townsend (1994) or Mace (1991) consists in imposing homogeneity of risk aversion among agents. Then the panel data can be fully used and the test consists in regressing the first difference of household consumption (or its logarithm) on the income change and to test that the income shock does not affect consumption change. This method is valid under the assumption that all agents have homogeneous risk aversion. Besides, the method consisting in using dummy variables to purge the aggregate shock effect on consumption change (Deaton, 1990) instead of substracting the average consumption change to the individual consumption change (Grimard, 1997, Jalan and Ravallion, 1999) allows to avoid the attenuation bias of income coefficient in the case of the alternative hypothesis (incomplete markets hypothesis) where this coefficient would be strictly positive (Ravallion and Chaudhuri, 1997). Actually, under the null hypothesis, both methods lead to consistent estimators but under the alternative the difference method is biased. Cochrane (1991) tests the full insurance property while introducing some unobserved preference parameters in order to take into account the heterogeneity of preferences. However, he has to do very strong distributional assumptions about this unobserved heterogeneity so that its test remain valid and in particular that these preference shifts may be independent of idiosyncratic shocks. The complete markets hypothesis predicts that the marginal utility of consumption increases at the same rate for each agent (Altug and Miller, 1990). With isoelastic utility functions, even if preferences are heterogeneous and unobserved, it remains that an increasing function of the marginal utility growth rate depends only on aggregate resources and not on idiosyncratic shocks. If you assume that idiosyncratic shocks are independent of household preferences, then they must be cross sectionally independent of the growth rate of consumption. It is the method of test of Cochrane also used by Jacoby and Skoufias (1998), and which allows to avoid the assumption of homogeneity of preferences but which depends crucially on this assumption of independence of preferences and idiosyncratic shocks (which can be correlated if both correlated to demographic characteristics for example).

Otherwise, most empirical tests of full insurance assume that preferences with respect to risk are homogeneous. It seems relevant to be willing to do tests of full insurance taking into account explicitly of preferences heterogeneity.

Blundell, Browning and Meghir (1994) estimate preference parameters of household analyzing the commodity allocation during the life cycle. Here, we aim at deriving full insurance tests with using the assumption generally done of homogeneity of preferences like in Townsend (1994), Mace (1991), Grimard (1997) or Kochar (1999).

Assume that the instantaneous utility of consumption c for household i at time t is of the isoelastic following form

$$\beta^t u_{it}(c) = \exp\left(\alpha\left(\widetilde{z_{it}}\right)\right) \frac{c^{1-\theta(z_{it})}}{1-\theta\left(z_{it}\right)} \tag{1}$$

where vectors z_{it}, $\widetilde{z_{it}}$ are characteristic variables of household i at time t and β the discount factor (vectors z_{it}, $\widetilde{z_{it}}$ can consist in the same or in different variables, their notations are distinguished in the econometric model because they will not be treated in the same manner in the instrumentation method even if they finally will be the same set of variables in the empirical application). We thus assume that households have a constant (in consumption level) relative risk aversion equal to $\theta\left(z_{it}\right)$ which depends on its characteristics z_{it}. This method borrowed from Blundell, Browning and Meghir (1994) was also used in Hayashi, Altonji and Kotlikoff (1996) who parameterized multiplicative factors of marginal utility of consumption with observable characteristics $\left(\alpha\left(\widetilde{z_{it}}\right)\right)$ but who where assuming that risk aversion was homogeneous across households or individuals.

The first order condition verified by the marginal rate of substitution of consumption between time t and $t+1$ under the hypothesis of consumption smoothing is then[1]:

$$\frac{u'_{it+1}\left(c_{it+1}\right)}{u'_{it}\left(c_{it}\right)} = \varepsilon_{it+1} \tag{2}$$

where ε_{it+1} is a random variable which distribution depends on the availability of contingent security markets and of their relative prices. Given the availability and accessibility of the markets to the household, we assume that they optimally smooth their consumption in order to maximize their expected discounted lifetime utility. The consumption smoothing achieved by them may be perfect or imperfect depending on the contingent markets on which they can exchange, trade and bargain.

In the following, we will make more explicit the distribution properties of these random terms according to the assumptions made concerning markets. Using (1), this first order condition can be written under the logarithmic form

$$\alpha\left(\widetilde{z_{it+1}}\right) - \alpha\left(\widetilde{z_{it}}\right) - \theta\left(z_{it+1}\right)\ln c_{it+1} + \theta\left(z_{it}\right)\ln c_{it} = \ln \varepsilon_{it+1} \tag{3}$$

The function $\theta(.)$ can be identified up to a multiplicative constant only. Assuming that the functions $\alpha(.)$ and $\theta(.)$ are linear, we normalize $\theta(.)$ by writing

$$\theta\left(z_{it}\right) = 1 + z_{it}\theta \tag{4}$$

[1] In all the following of the paper, the date $t+1$ will be the current period. The lagged variables correspond to periods t and $t-1$ for the double lagged variables.

The relative risk aversion of household i at t is assumed to be a function of observable characteristics. It is increasing in function of element z_{it}^k of vector z_{it} if $\theta^k > 0$ $(\theta = (\theta_1, .., \theta_k, .., \theta_K))$. The homogeneity of relative risk aversion among agents is obtained when $\theta = 0$. The function $\alpha(.)$ allows to introduce multiplicative shocks to marginal utility of consumption eventually depending on observable characteristics $\widetilde{z_{it}}$. Taking a linear additive form between an unobservable shock η_{it} and a factor $\widetilde{z_{it}}\alpha$ function of observable variables , we write

$$\alpha\left(\widetilde{z_{it}}\right) = \widetilde{z_{it}}\alpha + \eta_{it} \tag{5}$$

The factor η_{it} allows to capture the individual variations in the discount factor and any other kind of unobserved specific effect multiplicative to marginal utility of consumption.

Then the first order condition becomes

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}\right] \theta + \Delta \widetilde{z_{it+1}} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{6}$$

or equivalently

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \Delta \ln c_{it+1} - \ln c_{it} \Delta z_{it+1}\right] \theta + \Delta \widetilde{z_{it+1}} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{7}$$

where Δ is the first difference operator defined by $\Delta X_{t+1} = X_{t+1} - X_t$.

Assume now that consumption is measured with error independently distributed across households and periods. We observe $\widetilde{c_{it}}$ instead of true consumption c_{it}:

$$\ln \widetilde{c_{it}} = \ln c_{it} + u_{it} \tag{8}$$

Measuring consumption is a difficult task in any household survey and measurement errors are almost always present. Ignoring measurement error may lead to important bias in estimations. We therefore need to consider them seriously. Taking into account explicitly measurement error, the first order condition is

$$\Delta \ln \widetilde{c_{it+1}} = \left[-z_{it+1} \Delta \ln \widetilde{c_{it+1}} - \ln \widetilde{c_{it}} \Delta z_{it+1}\right] \theta + \Delta \widetilde{z_{it+1}} \alpha + v_{it+1} \tag{9}$$

with[2] $v_{it+1} = \Delta \eta_{it+1} - \ln \varepsilon_{it+1} + (1 + z_{it+1}\theta) \Delta u_{it+1} + u_{it} \Delta z_{it+1} \theta$

Now, we give precisely the properties of random terms ε_{it+1} according to the hypothesis made on market completeness:

- **Within and between villages complete markets**: Under the complete markets hypothesis, the random terms ε_{it+1} are aggregate temporal shocks: $\varepsilon_{it} = \varepsilon_t$.

[2] $(1 + \theta z_{it+1}) \Delta u_{it+1} + \theta u_{it} \Delta z_{it+1} = (1 + \theta z_{it}) \Delta u_{it+1} + \theta u_{it+1} \Delta z_{it+1}$

- **Within village complete markets**: Under the complete markets hypothesis in each village, the random terms ε_{it+1} are village-level aggregate temporal shocks: $\varepsilon_{it} = \varepsilon_t^v$.
- **Within village incomplete markets**: Under within village incomplete markets, $\ln \varepsilon_{it+1} = E_t [\ln \varepsilon_{it+1} \mid X_{it}] + \xi_{it+1} = \ln f(X_{it}) + \xi_{it+1}$ where ξ_{it+1} is an innovation orthogonal to the expectation of $\ln \varepsilon_{it+1}$ conditional at information at time t, hence at variables X_{it} of time t (the X_{it} include in particular the variables of consumption and labor supply).

We then have to do the following stochastic assumption concerning the disturbance terms:

Assumption 1: The measurement errors on consumption u_{it} are independent and identically distributed across households and periods.

Assumption 2: Conditionally on observable household characteristics z_{it}, the unobservable preference shocks η_{it} are independent martingales between households and are independent of measurement errors[3].

2.2. Estimation method and inference

We can test the null hypothesis of within and between-villages or within-villages only full insurance by estimating equation (9) and by testing the statistical properties of disturbance terms ε_{it+1}. Similarly, we can test within-province full insurance. The usual tests of complete markets or full insurance consist in directional tests against precise alternatives. In general, it consists in testing the null hypothesis against the alternative that the random terms ε_{it+1} depends on an household idiosyncratic shock. For example, if a negative income shock reduces household consumption during a period, it means that markets are incomplete because markets completeness implies that consumption smoothing provide full insurance and shocks should be fully insured via some insurance markets. But, these tests are directional and can only reject the null hypothesis in some given direction. Here, we show that an overidentifying restrictions test of the model (9) allows to perform a "non directional" test of the null hypothesis of complete markets. This test is non directional in the sense that it does not test the model against some known alternative but simply teste the internal consistency of the estimated model, which allows to reject the model undirectionaly (i.e. in favor of an unknown alternative) if this condition is not satisfied. This test has the advantage that it does not necessitate a known testable alternative i.e. data allowing to test this alternative. If the non directional test does not reject the model, it may be because it is not sufficiently powerful

[3] $\Delta\eta_{it+1}$ is the a martingale difference implying that $\Delta\eta_{it+1}$ is independent of $\Delta\eta_{it}$.

and that a directional test eventually more powerful and reject it, even if we cannot a priori rank the power of these different tests.

We therefore use also directional tests allowing in particular to establish at least some directions towards which full insurance is rejected[4]. In the case of the within-village full insurance, the testable prediction is that random terms $\ln \varepsilon_{it+1}$ contains and household specific idiosyncratic innovation whereas the within-village complete markets hypothesis predicts that this innovation is zero. Consequently, if we have a variable ω_{it+1} correlated with the innovation ξ_{it+1}, such that $\xi_{it+1} = \delta \left[E_t \omega_{it+1} - \omega_{it+1}\right]$, we then only need to test that $\delta = 0$ in the estimation of the following equation:

$$\Delta \ln \widetilde{c_{it+1}} = \left[-z_{it+1} \Delta \ln \widetilde{c_{it+1}} - \ln \widetilde{c_{it}} \Delta z_{it+1}\right] \theta + \delta \omega_{it+1} + \Delta \widetilde{z_{it+1}} \alpha + \widetilde{v}_{it+1} \qquad (10)$$

with $\widetilde{v}_{it+1} = v_{it+1} - \delta \omega_{it+1} = \Delta \eta_{it+1} + (1 + z_{it+1} \theta) \Delta u_{it+1} + u_{it} \Delta z_{it+1} \theta - \ln f(X_{it}) - \xi_{it+1} - \delta \omega_{it+1}$ and $\xi_{it+1} = \delta \left[E_t \omega_{it+1} - \omega_{it+1}\right]$.

Instrumental variables estimation:

To estimate the equation (9) under one of the null hypothesis, we include some time dummy variables (in the case of the complete markets hypothesis) or some village-time dummy variables (for the within-village complete markets hypothesis), and use the two stage least squares instrumental variables method to account for the endogeneity of right hand side variables $\left[z_{it+1} \Delta \ln \widetilde{c_{it+1}} + \Delta z_{it+1} \ln \widetilde{c_{it}}\right]$. The choice of instruments is very important. Very often, it is considered that instrumental variables can be all current and lagged exogenous variables i.e. z_{it+1}, z_{it}, and any variable uncorrelated with preference shocks or measurement errors at time t, $t+1$ (c_{it} and l_{it} then cannot be instruments, but two periods lagged variables can be). However, the use of a large number of instrumental variables often leads to a weak instruments problem and to biased estimators (Bound, Jaeger and Baker, 1995). Hence, we seek which instruments should be theoretically used and be valid under the null hypothesis of the model under complete markets. To avoid weak instrumentation, we compute which instruments should be the best correlated to endogenous variables. The appendix **??** shows how we determine the set of instrumental variables that should have the strongest correlation with the endogenous variables under the null hypothesis. Some instruments theoretically valid under the null hypothesis of complete markets are: $\Delta z_{it+1} \ln c_{it-1}$ and $z_{it} \Delta \widetilde{z_{it}} - z_{it+1} \Delta^2 \widetilde{z_{it+1}}$ to which we can add $\Delta z_{it+1} \left(z_{it+1} + z_{it} - z_{it-1}\right) \ln c_{it-1}$ and $z_{it+1}^2 \Delta^2 \widetilde{z_{it+1}} - z_{it}^2 \Delta \widetilde{z_{it}}$. Doing an overidentifying

[4]It is worth noting that the directional test is not a valid evidence when the undirectional one rejected the null hypothesis because then instruments are not valid and therefore the estimated coefficient of idiosyncratic shock may suffer an endogeneity bias. the directional test is valid only whenever the undirectional one failed to reject the null hypothesis which is however sufficient for us.

restrictions test, for example with the Sargan statistic (Sargan, 1958, Davidson and McKinnon, 1993), we get a test of this null hypothesis of full insurance (of course we simultaneously test for the orthogonality hypothesis made for preference shocks and measurement errors).

To avoid the weak instruments problem which can sensibly affect the asymptotic size of the overidentifying restrictions tests and bias the instrumental variables estimators in finite samples[5] (Magdalinos, 1994, Bound, Jaeger and Baker, 1995, Staiger and Stock, 1997), we restrict our set of instrumental variables to the theoretical instruments computed earlier. In addition, it is crucial to control the instrumental regressions in this empirical work in order to escape from the weak instruments problem. This is generally not shown in articles using two stage least squares with a large set of instruments (Jacoby and Skoufias, 1998, Kochar, 1999). In the following empirical study, we report some first stage instrumental regressions in appendix.

The estimation of (9) under the null hypothesis of within village complete markets necessitates the inclusion of numerous dummy variables on the right hand side of the equation (village-time dummies for the within-village full insurance test, province-time dummies for the within province full insurance). According to Frisch-Waugh theorem, the regression (9) with dummy variables for each village and period is exactly equivalent to the regression done by replacing all variables by their image through the projection operator on the orthogonal space generated by the corresponding dummy variables (the dependent, explanatory and instrumental variables). Then, as the coefficients of all these dummy variables do not lead to any interpretation in the model, and are very numerous (46 villages×12 periods resulting after first differences in 505 coefficients), we transform the model and estimate it by substracting the period-village average[6] which is equivalent to the use of the whole set of dummy variables.

At last, we remark that when there are measurement errors on consumption, the residuals of equation (9) are autocorrelated because $cov(v_{it+1}, v_{it}) = -(1 + z_{it+1}\theta)(1 + z_{it}\theta)\, var(u_{it})$. It is necessary to take into account this autocorrelation in our estimation.

2.3. Labor supply

Until now, we have considered that consumption and leisure were separable in households utility functions. As this specification assumption may not be true and obviously may lead to wrong inference in our tests. Non separability of consumption and leisure can lead to biased estimates if

[5] The finite sample bias can be large even with relatively large samples because the sample size is to be compared to the amplitude of correlations (Staiger et Stock, 1994, Buse, 1992).

[6] Using this method, we need to be careful since our panel data sample from Pakistan is not balanced because of attrition (see appendix 5.2).

we neglect the household leisure demand or equivalently its labor supply (Browning and Meghir, 1991). Income and hours of labor supply are obviously highly correlated. It seems then important to take into account of household labor supply otherwise its omission has similar effects to some unobserved preference shocks correlated with income biasing the income variable coefficient in our regressions. Taking into account the non separability between consumption and leisure we can avoid this problem provided that our specification is correct. For consumption c and labor supply l, we will assume that the utility of household i at time t is of the following form

$$\beta^t u_{it}(c,l) = \exp \widetilde{z_{it}} \alpha \frac{c^{1-z_{it}\theta}}{1-z_{it}\theta} (1+l)^{-\gamma} \tag{11}$$

where γ is a preference parameter of the household.

The first order condition with respect to consumption remains similar[7] and taking logarithms we get:

$$\Delta \ln c_{it+1} = -z_{it+1}\theta \ln c_{it+1} + z_{it}\theta \ln c_{it} - \gamma \Delta \ln l_{it+1} + \Delta \widetilde{z_{it+1}} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{12}$$

or equivalently

$$\Delta \ln c_{it+1} = -z_{it+1}\theta \Delta \ln c_{it+1} - \ln c_{it} \Delta z_{it+1}\theta - \gamma \Delta \ln l_{it+1} + \Delta \widetilde{z_{it+1}} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{13}$$

3. Data and empirical tests

3.1. Data description

The data available come from a survey realized by IFPRI (International Food Policy Research Institute) in Pakistan between 1986 and 1989 (see Alderman and Garcia, 1993). The survey consists of a stratified random sample interviewed 12 times beginning with 927 households from four districts of three regions (Attock and Faisalabad in Punjab, Badin in the Sind, and Dir in the North West Frontier Province, NWFP). For each of the four districts, the villages were chosen randomly from an exhaustive list of villages classified in three sets according to their distances to two markets (*mandis*). In each village, households were randomly drawn from an exhaustive list of village households. The attrition observed in the data (927 households at the beginning and only 887 at the end) seems to come from administrative and political problems rather than from a self selection of households (Alderman and Garcia, 1993). We consider this attrition phenomenon as exogenous. Although the sample is totally rural, it is not completely agricultural, which has an influence on the distribution and fluctuations of incomes. However, on the 927 households chosen in the first

[7] The first order condition with respect to labor supply is not useful for us because our estimation and tests can only be conditional to labor supply.

period, only 22 never had any agricultural income during the survey. The available data[8] are very rich and contain informations on household demographic characteristics, on incomes disaggregated in numerous sources, on individual labor supplies, on endowments and owned assets, on agrarian structure, on crops and productions, on contractual relationships (sharecropping). Some descriptive statistics appear in Table 1.

Income sources are wages, agricultural profits, rents from property rights, pensions, informal transfers (from relatives or others). The expenditures and incomes are in 1986 Rupees per week, areas

Table 1: Descriptive Statistics

Descriptive statistics on the full sample (all periods)			
Variable	Average	Std Err.	Obs.
Food consumption	197.9	151.4	9990
Other non durable expenditures (heating, ..)	47.3	196.1	9991
Durable expenditures	585.6	774.7	9906
Total owned land area (acres)	9.42	21.81	10083
Irrigated land (acres)	4.19	11.25	10083
Non irrigated land (acres)	5.24	17.09	10083
Rented in land under fixed rent (acres)	0.58	3.93	10083
Rented in land under sharecropping (acres)	2.75	6.03	10083
Rented out land under fixed rent (acres)	0.38	3.71	10083
Rented out land under sharecropping (acres)	3.72	14.56	10083
Household size	8.64	4.23	9987
Number of children (<=15years)	4.08	2.91	9987
Wage income	141.9	298.3	9906
Pensions	70.5	450.5	9906
Agricultural profits	109.26	1095.6	9906
Transfers	106	974	9906
Total income (without transfers)	321.7	1291.1	9906
Sharecropping in dummy	0.35	-	10083
Sharecropping out dummy	0.23	-	10083
Fixed rent in dummy	0.08	-	10083
Fixed rent out dummy	0.04	-	10083
Illness days, males (person*day/week)	0.51	1.94	9889
Illness days, females (person*day/week)	0.25	1.05	9885
Male labor (person*day/week)	2.62	4.13	9889
Female labor (person*day/week)	0.53	1.89	9885

are in acres[9]. The correlations between income sources for the total sample, presented in Table 2, show that there is quite little covariation between these sources. This should allow income diversification, but all households do not hold this market portfolio. Actually, the average share of each income source in the total income show for example that landless households have a much more important part of their income from wages. Landless households have on average 80% of their income from wages whereas it is only one third for landowners. In general, for these rural households, the income variability is strong in particular because of the Monsoon, of the important weather variability generating periods of drought and flooding relatively frequent and important.

[8]The appendix 5.1 provides more details on data construction.

[9]Units: 1 Pakistan Rupee (1986) = US$0.0062, 1 acre = 4046.86 m^2.

Besides, the (pseudo) coefficients of variation of household income[10] are very important, ranging

Table 2: Correlations between income sources

Correlation between income sources		Agricultural Profits	Wage Income	Pensions	Transfers
(N=9906)	Agricultural Profits	1	-	-	-
	Wage income	-0.01	1	-	-
	Pensions	0.19	-0.001	1	-
	Transfers	0.005	-0.005	0.003	1
	Total income (without transf.)	0.91	0.22	0.51	-0.005

from 0.31 to 2.76, with a household average of 0.86 (0.84 on average in Punjab and Sind and 0.90 in the North West Frontier Province). On the contrary, the coefficients of variation of household consumption are much lower, ranging from 0.009 to 1.98 with an average of 0.40. The graph (1) show the coefficients of variation of household income ranked by increasing value and the corresponding coefficients of variation of consumption (food, of non durable). We observe that the point estimates of coefficients of variation for consumption are much more concentrated towards zero than that of income. Only 46 households on 927 have a consumption coefficient of variation higher than that of income (97 in the case of total non durable expenditures). Thanks to the available data, we can

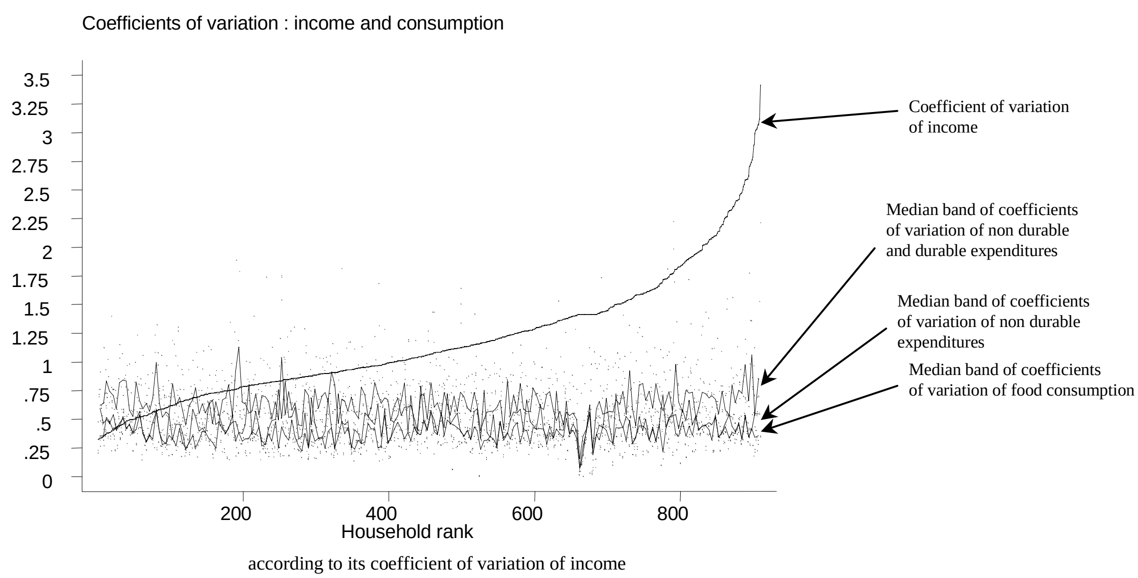

Figure 1: Individual coefficients of time variation of income and consumption

compute the consumption expenditures in durable goods as well as non durable goods. Assuming that instantaneous utility is separable between durable and non durable goods, we can estimate the model using non durable expenditures as our consumption variable. In the literature on full

[10] The per period incomes are net of production input expenditures and then can sometimes be negative. The pseudo coefficient of variation for a household i is computed as $\frac{\left(T\sum_{t=1}^{T} y_{it}^2 - \left(\sum_{t=1}^{T} y_{it}\right)^2\right)^{1/2}}{\sum_{t=1}^{T} y_{it} - T \min_{i=1,..,T}(y_{it})}$.

insurance tests, food consumption is often used (Townsend, 1994, Mace, 1991, Cochrane, 1991). Even the total non durable expenditures should be used according to the theoretical model, we perform our tests with both food and non durable expenditures.

At last, we have to take into account the seasonality of behavior. Paxson (1993) has shown the importance of seasonality in the case of Thailand data. Actually, the problem is less stringent with annual data, but here the average gap between interviews is about four months. Seasonality is a priori an important phenomenon for these rural households for calendar reasons linked to agricultural activity and religion (Islam). The agricultural activity in Pakistan is markedly affected by the Monsoon, generating two plantation and harvest seasons (Kharif for the most humid and Rabi for the driest), which dates vary with region according to latitude. For the Punjab province, the plantation period of the Rabi season is in November-December, and harvests are in march-April. The plantation period of the Kharif season is in may and July and harvests are in October and December. We have then to take into account of these seasonal effects in the various specifications because affect incomes but also mark the rural life with several celebrations (as the lights feast said *dipavali* at the end of October and many other ones), with the seasonal fluctuations of frequent pathologies (viral diseases and leishmanioses). In addition to this seasonal structure and by several celebrations from Hindus origin, seasons are affected by the religious Islamic calendar. Several reasons justify then the presence of seasonality in behavior and preferences of rural households from Pakistan.

The total populations of the 46 villages vary between 200 and 8000 inhabitants by village with an average of 1818 and a median of 1108. The average density of the population of these villages is high with 1.12 inhabitants per acre[11] i.e. 276 inhabitants by km^2 which is higher than the Pakistan average of 163 inhabitants by km^2 (World Bank, 1997).

Concerning the agrarian structure, 61% of households of this sample own a plot of land. The average area owned is 9.42 acres or approximately 3.8 hectares but less than a half of these lands are irrigated. Land rental contracts are numerous. Sharecropping is much more used than fixed rent contracts with 34.2% of households leasing in a plot of land in sharecropping against 7.3% leasing at fixed rent. Among the landowners households, 6.16% lease all or a part of their land at fixed rent and 36.9% lease all or a part of their land by sharecropping. Sharecropping contracts are prevalent and crucial in the agrarian structure of this country. Moreover, the risk sharing properties of sharecropping are often invoked. Actually, the production being shared between the landlord

[11] 1 acre = 4046.86 m^2.

and the sharecropper, they mutually insure themselves in this relationship. It is then probable that these agricultural contracts play a significant role in the risk allocation. In the case where markets were incomplete, this institution can allow to improve the insurance portfolio of households which can be tested by evaluating the degree of risk sharing obtained by households using these contracts. If the complete markets hypothesis is rejected, it is then interesting to test if sharecropping enable to improve risk sharing or not.

3.2. Empirical tests of full insurance

Thanks to these data from Pakistan, we implement the empirical tests proposed previously. We also used the method of Townsend (1994) which allows to compare the empirical results from each method. The graph ?? shows the estimated coefficients from household level time series of consumption on average village consumption and individual income. The hypothesis that this coefficient is equal to one is accepted for 75% of households (with food consumption and 74% with non durable expenditures) but the power of this test is relatively weak (although our estimated standard error be better than that of Townsend, 1994) because the hypothesis that the coefficient is for example equal 0.5 would also be rarely rejected. Moreover, the hypothesis that the income coefficient is equal to zero is also rarely rejected (only 7% of households in the case of food consumption and 5.9% for non durable expenditures). Given the standard errors and the method of test, the probability to accept a wrong hypothesis (type II error) is high.Our method allows to provide much more

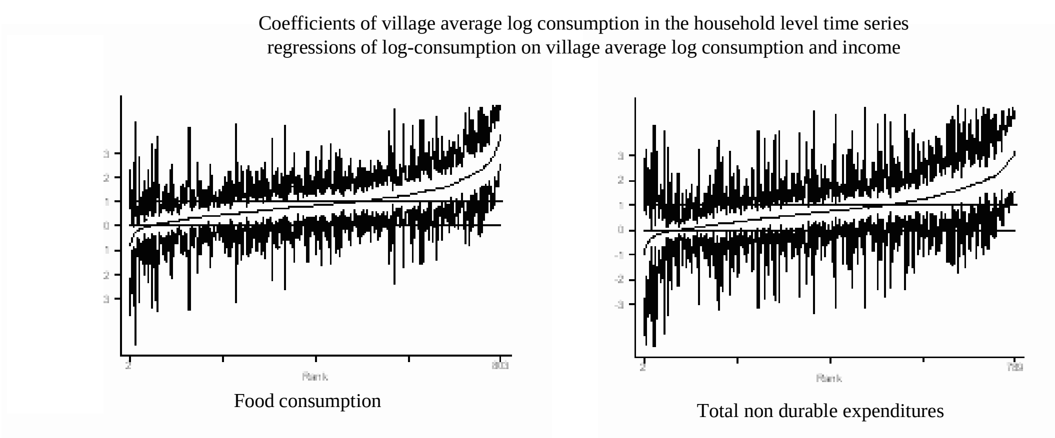

Figure 2: Coefficients on household time series

powerful tests of the within and between or within village full insurance property without being forced to do strong homogeneity assumptions on preferences.

The empirical tests consist in estimating equations (9) and (10) with the instrumental variables two stage least squares method described in section 2.2. In this empirical study, we first successively test three hypothesis: the full insurance hypothesis for all households from the 46 villages of 3 provinces of Pakistan, the within-province full insurance, and the within village full insurance. In the previous section, we have seen that under the null hypothesis, the instrumental variables for $-z_{it+1}\Delta\ln\widetilde{c_{it+1}}-\ln\widetilde{c_{it}}\Delta z_{it+1}$ are $\Delta z_{it+1}\ln c_{it-1}$ and $z_{it}\Delta\widetilde{z_{it}}-z_{it+1}\Delta^2\widetilde{z_{it+1}}$ noted [1] to which can be added the instruments $\Delta z_{it+1}\left(z_{it+1}+z_{it}-z_{it-1}\right)\ln c_{it-1}$ and $z_{it+1}^2\Delta^2\widetilde{z_{it+1}}-z_{it}^2\Delta\widetilde{z_{it}}$ defining then the instruments set noted [2].

The instrumental regressions in appendix **??** are given for the case of within village full insurance with or without the inclusion of the income shock. They show that the instrumented variables are correctly identified because the instrumental variables are sufficiently correlated with endogenous variables. Therefore, the test of overidentifying restrictions given by Sargan statistic allows to test the null 'hypothesis of full insurance since these instruments are theoretically valid under the null hypothesis. This non directional test of the null hypothesis is implemented first with the assumption of separability between consumption and leisure in the utility function and then with the non separable specification (11) allowing to take into account labor supply. When labor supply is used in the regressions, the doubly lagged variables for male and female household labor supply are introduced among the instruments: l_{it-1}^m, l_{it-1}^f. For the idiosyncratic shocks variables, we use household incomes. So as to take into account for measurement errors in income, we use the rental incomes as instruments for agricultural benefits. This instrument appears to be very informative because sufficiently correlated with agricultural profits (see instrumental regression in Table 2 of appendix **??**), which enable to identify the parameter δ of agricultural profit with more precision because estimations without instrumenting are biased and very imprecise. When income is not instrumented, the estimated parameter $\widehat{\delta}$ is much more closer to zero and its standard error is twice or four times larger. Moreover, the tested hypothesis is that the idiosyncratic non anticipated income shock has a significative effect on marginal utility of consumption. The difficulty is to find good measures of idiosyncratic shocks otherwise the test will be powerless. By choosing to instrument agricultural income with rental incomes which are perfectly anticipated, we get a better measure of the unanticipated production shock undergone by the household.

For the exogenous characteristic variables of households z_{it+1} and $\widetilde{z_{it+1}}$, we chose demographic and patrimonial characteristics (owned land). The estimations presented show the case where these variables are household size, number of children in household and irrigated owned land per household adult equivalent[12]. This specification results from a preliminary research that showed that other demographic characteristics or that on the composition of owned land do not bring additional information in the regressions but only raise uselessly the number of parameters to be estimated[13].

Table 3: Results of within and between village full insurance tests

	Dependent variable : $\Delta \widetilde{\ln c_{it+1}}$							
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
θ: z_{it+1}								
Number of children	0.083	0.077	0.067	0.062	0.090	0.084	0.078	0.075
	(2.86)	(2.63)	(2.22)	(2.03)	(3.69)	(3.48)	(3.13)	(2.98)
Household size	-0.060	-0.060	-0.052	-0.052	-0.073	-0.075	-0.068	-0.070
	(3.56)	(3.36)	(2.97)	(2.81)	(5.16)	(5.36)	(4.68)	(4.87)
Irrigated owned land./ad. eq.	-0.017	-0.020	-0.015	-0.018	-0.029	-0.028	-0.032	-0.030
	(1.04)	(1.26)	(0.93)	(1.10)	(2.34)	(2.41)	(2.53)	(2.54)
Seasonal dummies								
1: Winter	-0.073	-0.088	-0.070	-0.082	-0.078	-0.091	-0.075	-0.087
	(3.19)	(2.92)	(2.98)	(2.67)	(3.89)	(4.06)	(3.71)	(3.84)
2: Rabi Harvest	-0.133	-0.130	-0.136	-0.132	-0.125	-0.123	-0.127	-0.125
	(5.06)	(4.57)	(5.02)	(4.49)	(5.44)	(5.35)	(5.43)	(5.32)
3: Monsoon	-0.114	-0.127	-0.102	-0.113	-0.110	-0.120	-0.100	-0.110
	(4.38)	(3.78)	(3.79)	(3.23)	(4.84)	(4.74)	(4.30)	(4.22)
4: (reference): Kharif harvest								
α: $\widetilde{z_{it+1}}$								
Number of children	0.455	0.415	0.367	0.336	0.491	0.456	0.426	0.401
	(2.87)	(2.60)	(2.22)	(2.01)	(3.67)	(3.42)	(3.10)	(2.92)
Household size	-0.297	-0.296	-0.253	-0.252	-0.374	-0.383	-0.344	-0.355
	(3.15)	(2.91)	(2.58)	(2.39)	(4.71)	(4.87)	(4.23)	(4.38)
Irrigated owned land./ad. eq.	-0.069	-0.078	-0.064	-0.070	-0.128	-0.122	-0.140	-0.132
	(0.94)	(1.09)	(0.84)	(0.95)	(2.24)	(2.25)	(2.45)	(2.39)
Seasonal dummies								
1: Winter	-0.352	-0.464	-0.338	-0.433	-0.382	-0.476	-0.371	-0.458
	(2.91)	(2.70)	(2.73)	(2.47)	(3.61)	(3.84)	(3.45)	(3.63)
2: Rabi Harvest	-0.645	-0.638	-0.653	-0.639	-0.609	-0.611	-0.614	-0.616
	(4.66)	(4.07)	(4.60)	(3.98)	(5.03)	(4.92)	(5.00)	(4.87)
3: Monsoon	-0.545	-0.652	-0.476	-0.571	-0.535	-0.625	-0.479	-0.567
	(3.86)	(3.30)	(3.25)	(2.77)	(4.33)	(4.32)	(3.78)	(3.79)
4: (reference): Kharif harvest								
γ								
l^f_{it+1} : female labor		-0.109		-0.092		-0.104		-0.099
		(0.72)		(0.60)		(1.25)		(1.17)
l^m_{it+1} : male labor		-0.105		-0.102		-0.060		-0.053
		(1.52)		(1.46)		(1.45)		(1.26)
δ: ω_{it+1}								
Agricultural profit			$5.98\ 10^{-5}$	$5.52\ 10^{-5}$			$4.73\ 10^{-5}$	$4.44\ 10^{-5}$
			(3.03)	(2.82)			(2.91)	(2.86)
Instruments	[1]	[1]	[1]	[1]	[2]	[2]	[2]	[2]
Inst. of labor supplies l^m_{it-1}, l^f_{it-1}		*		*		*		*
Degrees of freedom: #	12	12	12	12	21	21	21	21
Sargan Statistic :$\chi_2(\#)$	29.4*	39.4*	22.3*	31.1*	54.7*	70.4*	47.3*	60.9*
Observations	7740	7731	7740	7731	7740	7731	7740	7731

Full insurance

The Table 3 show the results of estimations providing the test of complete markets within the

[12] We use the definition of Townsend (1994) for the equivalence scales (see details in appendix 5.1) but the results change only very slightly when we use other equivalence scales or simply the household size. We kept the measure of used by Townsend (1994) because in or case, the results were a little bit more precise wit hit.

[13] The results presented in all tables are estimates in which all variables are projected on the space orthogonal to the one generated by the corresponding dummy variables that should be included in the right hand side of the regression (as already explained, we use Frisch Waugh theorem). Hence, the coefficient estimates of dummies do not appear in the results.

three provinces of Pakistan surveyed (Punjab, Sind and the NWPF). The tests of overidentifying restrictions are easily rejected by the Sargan statistic[14], rejecting then the null hypothesis of full insurance between households of Pakistan. This result is not very surprising, but it allows to show that the power of the tests of overidentifying restrictions is sufficiently high to reject the complete markets hypothesis in Pakistan. We also know that when we increase the number of instruments, the problem of weak instruments leading to powerless tests of size zero becomes more probable (Bound, Jaeger and Baker, 1995, Staiger and Stock, 1997). We seek to avoid this problem and prefer to limit the number of instruments and keep instruments which level of significance in instrumental regressions is sufficiently high. Of course, the choice of this minimum admissibility level for instruments is arbitrary, but our results with the set of instruments [1] and [2] are relatively robust compared to this minimum level. As shown by the results of Table 3, full insurance is also rejected by the directional tests testing the idiosyncratic income shocks have an effect on changes of marginal utility of household consumption.

Within province full insurance

The estimates of Table 4 allow to test the within Province complete markets hypothesis in Pakistan (provinces are Punjab, Sind and NWFP). The overidentifying restrictions tests given by Sargan statistic, reject the within province full insurance whatever be the specification introduced (with or without labor supply). As for the preceding tests, the directional tests show that a positive agricultural income shock increases significantly household consumption which induces a rejection of the complete markets hypothesis. Finally, the estimated parameters show that household risk aversion increases with the number of children in the household, decreases with household size and the owned irrigated land per adult equivalent. Since within province full insurance is rejected, we can test the within village complete markets hypothesis. It may happen that households manage actually to insure themselves against risks with borrowing, lending, solidarity networks, credit and other mechanisms within the village, because for example informational asymmetries between different villages prevent the enforcement and realization of such insurance transactions. The within village complete markets hypothesis is the usual hypothesis tested for rural developing countries where economic life occurs mostly at the village level (Townsend, 1994) and because it seems a priori more plausible than the complete markets hypothesis at a country level.

[14] The sign * means a rejection of the null hypothesis at the critical level of 5%. The 5% critical levels of χ^2 distributions according to their degrees of freedom are the following:

#	1	2	3	4	5	6	7	8	9	10	11	12	21
$\chi^2_{.05}$	3.84	5.99	7.81	9.49	11.07	12.59	14.07	15.51	16.92	18.31	19.67	21.03	32.67

Table 4: Results of within province full insurance tests

Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependant variable: $\Delta\ln\widetilde{c}_{it+1}$							
θ: z_{it+1}								
Number of children	0.075	0.087	0.060	0.075	0.078	0.088	0.067	0.079
	(2.80)	(2.78)	(2.18)	(2.31)	(3.28)	(3.11)	(2.74)	(2.72)
Household size	-0.062	-0.069	-0.055	-0.063	-0.069	-0.071	-0.064	-0.067
	(4.02)	(3.84)	(3.45)	(3.38)	(4.99)	(4.41)	(4.51)	(4.07)
Irrigated owned land./ad. eq.	-0.022	-0.022	-0.021	-0.020	-0.031	-0.025	-0.033	-0.028
	(1.50)	(1.33)	(1.39)	(1.18)	(2.56)	(1.86)	(2.75)	(2.02)
Seasonal dummies								
1: Winter	-0.078	-0.093	-0.071	-0.085	-0.083	-0.094	-0.077	-0.087
	(3.04)	(3.16)	(2.69)	(2.78)	(3.54)	(3.49)	(3.23)	(3.18)
2: Rabi harvest	-0.093	-0.094	-0.092	-0.088	-0.100	-0.099	-0.100	-0.095
	(2.57)	(2.12)	(2.48)	(1.94)	(2.98)	(2.46)	(2.95)	(2.35)
3: Monsoon	-0.120	-0.111	-0.111	-0.100	-0.116	-0.115	-0.109	-0.106
	(3.44)	(2.65)	(3.10)	(2.33)	(3.61)	(3.06)	(3.33)	(2.78)
4: (reference): Kharif harvest								
α: $\widetilde{z}_{it+1}$								
Number of children	0.399	0.463	0.319	0.398	0.417	0.471	0.354	0.419
	(2.72)	(2.70)	(2.10)	(2.24)	(3.18)	(3.01)	(2.63)	(2.63)
Household size	-0.307	-0.348	-0.271	-0.315	-0.348	-0.359	-0.320	-0.336
	(3.57)	(3.39)	(3.02)	(2.97)	(4.50)	(3.93)	(4.04)	(3.61)
Irrigated owned land/ad. eq.	-0.102	-0.096	-0.097	-0.089	-0.141	-0.113	-0.153	-0.124
	(1.52)	(1.27)	(1.43)	(1.15)	(2.59)	(1.80)	(2.78)	(1.98)
Seasonal dummies								
1: Winter	-0.398	-0.542	-0.360	-0.493	-0.428	-0.533	-0.396	-0.494
	(2.97)	(3.34)	(2.61)	(2.94)	(3.46)	(3.67)	(3.15)	(3.34)
2: Rabi harvest	-0.479	-0.511	-0.465	-0.470	-0.516	-0.532	-0.508	-0.506
	(2.50)	(2.16)	(2.37)	(1.93)	(2.91)	(2.48)	(2.84)	(2.33)
3: Monsoon	-0.604	-0.603	-0.544	-0.527	-0.586	-0.617	-0.539	-0.556
	(3.17)	(2.55)	(2.78)	(2.16)	(3.35)	(2.93)	(3.03)	(2.59)
4: (reference): Kharif harvest								
γ								
l^f_{it+1} : Female labor		-0.415		-0.409		-0.326		-0.319
		(2.86)		(2.77)		(3.28)		(3.17)
l^m_{it+1} : Male labor		0.098		0.115		0.072		0.085
		(1.07)		(1.22)		(0.99)		(1.15)
δ: ω_{it+1}								
Agricultural income			$5.35\ 10^{-5}$	$5.04\ 10^{-5}$			$4.52\ 10^{-5}$	$4.41\ 10^{-5}$
			(2.89)	(2.39)			(2.80)	(2.40)
Instruments	[1]	[1]	[1]	[1]	[2]	[2]	[2]	[2]
Inst. labor supply l^m_{it-1}, l^f_{it-1}		*		*		*		*
Degrees of freedom: #	12	12	12	12	21	21	21	21
Sargan statistic: $\chi_2(\#)$	43.0*	27.8*	36.1*	22.3*	62.0*	39.5*	55.1*	34.6*
Observations	7740	7731	7740	7731	7740	7731	7740	7731

Within village full insurance

The parameters $\widehat{\alpha}$ corresponding to seasonal dummy variables cannot be identified in this case because they are absorbed by the village-time fixed effects not reported in Table 5. In the presented results, we chose a reasonable degree of significance for the selection of instruments. Even if we have been very cautious in the choice of instrumental variables and always have checked that they were sufficiently informative with the problem of weak instruments in mind, we always did the experiment to raise the arbitrary level of significance for which we find the instruments acceptable in our instrumental regressions. Then we of course we loose some instruments but the results remained similar with respect to our inference of interest (i.e. the signs and significance of coefficients) and coefficients were not significantly different while the minimum level required for Student statistics to keep and instrument (of the defined sets [1] and [2]) was not more than

2.2. When raising even more this level, the estimated coefficients, change more and more but they remain not significantly different. When continuing to select the most informative coefficients to look at the robustness of identification, we finally diminish drastically the number of degrees of freedom and the model becomes under-identified. The choice of instruments is therefore crucial and needs a particular attention to Fisher statistics and correlations estimated in instrumental regressions (the instrumental regressions of column (5) of Table 5 are reported in ??).

The columns (1) and (5) of Table 5 show the estimation of the model under the null hypothesis as well as the overidentifying restrictions test (Sargan statistic) which reject the within village complete markets hypothesis. However, the estimated parameters are much less precise in that case when instruments [1] only are used. In the consumption leisure non separable case (columns (2) and (6) of Table 5), the overidentifying restrictions test is not always rejected. This non directional test does not allow to reject the within village complete markets hypothesis. But, the directional tests allow to reject within village full insurance because agricultural income shocks (instrumented by rental incomes)have a significant effect on household consumption changes.

Table 5: Results of within village full insurance tests

	Dependant variable: $\Delta \widetilde{\ln c_{it+1}}$							
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
θ: z_{it+1}								
Number of children	0.054	0.060	0.042	0.057	0.060	0.072	0.052	0.065
	(1.44)	(1.50)	(1.17)	(1.48)	(2.05)	(2.20)	(1.86)	(2.11)
Household size	-0.018	-0.022	-0.019	-0.031	-0.038	-0.042	-0.038	-0.044
	(0.76)	(0.83)	(0.86)	(1.26)	(2.19)	(2.25)	(2.30)	(2.43)
Irrigated owned land/ad. eq.	-0.012	-0.012	-0.013	-0.012	-0.027	-0.024	-0.031	-0.027
	(0.56)	(0.58)	(0.70)	(0.63)	(1.88)	(1.53)	(2.21)	(1.86)
Seasonal dummies								
1: Winter	-0.104	-0.109	-0.115	-0.133	-0.133	-0.141	-0.141	-0.151
	(1.56)	(1.57)	(1.86)	(2.03)	(2.54)	(2.47)	(2.83)	(2.80)
2: Rabi harvest	-0.029	-0.028	-0.061	-0.058	-0.076	-0.067	-0.098	-0.091
	(0.33)	(0.31)	(0.75)	(0.70)	(1.08)	(0.89)	(1.51)	(1.31)
3: Monsoon	-0.159	-0.149	-0.165	-0.125	-0.169	-0.142	-0.175	-0.152
	(2.20)	(1.58)	(2.44)	(1.39)	(2.94)	(2.22)	(3.20)	(2.51)
4: (reference): Kharif harvest								
α: $\widetilde{z}_{it+1}$								
Number of children	0.295	0.326	0.222	0.308	0.321	0.387	0.278	0.351
	(1.42)	(1.48)	(1.13)	(1.45)	(2.00)	(2.15)	(1.80)	(2.05)
Household size	-0.052	-0.079	-0.060	-0.133	-0.172	-0.196	-0.174	-0.204
	(0.39)	(0.52)	(0.49)	(0.94)	(1.76)	(1.82)	(1.86)	(2.00)
Irrigated owned land/ad. eq.	-0.054	-0.055	-0.064	-0.059	-0.127	-0.110	-0.143	-0.128
	(0.58)	(0.59)	(0.74)	(0.67)	(1.92)	(1.54)	(2.27)	(1.89)
γ								
l^f_{it+1} : Female labor		-0.072		-0.306		-0.231		-0.209
		(0.15)		(0.70)		(1.52)		(1.44)
l^m_{it+1} : Male labor		0.047		0.141		0.073		0.085
		(0.30)		(0.91)		(0.68)		(0.82)
δ: ω_{it+1}								
Agricultural income			$6.47\ 10^{-5}$	$6.61\ 10^{-5}$			$4.44\ 10^{-5}$	$4.50\ 10^{-5}$
			(2.54)	(2.42)			(2.27)	(2.11)
Instruments	[1]	[1]	[1]	[1]	[2]	[2]	[2]	[2]
Inst. labor supply l^m_{it-1}, l^f_{it-1}		*		*		*		*
Degrees of freedom: #	3	3	3	3	12	12	12	12
Sargan statistic: $\chi_2(\#)$	0.225	0.157	1.505	0.864	12.89	8.57	14.90	10.81
Observations	7740	7731	7740	7731	7740	7731	7740	7731

Preferences

At last, the estimated parameters show that household risk aversion increases with the number of children, decreases with owned irrigated land per adult equivalent. These empirical facts can be interpreted by the fact that when the household is larger, the within household solidarity allows them to diversify their activities and better insure themselves. However, we have to be prudent with this interpretation because a collective household model would be more relevant than the unitary household model used hereto explain that a larger household can share risk more efficiently. Moreover, the number of children within the household increases risk aversion which can be interpreted by the fact that children are more sensitive to consumption variations for example because of physiological or medical reasons. Households owning more land (per adult equivalent) are less risk averse. It can be interpreted by the usual wealth effect implying in general that household risk aversion decreased in function of owned assets. The fact that household risk aversion depends on its characteristics probably means in itself that markets are incomplete unless we interpret this as individual correlated heterogeneity such that the more risk averse individuals have more children, that less risk averse create and remain into larger households and that less risk averse ones are also the wealthier (in terms of land owning). This interpretation is difficult to support and would probably prefer the first one even if it is not impossible. However, we here reach the limits of our economic and économétriqu model of unitary households in the analysis of risk sharing.

In addition, the estimated parameters for seasonal dummies show that households are more risk averse during the Kharif harvest period i.e. after the Monsoon. This period is the fourth trimester of the year and is the period of the more important and risky harvest of the year. This season also corresponds to the period where numerous traditional feasts occur. It seems that this period is a crucial one during the year and has then an influence on household preferences during them more risk averse[15].

Then, the estimation of parameters $\widehat{\alpha}$ parameterizing household preferences having a constant relative risk aversion, show that the marginal utility of consumption increases with household size and with its wealth in terms of owned irrigated land per adult equivalent.

At last in the case of non separability between consumption and leisure, the labor supply parameters are quite imprecisely estimated. The results on other coefficients of interests are very slightly modified. It seems for instance that separability between consumption and leisure can be accepted for these rural households of Pakistan conditionally to the chosen specification taking into account

[15] For other periods, it seems that during the Monsoon and winter, households are a bit more risk averse than during the Rabi harvest, but the estimated coefficients are not significantly different.

preferences heterogeneity[16].

3.3. Insurance and sharecropping

The within village complete markets hypothesis being rejected, we are interested in the diverse alternatives with respect to the consumption smoothing mechanisms involved in an incomplete markets environment.

Partial insurance and sharecropping contracts

The risk sharing properties of sharecropping contracts are often invoked (Stiglitz, 1974, Otsuka, Chuma, Hayami, 1992). For these Rural household from Pakistan, sharecropping contracts are relatively frequent. More than 35% of households surveyed actually were renting in some piece of land by sharecropping. It seems ten interesting to test if households participating to sharecropping contracts manage to better insure themselves against risk. We want to test if the risk sharing mechanism provided by sharecropping contracts allows to complete at least partially the risk sharing and insurance markets because there may not exist other institution allowing to replicate the market portfolio as the one generated by a sharecropping contract. Jalan and Ravallion (1999) showed that wealthier households succeed in insuring themselves much better than poor households. Townsend (1994) showed that landless households were much less insured than landowners. In addition, the risk sharing properties of sharecropping have never been studied empirically, neither in the contract literature, nor in the consumption smoothing literature. Full insurance is globally rejected but we can wonder if it would also be for sharecroppers or non sharecroppers. The results of Table 6 show that sharecroppers are better protected against income shocks[17].

Then, we realize the same tests but without constraining the other coefficients to be the same in the model fro sharecroppers and non sharecroppers. Instead of decomposing the effect of income shocks for these two groups with a sharecropping dummy, we estimate the model on both groups separately. The Table 7 show the results. Each specification is first estimated with the instruments set [2] and then with a selection of the most informative ones from this set. This is to take care about a possible weak instrumentation problem that we seek to avoid and could be more problematic with the smaller sample size of these two groups. The estimations show that the results with these two sets of instruments are comparable. We remark that the non directional tests do not reject full insurance for the group of sharecroppers but that directional tests made with agricultural

[16] But this result may be only due to a lack of precision in the estimations for example because of measurement errors on labor supply.

[17] I sharecropper is a dummy variable equal to one if the household is renting in some land with sharecropping and zero otherwise.

profit shock reject it whatever be the specification chosen (with or without consumption leisure separability).

However, for the sharecroppers, full insurance is not rejected, neither by the non directional test, nor by the directional test with agricultural profit. For this group of sharecropper, the consumption leisure separability is rejected (see column (7) of Table 7) although the results seem not very robust to the number of instruments (column (8) of Table 7). In Table 7, the instruments set [2] is used with twice lagged labor supply for the odd number columns. For the even number columns, we reduced the set of instruments keeping only the most informative ones (according to instrumental regressions) in order to test if results were robust to instrumentation. In this Table, we show the specification with labor supply and income shock test but the results were similar with other specifications and did not modify the interpretable results.

It seems that sharecropping is an institution able to complete markets within the village. By this king of formal contract, households seem to succeed in reducing sufficiently the agricultural risk to be fully insured against these income idiosyncratic shocks. The non directional tests allow to say that full insurance against all shocks (not only agricultural income) is accepted for sharecroppers but it would be interesting to test against other directions to get a more powerful inference about insurance against all the possible idiosyncratic shocks affecting households.

Table 6: Within village full insurance tests for sharecroppers and non sharecroppers

	Dependant variable: $\Delta \ln \widetilde{c}_{it+1}$							
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
θ: z_{it+1}								
Number of children	0.054	0.060	0.024	0.033	0.060	0.072	0.035	0.048
	(1.44)	(1.50)	(0.61)	(0.55)	(2.05)	(2.20)	(1.10)	(1.41)
Household size	-0.018	-0.022	-0.016	-0.021	-0.038	-0.042	-0.029	-0.035
	(0.76)	(0.83)	(0.72)	(0.64)	(2.19)	(2.25)	(1.54)	(1.80)
Irrigated owned land/ad. eq.	-0.012	-0.012	-0.017	-0.016	-0.027	-0.024	-0.028	-0.028
	(0.56)	(0.58)	(0.88)	(0.80)	(1.88)	(1.53)	(1.89)	(1.84)
Seasonal dummies								
1: Winter	-0.104	-0.109	-0.083	-0.096	-0.133	-0.141	-0.104	-0.121
	(1.56)	(1.57)	(1.19)	(0.99)	(2.54)	(2.47)	(1.83)	(2.03)
2: Rabi harvest	-0.029	-0.028	-0.058	-0.054	-0.076	-0.067	-0.080	-0.077
	(0.33)	(0.31)	(0.72)	(0.67)	(1.08)	(0.89)	(1.12)	(1.08)
3: Monsoon	-0.159	-0.149	-0.152	-0.156	-0.169	-0.142	-0.163	-0.159
	(2.20)	(1.58)	(2.23)	(1.47)	(2.94)	(2.22)	(2.73)	(2.57)
4: (reference): Kharif harvest								
α: $\widetilde{z}_{it+1}$								
Number of children	0.295	0.326	0.116	0.170	0.321	0.387	0.173	0.249
	(1.42)	(1.48)	(0.52)	(0.50)	(2.00)	(2.15)	(0.98)	(1.31)
Household size	-0.052	-0.079	-0.043	-0.075	-0.172	-0.196	-0.119	-0.156
	(0.39)	(0.52)	(0.35)	(0.42)	(1.76)	(1.82)	(1.13)	(1.41)
Irrigated owned land/ad. eq.	-0.054	-0.055	-0.078	-0.079	-0.127	-0.110	-0.131	-0.128
	(0.58)	(0.59)	(0.89)	(0.84)	(1.92)	(1.54)	(1.90)	(1.86)
γ								
l^f_{it+1} : Female labor		-0.072		0.008		-0.231		-0.076
		(0.15)		(0.01)		(1.52)		(0.42)
l^m_{it+1} : Male labor		0.047		0.090		0.073		0.083
		(0.30)		(0.50)		(0.68)		(0.78)
δ: ω_{it+1}								
Agricultural income*(1-I sharecropper)			$6.27\ 10^{-5}$	$6.63\ 10^{-5}$			$5.23\ 10^{-5}$	$5.32\ 10^{-5}$
			(2.49)	(2.52)			(2.44)	(2.36)
Agricultural income*(I sharecropper)			$-3.16\ 10^{-4}$	$-2.8\ 10^{-4}$			$-3.16\ 10^{-4}$	$-2.5\ 10^{-4}$
			(0.79)	(0.41)			(1.69)	(1.13)
Instruments	[1]	[1]	[1]	[1]	[2]	[2]	[2]	[2]
Inst. labor supply l^m_{it-1}, l^f_{it-1}		*		*		*		*
Degrees of freedom: #	3	3	2	2	12	12	11	11
Sargan statistic: $\chi_2(\#)$	0.22	0.16	0.64	0.67	12.89	8.57	8.94	8.64
Observations	7740	7731	7740	7731	7740	7731	7740	7731

Table 7: Within village full insurance tests for sharecroppers and non sharecroppers

Dependant variable: $\Delta \ln \widetilde{c_{it+1}}$	Sharecroppers								Non sharecroppers							
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
θ: z_{it+1}																
Number of children	0.021	0.032	0.035	0.025	0.022	0.047	0.023	0.087	0.068	0.075	0.095	0.097	0.054	0.080	0.081	0.101
	(0.80)	(0.87)	(0.44)	(0.24)	(0.75)	(1.26)	(0.41)	(0.16)	(1.94)	(1.89)	(2.17)	(2.02)	(1.47)	(1.96)	(1.97)	(2.14)
Household size	-0.067	-0.097	-0.109	-0.104	-0.086	-0.090	-0.107	-0.10	-0.053	-0.063	-0.068	-0.073	-0.046	-0.062	-0.063	-0.074
	(4.46)	(4.48)	(2.38)	(2.43)	(4.48)	(4.11)	(3.04)	(2.89)	(2.56)	(2.72)	(2.63)	(2.65)	(2.14)	(2.52)	(2.58)	(2.63)
Irrigated owned land/ad. eq.	-0.135	-0.163	0.015	-0.076	-0.160	-0.147	-0.014	0.086	-0.024	-0.023	-0.013	-0.016	-0.026	-0.026	-0.017	-0.017
	(1.92)	(2.04)	(0.07)	(0.30)	(2.01)	(1.87)	(0.08)	(0.05)	(1.97)	(2.00)	(0.86)	(1.05)	(2.10)	(2.10)	(1.18)	(1.16)
Seasonal dummies																
1: Winter	-0.186	-0.180	-0.478	-0.382	-0.227	-0.189	-0.377	-0.33	-0.177	-0.144	-0.149	-0.138	-0.168	-0.171	-0.152	-0.157
	(4.16)	(3.60)	(2.54)	(1.64)	(4.14)	(3.19)	(2.94)	(2.59)	(2.83)	(2.30)	(1.89)	(1.89)	(2.64)	(2.68)	(2.08)	(2.15)
2: Rabi harvest	-0.238	-0.200	-0.242	-0.217	-0.246	-0.226	-0.246	-0.25	-0.128	-0.076	-0.137	-0.099	-0.137	-0.123	-0.153	-0.140
	(4.28)	(3.29)	(1.58)	(1.51)	(3.92)	(3.91)	(2.21)	(2.44)	(1.59)	(0.95)	(1.34)	(1.01)	(1.72)	(1.54)	(1.63)	(1.47)
3: Monsoon	-0.175	-0.079	-0.176	-0.123	-0.119	-0.138	-0.124	-0.14	-0.142	-0.106	-0.056	-0.057	-0.140	-0.138	-0.077	-0.079
	(3.49)	(1.33)	(1.30)	(0.95)	(1.89)	(1.99)	(1.12)	(1.36)	(2.04)	(1.52)	(0.58)	(0.61)	(1.98)	(1.97)	(0.85)	(0.85)
4: (reference): Kharif harvest																
α: $\widetilde{z}_{it+1}$																
Number of children	0.122	0.191	0.310	0.225	0.145	0.265	0.215	0.12	0.365	0.398	0.507	0.519	0.279	0.426	0.429	0.539
	(0.85)	(0.95)	(0.72)	(0.44)	(0.90)	(1.36)	(0.69)	(0.42)	(1.85)	(1.80)	(2.07)	(1.94)	(1.36)	(1.85)	(1.86)	(2.04)
Household size	-0.35	-0.517	-0.636	-0.593	-0.456	-0.475	-0.610	-0.55	-0.265	-0.323	-0.344	-0.378	-0.225	-0.309	-0.319	-0.382
	(4.20)	(4.34)	(2.38)	(2.40)	(4.27)	(3.86)	(3.00)	(2.85)	(2.21)	(2.41)	(2.31)	(2.38)	(1.79)	(2.20)	(2.26)	(2.35)
Irrigated owned land/ad. eq.	-0.724	-0.886	0.034	-0.435	-0.889	-0.804	-0.153	-0.002	-0.112	-0.112	-0.060	-0.073	-0.121	-0.120	-0.079	-0.081
	(2.08)	(2.24)	(0.03)	(0.33)	(2.23)	(2.00)	(0.18)	(0.03)	(2.01)	(2.07)	(0.80)	(1.02)	(2.14)	(2.15)	(1.14)	(1.13)
γ																
l^{f}_{it+1} : Female labor			0.301	0.198			0.208	0.358			-0.555	-0.406			-0.452	-0.430
			(0.95)	(0.33)			(0.81)	(0.90)			(1.78)	(1.09)			(1.55)	(1.25)
l^{m}_{it+1} : Male labor			0.855	0.601			0.470	0.442			0.143	0.117			0.132	0.137
			(1.99)	(1.05)			(1.97)	(0.98)			(1.20)	(1.02)			(1.20)	(1.23)
δ: ω_{it+1}					$1.4\ 10^{-4}$	$5.8\ 10^{-5}$	$1.1\ 10^{-4}$	$1.0\ 10^{-4}$					$4.0\ 10^{-5}$	$4.2\ 10^{-5}$	$3.8\ 10^{-5}$	$4.1\ 10^{-5}$
					(1.85)	(0.53)	(0.76)	(0.39)					(2.31)	(2.42)	(1.87)	(2.00)
Inst. labor supply l^{m}_{it-1},l^{f}_{it-1}			*	*			*	*			*	*			*	*
Degrees of freedom: #	12	9	12	9	12	9	12	9	12	7	12	6	12	8	12	7
Sargan statistic: $\chi_2(\#)$	55.1*	41.1*	3.2	3.1	40.3*	25.1*	10.1	8.1	16.7	9.7	6.8	5.5	14.6	11.8	8.3	6.6
Observations	2520	2520	2519	2519	2520	2520	2519	2519	4814	4814	4806	4807	4814	4814	4806	4807

4. Conclusion and future research

In this paper, we implement some tests of the complete markets hypothesis for rural households of Pakistan thanks to panel data on consumption and incomes. In order to take into account the heterogeneity of preferences, we parameterize household utility functions with observable characteristics. Under the complete markets hypothesis, the marginal utility of consumption must be equal to the product of a household specific effect and a time effect. We show how to estimate the preference parameters under this null hypothesis with an instrumental variables technique. The overidentifying restrictions test of the theoretically valid instruments under the null hypothesis provide then a non directional test of the null hypothesis. These non directional tests reject the within and between provinces full insurance but not the within village full insurance. We then use a directional test which allow to reject the within village complete markets hypothesis. The directional tests consist in testing if some idiosyncratic shocks affect the household marginal utility of consumption. We implement this test again by estimating simultaneously the household preference parameters allowing for risk aversion heterogeneity. The complete markets hypothesis is globally rejected even within the village thogh the informational asymetries and commitment problems, which could limit the possibility of informal insurance be usually considered less important at teh village level. We then analyze the possibility that the sharecropping institution, a formal contract providing some risk sharing between a landlord and a sharecropper, allow to complete markets. The empirical results suggest actually that households participating to these sharecropping contracts manage to better insure themselves against agricultural income risk. It seems that the formal sharecropping contracts allow to complete the accessible markets for households within the village.

These results show that formal and informal institutions allowing to share risk are linked. Actually, the formal sharecropping contracts alone cannot provide full insuranc to ehouseholds. If the complete markets hypothesis is accepted for the group of sharecroppers and not for others, it means that informal solidarity mechanisms, like credit and informal loans between relatives or any kind of savings allow to realize the contingent transfers necessary to insure households from idiosyncratic risks. Only households participating to sharecropping manage to be fully insured with these complementary mechanisms. Either sharecropping indirectly improves the functioning of these mechanisms for those participating to sharecropping or it directly generates state contingent security impossible to replicate with other available securities. In both cases, we can say that sharecropping do really complete markets. This reduced form evidence obviously opens several questions regarding the very role of sharecropping institutions or other kinds of institutions in the functioning of all informal insurance mechanisms used in developing countries when markets are incomplete.

From a theoretical point of view, it will be interesting to develop a structural model defining the way formal and informal contracts interact when markets are incomplete because of limited commitment constraints or informational asymmetries (Dubois, 1999). When commitment is limited, the set of Pareto efficient allocations implementable by informal transfers is constrained (Thomas and Worrall, 1988, Ligon, Thomas and Worrall, 1997). A possible mean to reduce the effect of these constraints is then to use some formal contracts, for example sharecropping, for which the ex post enforcement of the contract is credible ex ante (before the realization of shocks). Formal contracts allow to solve the commitment problems of informal transfers between households but they cannot provide full insurance as they may only be contingent for example to some production variable and not to other characteristics of the state of the world (for example the disease of some household members, the income shocks on other sources of income). The simultaneous modelization of formal contracts and informal transfers (with for example limited commitment) seems a potentially interesting research direction to explain the degree of consumption smoothing achieved by rural households of developing countries and the insurance mechanisms in play in an incomplete markets environment.

5. Appendix

5.1. Data construction

The data provided by IFPRI consist of a sample of 927 households (in first round) interviewed 12 times between 1986 and 1989. To get the variables of interest for this study, we have had to construct some of them from the different available data files. First, the household demographic variables were obtained easily the individual data available. Household food consumption was initially available for each good in quantity and value or quantity with price. Food consumption consist in food expenditures for all members of the household for meals at home including the owned production consumed, the expenditures for meals taken outside but not the value of outside meals due to invitation or rewards in kind because they were not available. The non durable non food expenditures correspond mainly to heating expenditures. Other expenditures are travel expenditures, education, entertainment (very few), health, hygiene, clothes and tobacco, electricity and gas which were missing in the sample for several periods. We classified all these expenditures among durable goods.

With respect to incomes, the agricultural incomes correspond to cash income from all household agricultural productions, from milk products, from animal poultry and livestock production, net of total agricultural input expenditures including wage costs, feeding costs of productive animals, and all other agricultural inputs like fertilizers and pesticides. Finally, we add all handicraft incomes to this agricultural income.

The wage income correspond to wages received by household members or different agricultural and non agricultural tasks done outside the farm when the households operates one.

the rental incomes correspond to property rights rents, fixed pensions regularly received from the government and rentals of different productive assets.

Transfers correspond to transfers received from relatives, friends and from solidarity funds of local mosques (*zakat*).

The equivalence scales of Townsend (1994) are computed as follows: the weights depend on gender and age: 1 for male adults, 0.9 for female adults, 0.94 and 0.83 respectively for males and females between 13 and 18 , 0.67 for children between 7 and 12, 0.52 for children between 4 and 6, 0.32 between 1 and 3 and 0.05 for babies of less than a year. These figures come from an Indian nutritional study (see Townsend, 1994).

5.2. Application of Frisch-Waugh theorem

Defining Γ^v, the group v average difference operator, by $\Gamma^v\left[X_{it}\right] = X_{it} - \frac{1}{Card(v)}\sum_{i\in v} X_{it}$, that we apply to (9), we have :

$$\Gamma^v \Delta \ln \widetilde{c_{it+1}} = -\Gamma^v\left[z_{it+1}\theta\Delta\ln\widetilde{c_{it+1}}\right] - \Gamma^v\left[\ln\widetilde{c_{it}}\Delta z_{it+1}\theta\right] + \Gamma^v\left[\Delta\widetilde{z_{it+1}}\right]\alpha + \Gamma^v\left[v_{it+1}\right] \quad (1)$$

with $E\Gamma^v\left[v_{it+1}\right] = 0$ because :

$E\Gamma^v\left[\Delta\eta_{it+1}\right] = \Gamma^v E\left[\Delta\eta_{it+1}\right] = \Gamma^v\left[\Delta E\eta_{it+1}\right] = 0$ since $E\eta_{it+1} = 0, \forall t$ and η_{it} are independents and identically distributed.

$E\Gamma^v\left[\ln\varepsilon_{it+1}\right] = \Gamma^v E\left[\ln\varepsilon_{it+1}\right] = 0$ under the within village full insurance hypothesis because then $\forall i, E\left[\ln\varepsilon_{it+1}\right] = E\left[\ln\varepsilon^v_{t+1}\right]$

$E\Gamma^v\left[\left(1+z_{it+1}\theta\right)\Delta u_{it+1}\right] = \Gamma^v E\left[\left(1+z_{it+1}\theta\right)\Delta u_{it+1}\right] = \Gamma^v\left[\left(1+z_{it+1}\theta\right)\Delta E u_{it+1}\right] = 0$ since $Eu_{it+1} = 0, \forall t$ and the u_{it} are iid.

$E\Gamma^v\left[u_{it}\Delta z_{it+1}\theta\right] = \Gamma^v\left[\Delta z_{it+1}\theta E u_{it}\right] = 0$

using the fact that Γ^v and Δ are linear and then permutable with the expectation[18].

[18] The transformations by Γ^v of equations (6) and (7) where we add the measurement errors are not equivalent to (1) if the panel data exhibit some attrition because the equivalence needs to be able to permute Γ^v and Δ ($\Gamma^v\Delta = \Delta\Gamma^v$)

5.3. Instrumental variables

5.3.1. Instruments under the null hypothesis of full insurance

We want to estimate the following equation

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}\right] \theta + \Delta \widetilde{z_{it+1}} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{2}$$

or equivalently

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \Delta \ln c_{it+1} - \ln c_{it} \Delta z_{it+1}\right] \theta + \Delta \widetilde{z_{it+1}} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{3}$$

Besides the variables $\left[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}\right]$ of this equation are endogenous while variables $\Delta \widetilde{z_{it+1}}$ are considered as exogenous.

In the case of separability between consumption and leisure, ignoring measurement errors, we can write the expectations:

$$(1 + z_{it+1}\theta) \ln c_{it+1} = (1 + z_{it}\theta) \ln c_{it} + \Delta \widetilde{z_{it+1}} \alpha$$

Hence

$$\ln c_{it+1} = \frac{1 + z_{it}\theta}{1 + z_{it+1}\theta} \ln c_{it} + \frac{\Delta \widetilde{z_{it+1}} \alpha}{1 + z_{it+1}\theta}$$

and at time t

$$\ln c_{it} = \frac{1 + z_{it-1}\theta}{1 + z_{it}\theta} \ln c_{it-1} + \frac{\Delta \widetilde{z_{it}} \alpha}{1 + z_{it}\theta} \tag{4}$$

Then

$$\ln c_{it+1} = \frac{1 + z_{it}\theta}{1 + z_{it+1}\theta} \left[\frac{1 + z_{it-1}\theta}{1 + z_{it}\theta} \ln c_{it-1} + \frac{\Delta \widetilde{z_{it}} \alpha}{1 + z_{it}\theta}\right] + \frac{\Delta \widetilde{z_{it+1}} \alpha}{1 + z_{it+1}\theta}$$

$$\ln c_{it+1} = \frac{1 + z_{it-1}\theta}{1 + z_{it+1}\theta} \ln c_{it-1} + \frac{\Delta^2 \widetilde{z_{it+1}} \alpha}{1 + z_{it+1}\theta} \tag{5}$$

where Δ^2 is the second difference operator defined by $\Delta^2 X_{t+1} = X_{t+1} - X_{t-1}$.

But according to (3), $\left[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}\right] \theta = \Delta \ln c_{it+1} - \Delta \widetilde{z_{it+1}} \alpha$, using (4) and (5), we get :

$$\left[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}\right] \theta = \frac{-\left(1 + z_{it-1}\theta\right) \Delta z_{it+1}\theta}{\left(1 + z_{it+1}\theta\right)\left(1 + z_{it}\theta\right)} \ln c_{it-1} + \frac{\Delta^2 \widetilde{z_{it+1}} \alpha}{1 + z_{it+1}\theta} - \frac{\Delta \widetilde{z_{it}} \alpha}{1 + z_{it}\theta} - \Delta \widetilde{z_{it+1}} \alpha$$

Writing simply a second order series expansion in θ of these expressions:

We have $\frac{1}{(1+z_{it+1}\theta)(1+z_{it}\theta)} = 1 - \left(z_{it+1} + z_{it}\right)\theta + \left(z_{it}^2 + z_{it+1} z_{it} + z_{it+1}^2\right)\theta^2 + o\left(\theta^2\right)$

Hence $\frac{(1+z_{it-1}\theta)}{(1+z_{it+1}\theta)(1+z_{it}\theta)} = 1 - \left(z_{it+1} + z_{it} - z_{it-1}\right)\theta + o\left(\theta\right)$

Leading to $\frac{-(1+z_{it-1}\theta)\Delta z_{it+1}\theta}{(1+z_{it+1}\theta)(1+z_{it}\theta)} = -\Delta z_{it+1}\theta + \Delta z_{it+1}\left(z_{it+1} + z_{it} - z_{it-1}\right)\theta^2 + o\left(\theta^2\right)$

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which is not possible if $\forall t \ i \in v_t \Rightarrow i \in v_{t+1}$. In that case, we have to define the variables équation by equation.

since $\frac{\Delta^2 \widetilde{z_{it+1}}\alpha}{1+z_{it+1}\theta}$-$\frac{\Delta \widetilde{z_{it}}\alpha}{1+z_{it}\theta} = \Delta\widetilde{z_{it+1}}\alpha$+$[z_{it}\Delta\widetilde{z_{it}}$-$z_{it+1}\Delta^2\widetilde{z_{it+1}}]\alpha\theta$+$[z_{it+1}^2\Delta^2\widetilde{z_{it+1}}$-$z_{it}^2\Delta\widetilde{z_{it}}]\alpha\theta^2$+$o\left(\theta^2\right)$

After some rearrangements and simplifications, we obtain

$$[-z_{it+1}\ln c_{it+1} + z_{it}\ln c_{it}]\theta \underset{\theta=0}{\sim} -\Delta z_{it+1}\theta\ln c_{it-1} + [z_{it}\Delta\widetilde{z_{it}} - z_{it+1}\Delta^2\widetilde{z_{it+1}}]\alpha\theta \qquad (6)$$
$$+\Delta z_{it+1}\left(z_{it+1} + z_{it} - z_{it-1}\right)\theta^2\ln c_{it-1} + [z_{it+1}^2\Delta^2\widetilde{z_{it+1}} - z_{it}^2\Delta\widetilde{z_{it}}]\alpha\theta^2$$

The following instrumental variables are theoretically valid:

$$-\Delta z_{it+1}\ln c_{it-1}, \qquad z_{it}\Delta\widetilde{z_{it}} - z_{it+1}\Delta^2\widetilde{z_{it+1}}$$

at the first order, to which we can add

$$\Delta z_{it+1}\left(z_{it+1} + z_{it} - z_{it-1}\right)\ln c_{it-1}, \qquad z_{it+1}^2\Delta^2\widetilde{z_{it+1}} - z_{it}^2\Delta\widetilde{z_{it}}$$

at the second order.

5.3.2. Instrumental regressions

As shown and recommended by theoretical researches on estimation methods with instrumental variables , it is important to present first step instrumental regressions when an instrumentation method is used (Bound, Jaeger and Baker, 1995, Magdalinos, 1994, Staiger and Stock, 1997). As we cannot present all of them, We show only those concerning the within village complete markets hypothesis in the case of consumption leisure separability (Table 1 corresponds to the first step regressions of column (5) of Table 5). Each column of Table 1 is the instrumental regression of one endogenous variable. The instrumental regressions in the case where agricultural income is introduced and where it is instrumented by rental incomes are in Table 2. They correspond to the first step estimation of column (7) in Table 5.

Table 1: Instrumental regressions

	Instrumented variables $[-z_{it+1}\ln c_{it+1}+z_{it}\ln c_{it}]$					
z_{it+1}	Nb.. of children	Household size	Irrigated land	Winter	Rabi	Monsoon
Explanatory variables						
z_{it+1}			Δz_{it+1}			
Nb.. of children	-2.48981	-1.56148	-0.38542	-0.27182	0.04701	-0.20300
	(1.80)	(0.60)	(0.82)	(1.59)	(0.34)	(1.43)
Household size	0.09803	-1.54706	0.02659	0.19602	-0.00702	0.00521
	(0.10)	(0.86)	(0.08)	(1.66)	(0.07)	(0.05)
Irrigated land	-1.58406	-2.42193	-3.39219	-0.22457	-0.00253	-0.09967
	(1.31)	(1.07)	(8.30)	(1.51)	(0.02)	(0.80)
z_{it+1}			$(\Delta z_{it+1})\ln c_{it-1}$			
Nb.. of children	-0.49791	0.25229	0.05247	0.04671	-0.00682	0.03658
	(1.93)	(0.52)	(0.60)	(1.47)	(0.26)	(1.38)
Household size	-0.00569	-0.61029	0.01390	-0.03581	0.00267	-0.00386
	(0.03)	(1.84)	(0.23)	(1.64)	(0.15)	(0.21)
Irrigated land	0.36749	0.61096	-0.08021	0.04902	-0.00167	0.03818
	(1.42)	(1.26)	(0.92)	(1.54)	(0.06)	(1.44)
Winter	-0.36648	-0.61409	-0.22240	-0.43938	0.03465	0.01052
	(1.50)	(1.35)	(2.69)	(14.58)	(1.40)	(0.42)
Rabi	0.26855	0.57257	-0.20795	-0.10504	-0.25796	0.02112
	(0.89)	(1.01)	(2.02)	(2.81)	(8.38)	(0.68)
Monsoon	-1.43126	-2.16562	0.00890	-0.01070	-0.00072	-0.43896
	(3.32)	(2.69)	(0.06)	(0.20)	(0.02)	(9.91)
z_{it+1}			$(\Delta z_{it+1})(z_{it+1}+z_{it}-z_{it-1})\ln c_{it-1}$			
Nb.. of children	0.00450	-0.02708	0.00454	-0.00528	0.00116	-0.00468
	(0.14)	(0.44)	(0.41)	(1.30)	(0.35)	(1.39)
Household size	-0.00186	0.00538	-0.00505	0.00316	0.00054	-0.00018
	(0.12)	(0.19)	(0.96)	(1.66)	(0.35)	(0.11)
Irrigated land	-0.08031	-0.14621	-0.10005	-0.00655	0.00037	-0.00993
	(1.79)	(1.75)	(6.59)	(1.18)	(0.08)	(2.16)
Winter	0.27402	0.81847	0.13812	0.07848	-0.03179	0.00822
	(1.23)	(1.96)	(1.82)	(2.84)	(1.40)	(0.36)
Rabi	-0.18609	-0.35104	0.23528	0.10310	-0.06799	-0.01950
	(0.59)	(0.59)	(2.18)	(2.63)	(2.11)	(0.60)
Monsoon	1.11738	1.67330	-0.10169	0.02676	0.03370	0.02300
	(2.43)	(1.94)	(0.65)	(0.47)	(0.72)	(0.49)
z_{it+1}			$z_{it}\Delta z_{it} - z_{it+1}\Delta^2 z_{it+1}$			
Nb.. of children	0.12186	-0.12102	0.00773	-0.02655	0.00386	-0.02969
	(0.68)	(0.36)	(0.13)	(1.21)	(0.21)	(1.62)
Household size	0.03123	0.16584	-0.01440	0.01582	0.00732	0.00064
	(0.37)	(1.06)	(0.51)	(1.54)	(0.86)	(0.07)
Irrigated land	-0.33064	-0.54969	-0.25307	-0.02540	-0.00062	-0.02993
	(1.57)	(1.40)	(3.55)	(0.98)	(0.03)	(1.38)
z_{it+1}			$z^2_{it+1}\Delta^2 z_{it+1} - z^2_{it}\Delta z_{it}$			
Nb.. of children	0.00442	0.00621	-0.00138	0.00055	-0.00019	-0.00046
	(1.13)	(0.85)	(1.04)	(1.14)	(0.48)	(1.16)
Household size	0.00123	0.00278	0.00054	-0.00016	0.00009	0.00020
	(1.04)	(1.26)	(1.35)	(1.11)	(0.78)	(1.68)
Irrigated land	0.00194	0.00537	0.00903	0.00020	0.00001	0.00056
	(1.05)	(1.56)	(14.46)	(0.90)	(0.03)	(2.96)
Observations	7740	7740	7740	7740	7740	7740
R^2	0.58	0.52	0.80	0.14	0.11	0.17

Table 2: Instrumental regressions

	Instrumented variables $[-z_{it+1}\ln c_{it+1}+z_{it}\ln c_{it}]$						$\Delta\omega_{it+1}$
z_{it+1}	Nb. of children	Household size	Irrigated land	Winter	Rabi	Monsoon	Agricultural income
Explanatory variables							
z_{it+1}				Δz_{it+1}			
Nb. of children	-2.489	-1.56	-0.385	-0.271	0.047	-0.203	1392.0
	(1.80)	(0.60)	(0.82)	(1.59)	(0.34)	(1.43)	(1.89)
Household size	0.098	-1.547	0.026	0.196	-0.007	0.005	-79.24
	(0.10)	(0.86)	(0.08)	(1.66)	(0.07)	(0.05)	(0.16)
Irrigated land	-1.58	-2.421	-3.39	-0.224	-0.002	-0.099	-1214.9
	(1.31)	(1.07)	(8.30)	(1.51)	(0.02)	(0.80)	(1.89)
z_{it+1}				$(\Delta z_{it+1})\ln c_{it-1}$			
Nb. of children	-0.497	0.252	0.052	0.046	-0.0068	0.036	-310.9
	(1.93)	(0.52)	(0.60)	(1.47)	(0.26)	(1.38)	(2.27)
Household size	-0.005	-0.610	0.0139	-0.0358	0.002	-0.003	49.87
	(0.03)	(1.84)	(0.23)	(1.64)	(0.15)	(0.21)	(0.53)
Irrigated land	0.367	0.610	-0.08	0.049	-0.0016	0.038	295.42
	(1.42)	(1.26)	(0.92)	(1.54)	(0.06)	(1.44)	(2.15)
Winter	-0.366	-0.61409	-0.22240	-0.439	0.034	0.0105	-60.22
	(1.50)	(1.35)	(2.69)	(14.58)	(1.40)	(0.42)	(0.46)
Rabi	0.268	0.57257	-0.20795	-0.105	-0.257	0.0211	-44.221
	(0.89)	(1.01)	(2.02)	(2.81)	(8.38)	(0.68)	(0.27)
Monsoon	-1.431	-2.16	0.008	-0.0107	-0.000	-0.438	113.97
	(3.32)	(2.69)	(0.06)	(0.20)	(0.02)	(9.91)	(0.50)
z_{it+1}				$(\Delta z_{it+1})(z_{it+1}+z_{it}-z_{it-1})\ln c_{it-1}$			
Nb. of children	0.0045	-0.027	0.0045	-0.0052	0.0011	-0.0046	5.416
	(0.14)	(0.44)	(0.41)	(1.30)	(0.35)	(1.39)	(0.31)
Household size	-0.0018	0.0053	-0.005	0.0031	0.00054	-0.00018	5.514
	(0.12)	(0.19)	(0.96)	(1.66)	(0.35)	(0.11)	(0.67)
Irrigated land	-0.0803	-0.1462	-0.10	-0.0065	0.0003	-0.009	-50.50
	(1.79)	(1.75)	(6.59)	(1.18)	(0.08)	(2.16)	(2.12)
Winter	0.274	0.818	0.138	0.078	-0.0317	0.008	-27.57
	(1.23)	(1.96)	(1.82)	(2.84)	(1.40)	(0.36)	(0.23)
Rabi	-0.186	-0.351	0.235	0.103	-0.067	-0.019	-84.85
	(0.59)	(0.59)	(2.18)	(2.63)	(2.11)	(0.60)	(0.50)
Monsoon	1.11738	1.67330	-0.10169	0.02676	0.03370	0.02300	-204.1
	(2.43)	(1.94)	(0.65)	(0.47)	(0.72)	(0.49)	(0.83)
z_{it+1}				$z_{it}\Delta z_{it} - z_{it+1}\Delta^2 z_{it+1}$			
Nb. of children	0.12186	-0.12102	0.00773	-0.02655	0.00386	-0.02969	-54.27
	(0.68)	(0.36)	(0.13)	(1.21)	(0.21)	(1.62)	(0.57)
Household size	0.03123	0.16584	-0.01440	0.01582	0.00732	0.00064	59.62
	(0.37)	(1.06)	(0.51)	(1.54)	(0.86)	(0.07)	(1.34)
Irrigated land	-0.33064	-0.54969	-0.25307	-0.02540	-0.00062	-0.02993	-186.8
	(1.57)	(1.40)	(3.55)	(0.98)	(0.03)	(1.38)	(1.67)
z_{it+1}				$z^2_{it+1}\Delta^2 z_{it+1} - z^2_{it}\Delta z_{it}$			
Nb. of children	0.0044	0.00621	-0.00138	0.00055	-0.00019	-0.00046	-3.32
	(1.13)	(0.85)	(1.04)	(1.14)	(0.48)	(1.16)	(1.60)
Household size	0.0012	0.0027	0.00054	-0.00016	0.00009	0.00020	0.788
	(1.04)	(1.26)	(1.35)	(1.11)	(0.78)	(1.68)	(1.26)
Irrigated land	0.0019	0.0053	0.00903	0.00020	0.00001	0.00056	2.190
	(1.05)	(1.56)	(14.46)	(0.90)	(0.03)	(2.96)	(2.23)
Income from rents							0.475
							(12.16)
Observations	7740	7740	7740	7740	7740	7740	7740
R^2	0.58	0.52	0.80	0.14	0.11	0.17	0.02

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