Consumption Insurance with Heterogeneous Preferences. Can Sharecropping Help Complete Markets?

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Abstract

This paper presents the first evidence linking directly household consumption profiles to the widely studied institution of sharecropping in developing countries. On the one hand, the theoretical rationale for sharecropping often calls for its risk sharing properties. On the other hand empirical studies on risk sharing in consumption often reject full insurance but admit that some formal or informal mechanisms help households to insure substantially their consumption since income shocks do not fully transfer in consumption. Risk sharing and consumption insurance achieved by rural households from three provinces of Pakistan are studied allowing for heterogeneity of preferences and in particular in risk aversion. As full insurance is rejected, there is some scope for Pareto improving risk sharing mechanisms. Actually, markets are found to be incomplete even at the village level and evidence that the sharecropping institution helps completing markets is exposed. Households able to use this contractual choice, which permits them 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 by sharing production risk. Finally, thanks to the estimated risk aversion parameter, the risk sharing motive for the contractual choice predicted by standard Principal-Agent theory is directly tested. It is found that more risk averse agents are more likely to get sharecropping contracts than fixed rent contracts and with a lower share of production when sharecropping.

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1. Introduction

Several empirical and theoretical questions on risk sharing issues have been recently raised in particular in developing countries (Alderman and Paxson, 1994, Townsend, 1994, Coate and Ravallion, 1993, Ligon, 1998, Ligon, Thomas and Worrall, 2001). The recent empirical literature on risk sharing in developing countries generally rejected the Complete Markets Hypothesis[1], but it is also acknowledged that even if markets are incomplete, several risk sharing mechanisms provide at least some partial insurance for households in developing countries. In poor developing countries, agricultural organization is obviously the theatre of many transaction mechanisms related to labor relationships and land leasing agreements like sharecropping or fixed rent contracts. This paper aims at looking at the role of these contractual relationships in risk sharing performance of households in terms of consumption smoothing. In particular, sharecropping is a widespread agricultural risk sharing institution, which has been the focus of a huge theoretical and empirical literature in development economics (Otsuka, Chuma and Hayami, 1992), but which has never been considered in the consumption smoothing literature although its risk sharing properties are often underlined. Thanks to the structural estimates of the risk aversion parameter, we test directly the standard implication of Principal-Agent theories land renting that sharecropping should be preferred to fixed rent contracts for more risk averse agents, without relying on wealth related proxies for risk aversion.

First, full insurance tests implemented empirically generally rely on strong homogeneity assumptions. Taking into account the heterogeneity of risk aversion of households may however be crucial since excess sensitivity of consumption to income could result from the heterogeneity in households preferences with respect to the desire of smoothing idiosyncratic shocks. Using data from Pakistan, we study the degree of consumption smoothing reached by rural households. Full insurance is rejected. In many other developing countries, consumption smoothing studies have also shown that markets are in general incomplete and have 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 were less well insured than others. Foster and Rosenzweig (1996, 1997, 2001) showed, with data from Pakistan, the importance of altruistic links between households

[1] 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), nonseparability (Browning and Meghir, 1991, Attanasio and Davis, 1996) and other mispecification issues as well as informational asymmetries (Ligon, 1998) and limited commitment problems (Coate and Ravallion, 1993, Ligon, Thomas and Worrall, 2001, Attanasio and Rios-Rull, 2000) have been introduced to help rationalize the observed empirical facts.

in the use of informal solidarity transfers as a risk sharing device and the role of individual savings and financial intermediation. Grimard (1997) studied the risk sharing within ethnic groups 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.

In the present paper, after finding that the within village complete markets hypothesis is rejected, we propose to test the conjecture that some kind of institutions may help households to complete markets. Actually, sharecropping is an agricultural risk sharing institution[2], which has been extensively studied in development economics but never been considered in the consumption smoothing literature. We try to fill this gap between the literature on agrarian structure and that on consumption insurance by testing the full insurance predictions and the conjecture that sharecropping allows to complete markets taking into account the heterogeneity of risk aversion. Sharecropping, which is a contract between a landlord and a tenant specifying that land production should be shared between parties according to some fixed rate, 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.

We also deal with methodological problems of testing the complete markets hypothesis. More precisely, the complete markets hypothesis tests 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 and Hayashi, Altonji, Kotlikoff, 1996 use similar 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 complete markets hypothesis. With instrumental variables techniques, we estimate the parameters

[2]The risk sharing properties of sharecropping are often invoked in the literature on agricultural contracts.

of households' preferences and test different assumptions on the range of the complete markets hypothesis.

The results can be summarized as follows. The heterogeneity of preferences is important and both kinds of empirical tests developed show that full insurance is rejected. In the Pakistan regions studied, the sharecropping institution helps 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. Finally, thanks to the estimated risk aversion parameter, we directly test the risk sharing motive for sharecropping predicted by standard Principal-Agent theory. We find that more risk averse agents are more likely to get sharecropping contracts than fixed rent contracts and with a lower share of production. This represents the first direct test that risk aversion (here identified thanks to the consumption smoothing behavior) plays an important role in the choice of contractual form.

Section 2 presents the econometric model used to test the complete markets hypothesis. Section 3 presents the data from Pakistan, the results of empirical estimation and tests as well as the implications of risk aversion on contract choice. Section 4 concludes.

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 heterogeneous preferences while testing the complete markets hypothesis. In particular we take into account the heterogeneity of agents' risk aversion that may have biased previous econometric studies. 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 with aggregate shocks, because full insurance theory predicts that consumption changes should be more responsive to aggregate shocks for less risk averse than for more risk averse people.

2.1. Full Insurance with Heterogeneous Preferences

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) regresses household by household consumption on aggregate consumption at the village level including successively proxy variables for household idiosyncratic shocks testing if the coefficient of the idiosyncratic variable is equal to zero and if that of 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 (10 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 β_i must be equal to the ratio of household to average absolute risk tolerance i.e. $\beta_i = \frac{1/\sigma_i}{\frac{1}{N}\sum_{j=1}^{N}\frac{1}{\sigma_j}}$ where N is the size of the village. Consequently, the right way to test the complete markets hypothesis with these time series estimates is not to test $\beta_i = 1$ (which amounts to assume homogeneity) but rather $\frac{1}{N}\sum_{i=1}^{N}\beta_i = 1$ i.e. that the average of estimated coefficients should be equal to one. However, this test remains weak and measurement errors on consumption will turn it even more unreliable (Ravallion and Chaudhuri, 1997).

Another method of testing the full insurance property used 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 subtracting the average consumption change to the individual consumption change (Grimard, 1997, Jalan and Ravallion, 1999) allows to avoid the attenuation bias of the 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 that need to be independent of idiosyncratic shocks so that its test remains valid. 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 idiosyncratic shocks are assumed independent of household preferences, then they must be cross sectionally independent of the growth rate of consumption (Cochrane, 1991). Jacoby and Skoufias (1998) use this method which depends crucially on the assumption of independence of preferences and idiosyncratic shocks (which can be correlated if both correlated to demographic characteristics for example). Then, no empirical tests of full insurance takes into account explicitly the heterogeneity of risk aversion.

Assume that the instantaneous utility of consumption c for household i at time t is of the isoelastic following form[3]

$$\beta^t u_{it}(c) = \exp\left(\alpha\left(\widetilde{z}_{it}\right)\right) \frac{c^{1-\theta(z_{it})}}{1-\theta\left(z_{it}\right)} \tag{2.1}$$

where vectors z_{it}, $\widetilde{z}_{it}$ are characteristics 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 by the instrumentation method even if they can finally be the same set of variables in the empirical application). We thus

[3] The 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). In the case of Mace (1991), it seems that the opposite conclusions given by CRRA or CARA functions came from measurement error problems (Nelson, 1994). Finally, it has been recently argued that decreasing absolute risk aversion may be a better approximation to household preferences. Ogaki and Zhang, 2001, use utility functions in the class of HARA (Hyperbolic Absolute Risk Aversion). However, our strategy is rather to allow for heterogeneity of risk aversion in the class of CRRA functions than specifying a unique homogeneous HARA function for each household.

assume that households have a constant relative risk aversion (in consumption level for a given household) equal to $\theta(z_{it})$ which depends on some characteristics z_{it}. Similarly, Blundell, Browning and Meghir (1994) and Hayashi, Altonji and Kotlikoff (1996) parameterized multiplicative factors of marginal utility of consumption with observable characteristics $(\alpha(\widetilde{z}_{it}))$ but were assuming that risk aversion was homogeneous across households or individuals. Hence, we have parameterized the marginal utility of consumption with $\alpha(\widetilde{z}_{it})$ and the relative risk aversion by $\theta(z_{it})$.

The first order condition verified by the marginal rate of substitution of consumption between periods t and $t+1$ is then[4]:

$$\frac{u'_{it+1}(c_{it+1})}{u'_{it}(c_{it})} = \varepsilon_{it+1} \tag{2.2}$$

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.

In the following, we will make more explicit the distribution properties of these random terms according to the assumptions made concerning markets. Using (2.1), this first order condition can be written under the logarithmic form

$$\alpha(\widetilde{z}_{it+1}) - \alpha(\widetilde{z}_{it}) - \theta(z_{it+1})\ln c_{it+1} + \theta(z_{it})\ln c_{it} = \ln \varepsilon_{it+1} \tag{2.3}$$

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

$$\theta(z_{it}) = 1 + z_{it}\theta \tag{2.4}$$

The relative risk aversion of household i at t is assumed to be a function of observable characteristics z_{it}. It is increasing in function of element z_{it}^k of vector z_{it} if $\theta_k > 0$ (where $\theta = (\theta_1, ., \theta_k, ., \theta_K)$). The homogeneity of relative risk aversion among agents is obtained when $\theta = 0$. The function $\alpha(.)$ allows us 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 the factor $\widetilde{z}_{it}\alpha$ function of observable variables , we write

$$\alpha(\widetilde{z}_{it}) = \widetilde{z}_{it}\alpha + \eta_{it} \tag{2.5}$$

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

The term η_{it} allows to capture unobserved specific effect multiplicative to marginal utility of consumption for exmaple like individual variations in the discount factor.

Then the first order condition becomes

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}\right] \theta + \Delta \widetilde{z}_{it+1} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{2.6}$$

or equivalently

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \Delta \ln c_{it+1} - \ln c_{it} \Delta z_{it+1}\right] \theta + \Delta \widetilde{z}_{it+1} \alpha + \Delta \eta_{it+1} - \ln \varepsilon_{it+1} \tag{2.7}$$

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}:

$$\ln \widetilde{c}_{it} = \ln c_{it} + u_{it} \tag{2.8}$$

Measuring consumption is a difficult task in any household survey and measurement errors are almost always present. Taking into account explicitly measurement error, the first order condition is

$$\Delta \ln \widetilde{c}_{it+1} = \left[-z_{it+1} \Delta \ln \widetilde{c}_{it+1} - \ln \widetilde{c}_{it} \Delta z_{it+1}\right] \theta + \Delta \widetilde{z}_{it+1} \alpha + v_{it+1} \tag{2.9}$$

with[5] $v_{it+1} = \Delta \eta_{it+1} - \ln \varepsilon_{it+1} + (1 + z_{it+1}\theta) \Delta u_{it+1} + u_{it} \Delta z_{it+1} \theta$

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

We make the following assumption concerning the disturbance terms:

[5] $(1 + \theta z_{it+1}) \Delta u_{it+1} + \theta u_{it} \Delta z_{it+1} = (1 + \theta z_{it}) \Delta u_{it+1} + \theta u_{it+1} \Delta z_{it+1}$

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

Assumption 2: Conditional on observable household characteristics z_{it}, the unobservable preference shocks η_{it} are martingales independent across households and independent of measurement errors[6].

2.2. Estimation Method and Inference

We test the null hypothesis of full insurance by testing the statistical properties of ε_{it+1} in equation (2.9). 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} depend on a household idiosyncratic shock. For example, if a negative income shock reduces household consumption during some period, it means that markets are incomplete because otherwise 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, an overidentifying restrictions test of the model (2.9) 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 tests the internal consistency of the estimated model, which allows to reject the model undirectionally if this condition is not satisfied. This test has the advantage that it needs not a known testable alternative i.e. data allowing to test this alternative liek idiosyncratic shocks. If the non directional test does not reject the model, it may be because it is not powerful enough. A directional test eventually more powerful could perhaps reject it.

We therefore use also directional tests allowing in particular to establish at least some directions towards which full insurance is rejected[7]. In the case of the within-village full insurance, if random terms $\ln \varepsilon_{it+1}$ contain a household specific idiosyncratic innovation then the within-village complete markets hypothesis is rejected because otherwise this innovation is zero. Consequently, if we have a variable ω_{it+1} correlated with the innovation ξ_{it+1}, such that $\xi_{it+1} = \delta \left[\omega_{it+1} - E_t \omega_{it+1}\right]$, we then only need to test that $\delta = 0$ in the estimation of the following equation:

$$\Delta \ln \widetilde{c}_{it+1} = \left[-z_{it+1} \Delta \ln \widetilde{c}_{it+1} - \ln \widetilde{c}_{it} \Delta z_{it+1}\right] \theta + \delta \omega_{it+1} + \Delta \widetilde{z}_{it+1} \alpha + \widetilde{v}_{it+1} \tag{2.10}$$

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

[7] 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.

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

Instrumental variables estimation:

To estimate the equation (2.9) under one of the null hypothesis, we include some time specific 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 because the right hand side variables $[z_{it+1}\Delta \ln \widetilde{c}_{it+1} + \Delta z_{it+1} \ln \widetilde{c}_{it}]$ are endogenous. The choice of instruments is very important. Very often, 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) are used as instrumental variables. However, the use of a large number of instrumental variables frequently leads to a weak instruments problem and to biased estimators (Bound, Jaeger and Baker, 1995). 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 (Buse, 1992, Magdalinos, 1994, Bound, Jaeger and Baker, 1995, Staiger and Stock, 1997), we restrict our set of instrumental variables that should be theoretically valid under the null hypothesis of the model. Consequently, we compute which instruments should be the best correlated to endogenous variables. Appendix 5.3 shows how we determine the set of instrumental variables that should have the strongest correlation with the endogenous variables under the null hypothesis. The following instruments are theoretically valid under the null hypothesis of complete markets: $\Delta z_{it+1} \ln c_{it-1}$ and $z_{it}\Delta\widetilde{z}_{it} - z_{it+1}\Delta^2\widetilde{z}_{it+1}$ to which we can add $\Delta z_{it+1}\,(z_{it+1} + z_{it} - z_{it-1}) \ln c_{it-1}$ and $z_{it+1}^2\Delta^2\widetilde{z}_{it+1} - z_{it}^2\Delta\widetilde{z}_{it}$. Doing an overidentifying 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).

In this empirical work, it is crucial to control the instrumental regressions in order to avoid from the weak instruments problem which is unfortunately rarely shown in articles using two stage least squares with a large set of instruments. We report part of the first stage instrumental regressions in Appendix 5.4.

The estimation of (2.9) 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) but their estimates will not be presented in

Tables of results since they do not bring any interpretation[8].

At last, we remark that when there are measurement errors on consumption, the residuals of equation (2.9) 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 this autocorrelation into account 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, non-separability of consumption and leisure can lead to biased estimates if 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 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

$$\beta^t u_{it}(c,l) = \exp(\widetilde{z}_{it}\alpha)\frac{c^{1-z_{it}\theta}}{1-z_{it}\theta}(1+l)^{-\gamma} \tag{2.11}$$

where γ is a preference parameter of the household.

The first order condition with respect to consumption remains similar[9] and taking logarithms we get:

$$\Delta \ln c_{it+1} = -z_{it+1}\theta \ln c_{it+1} + z_{it}\theta \ln c_{it} - \gamma\Delta \ln l_{it+1} + \Delta\widetilde{z}_{it+1}\alpha + \Delta\eta_{it+1} - \ln\varepsilon_{it+1} \tag{2.12}$$

or equivalently

$$\Delta \ln c_{it+1} = -z_{it+1}\theta\Delta \ln c_{it+1} - \ln c_{it}\Delta z_{it+1}\theta - \gamma\Delta \ln l_{it+1} + \Delta\widetilde{z}_{it+1}\alpha + \Delta\eta_{it+1} - \ln\varepsilon_{it+1} \tag{2.13}$$

3. Data and Empirical Tests in Pakistan

3.1. Stylized Facts

The data come from a survey conducted by IFPRI (International Food Policy Research Institute) in Pakistan between 1986 and 1989 (see Alderman and Garcia, 1993). The survey consists of a strati-

[8] Moreover, by the Frisch-Waugh theorem, the regression (2.9) 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). The coefficients of all these dummy variables are very numerous (46 villages×12 periods resulting after first differences in 505 coefficients). We can then transform the model and estimate it by subtracting the period-village average which is equivalent to the use of the whole set of dummy variables.

[9] The first order condition with respect to labor supply is not useful for our tests.

fied 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). 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. 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 entirely rural, it is not completely agricultural, which has an influence on the distribution and fluctuations of incomes. However, of the 927 households chosen in the first period, only 22 never had any agricultural income during the survey. The available data[10] are very rich and contain information 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 3.1.

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 3.1: 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
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 dummy variable (renting in)	0.35	0.47	10083
Fixed rent dummy variable (renting in)	0.08	0.26	10083
Male labor (person*day/week)	2.62	4.13	9889
Female labor (person*day/week)	0.53	1.89	9885

are in acres[11]. Correlations between income sources for the total sample show that there is quite little covariation between these sources. Actually the correlation coefficient between agricultural

[10] Appendix 5.1 provides more details on data construction.

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

profits and wage income is only -0.01. The correlation coefficient between agricultural profits and pensions and transfers received is 0.08 and it is 0.70 with total income. This should allow income diversification, but all households do not hold this market portfolio. In particular, 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, income variability is high because of the Monsoon, of weather variability generating periods of drought, and of relatively frequent flooding. Besides, the (pseudo) coefficients of variation of household income[12] are very important, ranging 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. Graph **??** shows the coefficients of variation of household income ranked by increasing value and the corresponding coefficients of variation of consumption (food and non durable expenditures). 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 of 927 have a consumption coefficient of variation higher than that of income (97 in the case of total non durable expenditures). Assuming that instantaneous utility is separable between durable and

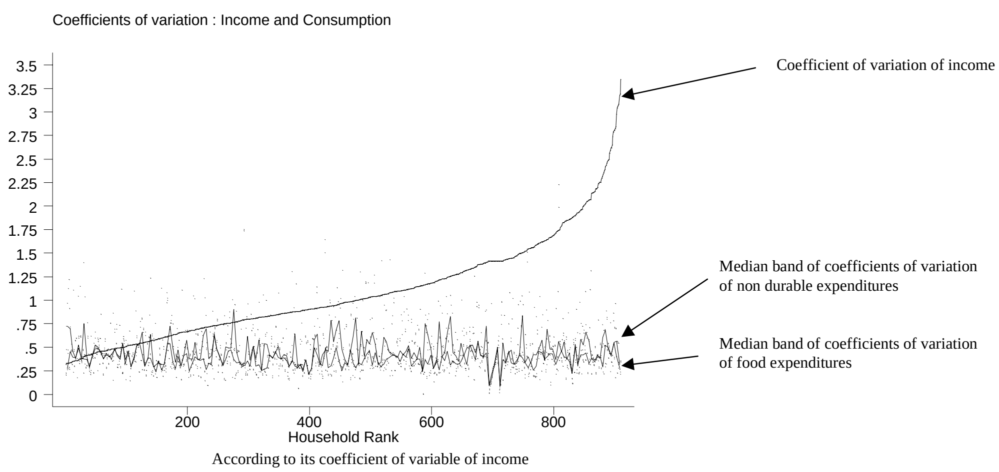

Figure 3.1: Individual coefficients of time variation of income and consumption

non durable goods, we can estimate the model using non durable expenditures as our consumption variable. In the literature on full insurance tests, food consumption is often used (Townsend, 1994,

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

Mace, 1991, Cochrane, 1991). However, the total non durable expenditures should be used according to the theoretical model, unless food and non food non durable expenditures are separable (which is unlikely). Hence, 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. The problem would be 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 planting 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 these seasonal effects in the various specifications because they affect incomes but also mark the rural life with several celebrations (as the lights feast called *dipavali* at the end of October and many other ones) or with the seasonal fluctuations of frequent pathologies (viral diseases, malaria and leishmaniasis). 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 population 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[13] 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 more used than fixed rent contracts with 34% of households leasing in a plot of land with sharecropping against 8% leasing at fixed rent. Among the landowning households, 7% lease all or a part of their land at fixed rent and 37% 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 and the sharecropper, they mutually insure

[13] 1 acre = 4046.86 m^2.

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 enables 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). The Graph 3.2 shows the estimated coefficients from household level time series of consumption on average consumption of the village 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 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. The method used in the following provides much more power for testing the

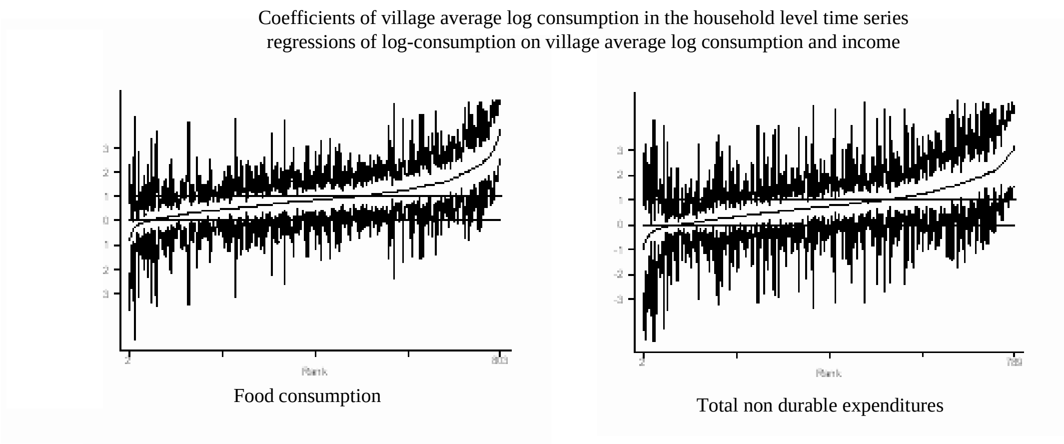

Figure 3.2: Coefficients on household time series

within village full insurance property without being forced to do strong homogeneity assumptions on preferences.

The empirical tests consist of estimating equations (2.9) and (2.10) with the instrumental variables two stage least squares method described in section 2.2. In this empirical study, we successively test the full insurance hypothesis for all households and the within village full insurance. In the previous section, we have seen that under the null hypothesis, the instrumental variables set 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 $z_{it}\Delta\widetilde{z}_{it} - z_{it+1}\Delta^2\widetilde{z}_{it+1}$. This set is noted [1] to which we can add the instruments $\Delta z_{it+1}(z_{it+1} + z_{it} - z_{it-1}) \ln c_{it-1}$ 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 5.3 are given for the case of within village full insurance with or without the inclusion of the income shock. Thier correlation with endogenous variables show that the instrumented variables are correctly identified. Therefore, the test of overidentifying restrictions given by the Sargan statistic allows us 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 (2.11) 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. So as to take into account 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 5.3 of Appendix 5.3), which enables 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 closer to zero and its standard error is two to four times larger.
For the exogenous characteristic variables of households z_{it+1} and $\widetilde{z}_{it+1}$, we chose demographic and patrimonial characteristics (owned land). The estimates presented show the case where these variables are household size, number of children in household and irrigated owned land per household adult equivalent[14]. This specification results from a preliminary research that showed that other demographic characteristics or the composition of owned land do not bring additional information in the regressions.

Full Insurance

Table 5.1 in appendix 5.2 shows the results of estimations providing the test of complete markets. The tests of overidentifying restrictions are easily rejected by the Sargan statistic[15], rejecting then

[14]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.

[15]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

the null hypothesis of full insurance between households of Pakistan. This result is not very surprising, but it allows us 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 likely (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 5.1, 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-village Full Insurance

Since global full insurance is rejected[16], we can test the within village complete markets hypothesis. It may happen that households manage to insure themselves against risks with borrowing, lending, solidarity networks, credit and other mechanisms within the village. 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.

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 3.2. Even if we have been very cautious in the choice of instrumental variables and always have checked that they were sufficiently informative because of the problem of weak instruments, we always did try to raise the arbitrary level of significance required in instrumental regressions for keeping an instrument. Of course, we lose some instruments but the results remained similar with respect to our interest (i.e. the signs and significance of coefficients). Moreover, the coefficients were not significantly different while the minimum level required for Student statistics 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

[16] Within province full insurance has been tested and also rejected in the same manner like shown in Dubois (2000).

instrumental regressions of column (5) of Table 3.2 are reported in 5.3).

The columns (1) and (5) of Table 3.2 show the estimation of the model under the null hypothesis as well as the overidentifying restrictions tests (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 3.2), 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 reject it because agricultural income shocks have a significant effect on household consumption changes.

Table 3.2: Results of within village full insurance tests

	Dependant variable: $\Delta \ln \tilde{c}_{it+1}$							
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: $\tilde{z}_{it+1}$								
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

The estimated parameters θ show that household risk aversion increases with the number of children and decreases with owned irrigated land per adult equivalent. These empirical facts may mean 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 to 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 which corresponds to the usual wealth interpretation that household risk aversion decreases as a function of owned assets[17]. 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 ones create and remain into larger households and that less risk averse ones are also the wealthier (in terms of land owning). This interpretation if not impossible is difficult to support. However, we reach here the limits of our economic and econometric 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 turning them more risk averse[18].

The estimation of parameters α 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 heterogeneity in preferences.

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. 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.

The risk sharing properties of sharecropping contracts are often invoked (Stiglitz, 1974, Otsuka,

[17] This argument is often used to proxy risk aversion with wealth like in Ackerberg and Botticini (2001).

[18] 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.

Chuma, Hayami, 1992). For these rural household in Pakistan, sharecropping contracts are relatively frequent. More than 35% of households surveyed actually were renting in some piece of land by sharecropping. It seems interesting to test if households participating in 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. In addition, the risk sharing properties of sharecropping have never been studied empirically in this way, neither in the contract literature, nor in the consumption smoothing literature. Full insurance is globally rejected but it may be different for sharecroppers or non sharecroppers. The results of Table 3.3 show that sharecroppers are better protected against income shocks[19].

We do the same tests but without constraining the preference parameters to be the same in the model for 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 (Table 3.4). 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 profit shock reject it whatever 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 sharecroppers, the consumption leisure separability is rejected (see column (7) of Table 3.4) although this particular result seems not very robust to the number of instruments (column (8) of Table 3.4). In the even numbered columns of Table 3.4, 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[20].

It seems that sharecropping is an institution able to complete markets within the village. By this kind 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

[19] The notation I_sharecropper means a dummy variable equal to one if the household is renting in some land with sharecropping and zero otherwise.

[20] Table 3.4 shows the specification with labor supply and income shock but the results are similar with other specifications and can be interpreted in the same way.

that full insurance against all shocks (not only agricultural income) is accepted for sharecroppers. Of course it does not mean that tests against other directions i.e. idiosyncratic shocks affecting households would give the same results.

Table 3.3: Within village full insurance tests for sharecroppers and non sharecroppers

	Dependant variable: $\Delta \ln \tilde{c}_{it+1}$							
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: $\tilde{z}_{it+1}$								
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 3.4: Within village full insurance tests for sharecroppers and non sharecroppers

Dependant variable: $\Delta \ln \tilde{c}_{it+1}$	Sharecroppers											Non
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
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
	(0.80)	(0.87)	(0.44)	(0.24)	(0.75)	(1.26)	(0.41)	(0.16)	(1.94)	(1.89)	(2.17)	(2.02)
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
	(4.46)	(4.48)	(2.38)	(2.43)	(4.48)	(4.11)	(3.04)	(2.89)	(2.56)	(2.72)	(2.63)	(2.65)
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
	(1.92)	(2.04)	(0.07)	(0.30)	(2.01)	(1.87)	(0.08)	(0.05)	(1.97)	(2.00)	(0.86)	(1.05)
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
	(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: 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
	(4.28)	(3.29)	(1.58)	(1.51)	(3.92)	(3.91)	(2.21)	(2.44)	(1.59)	(0.95)	(1.34)	(1.01)
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
	(3.49)	(1.33)	(1.30)	(0.95)	(1.89)	(1.99)	(1.12)	(1.36)	(2.04)	(1.52)	(0.58)	(0.61)
4: (reference): Kharif harvest												
α: $\tilde{z}_{it+1}$												
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
	(0.85)	(0.95)	(0.72)	(0.44)	(0.90)	(1.36)	(0.69)	(0.42)	(1.85)	(1.80)	(2.07)	(1.94)
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
	(4.20)	(4.34)	(2.38)	(2.40)	(4.27)	(3.86)	(3.00)	(2.85)	(2.21)	(2.41)	(2.31)	(2.38)
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
	(2.08)	(2.24)	(0.03)	(0.33)	(2.23)	(2.00)	(0.18)	(0.03)	(2.01)	(2.07)	(0.80)	(1.02)
γ												
l^f_{it+1} : Female labor			0.301	0.198			0.208	0.358			-0.555	-0.406
			(0.95)	(0.33)			(0.81)	(0.90)			(1.78)	(1.09)
l^m_{it+1} : Male labor			0.855	0.601			0.470	0.442			0.143	0.117
			(1.99)	(1.05)			(1.97)	(0.98)			(1.20)	(1.02)
δ: ω_{it+1}					$1.4\ 10^{-4}$	$5.8\ 10^{-5}$	$1.1\ 10^{-4}$	$1.0\ 10^{-4}$				
					(1.85)	(0.53)	(0.76)	(0.39)				
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
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
Observations	2520	2520	2519	2519	2520	2520	2519	2519	4814	4814	4806	4807

3.4. Testing the Insurance Motive for Sharecropping of Risk Averse Agents

The previous tests and estimation have shown that preferences are heterogeneous among these rural households. We showed that it is important to take into account this heterogeneity when testing for the complete markets hypothesis. The tests also proved that sharecropping helps complete markets by providing a risk sharing instrument either because this kind of contract modifies the constraints upon solidarity networks performing informal transfers among them or directly because sharecropping income is mechanically less variable than idiosyncratic yields thanks to the sharing of harvest between the landlord and the renter. Households having heterogenous preferences are willing to bear different levels of consumption volatility. Efficiency requires that households bear more risk whether they are less risk averse and less risk whether they are more risk averse. Sharecropping appears to be a good instrument in sharing risk. We can wonder if sharecroppers differ from other agricultural households in terms of preferences. The standard Principal-Agent theory of sharecropping predicts that the contract choice will depend on the risk preferences of the agent (Stiglitz, 1974). More risk averse agents being more likely to get a sharecropping contract than a fixed rent contract though the moral hazard problem militates for more incentives in the trade-off with risk sharing. Therefore, a strong prediction is that more risk averse households are more likely to organize their agricultural production using sharecropping contracts than others. This prediction is always present in the empirical contract choice literature where households' characteristics supposedly approximating risk aversion are generally included to show that sharecropping is positively correlated with characteristics assumed to reveal more risk averse preferences (like wealth or some household demographic variables). However, it is never clear if these kinds of regressions identify really the households preferences and the effect of risk aversion on contract "choice" or another effect also linked to these proxy variables. Actually it is in general not easy to identify risk aversion. In our study of risk sharing in consumption, we are nevertheless able to estimate preference parameters of households. An implication is that we can use these estimates of preferences to test the prediction on the choice of sharecropping. Using the estimates of the risk aversion parameters θ_{it} (in the following we used that of column (8) in Table 3.3[21]), we get an estimate of the coefficient of relative risk aversion of each household $\theta_{it} = \theta(z_{it})$. Of course, as we said in the previous section, this risk aversion parameter is identified only up to a scale and location normalization. However, this normalization does not affect the comparison of preferences across households. We can then

[21] The same results were found with the specification of column (7) of Table 3.3 where labor supply is assumed separable from consumption in the utility function.

provide an original and direct test of the effect of preferences on contract choice using this risk aversion estimates in a discrete choice model of sharecropping versus fixed rent contracts (which is the other widespread agricultural contract use din developing countries). The Table 3.5 shows the results of estimating a probit equation of sharecropping versus fixed rent according to several explanatory variables usually included in this kind of analysis (like land ownership and household characteristics, as well as numerous village dummy variables not shown in the Table 3.5) as well as the risk aversion parameters provided by the structural estimation of preferences performed on consumption[22]. Introducing household level random effects in the probit equation (column (2) of Table 3.5) we find the same kind of results. As the share of output given to the tenant by the landlord and specified in the sharecropping contract is available in the data, we can also test directly the prediction that this variable is lower for more risk averse tenants. With share of 1 for a fixed rent contracts and the observed shares of sharecropping contract (between zero and one, but mostly equal to 1/4, 1/2, 2/3 in the data), we estimate an ordered probit model in column (3) of Table 3.5 which shows similarly that the more risk averse the lower the share of production received by the tenant. The empirical results are consistent with the risk sharing theory of contractual choice.

Table 3.5: Determinants of contractual choice

	Probit		With Non Param. Unobs. Hetero.		Random Effect Probit		Ordered Probit	
Dependent Variable	Fixed rent vs Sharecropping		Fixed rent vs Sharecropping		Fixed rent vs Sharecropping		Discrete Output Share	
Explanatory variables	(1)		(1a)		(2)		(3)	
Risk aversion: $\widehat{\theta}_{it}$	**-2.16**	**(-6.61)**	**-3.68**	**(-6.92)**	**-4.51**	**(-5.14)**	**-1.56**	**(-4.54)**
Household size	-0.08	(-1.06)	0.06	(4.84)	-0.059	(-2.46)	0.09	(8.54)
Seasonal dummies								
1: Winter	-0.23	(-2.33)	-0.75	(-4.83)	-0.55	(-2.44)	-0.26	(-2.37)
2: Rabi harvest	-0.27	(-2.57)	-0.81	(-4.59)	-0.62	(-2.87)	-0.12	(-1.03)
3: Monsoon	-0.33	(-3.20)	-0.82	(-4.98)	-0.74	(-3.21)	-0.34	(-3.08)
4: (reference): Kharif harvest								
Intercept	0.97	(2.97)			2.99	(3.86)		
Unobserved mass $\widehat{\mu}_1$			-7.35	(-3.64)				
Unobserved mass $\widehat{\mu}_2$			3.57	(5.61)				
Probability $\widehat{\pi}_1$ ($\widehat{\pi}_2 = 1 - \widehat{\pi}_1$)			0.59	(19.41)				
Log-variance of random effects					2.44	(16.3)		
Ancillary parameter 1							-3.11	(-6.21)
Ancillary parameter 2							1.95	(3.94)
Village dummies	$\chi_2(34)=794.9$				$\chi_2(38)=230.5$		$\chi_2(43)=452.7$	
District dummies			$\chi_2(3)=25.9$					
Log likelihood	-1106.4		-1359.1		-561.8		-935.3	
Observations	3209		3740		3888		3283	

The results show clearly that risk aversion heterogeneity is a significant determinant of sharecropping. More risk averse households are more likely to be sharecroppers instead of renters and

[22] A logit estimation gave the same kind of results.

the share of production they receive is lower when they are more risk averse. While it is sometimes argued that risk sharing is not an important in the design of agricultural contracts, this result supports clearly the insurance motive behind the contractual form used in these Pakistani area.

However, an econometric issue needs to be considered. Actually, it may be that unobserved heterogeneity bias these estimates if unobserved factors determine the choice of sharecropping versus fixed rent contracts. To account for this possibility and test the robustness of the first results we estimate the discrete choice model introducing discrete non parametric unobserved heterogeneity *à la* Heckman and Singer (1984). The likelihood function is then just a finite mixture of probit likelihood functions. Column (1a) of Table 3.5 shows the results when estimating the probability with two mass points of unobserved heterogeneity noted μ_1 and μ_2 with probability π and $1 - \pi$[23]. In conclusion, the evidence that sharecropping provides risk sharing and more risk averse households prefer this contractual form of organization rather than fixed rent contracts seems very robust to specification errors of the binary choice model.

4. Conclusion

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 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 rejects 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 by estimating simultaneously the household preference parameters allowing for risk aversion heterogeneity. The complete markets hypothesis is rejected even within the village though the informational asymmetries and commitment problems, (which could limit the possibility of

[23] With three or more mass points of unobserved heterogeneity, it appeared that the additional mass points where insignificant. For example with three mass points, we found $\widehat{\mu}_1 = -7.5$, $\widehat{\mu}_2 = 3.2$, $\widehat{\mu}_3 = 1.1$, $\widehat{\pi}_1 = 0.64$, $\widehat{\pi}_2 = 0.12$, (and $\widehat{\pi}_3 = 1 - \widehat{\pi}_1 - \widehat{\pi}_2$) and moreover the results of main interest related to the risk aversion parameter remained similar (both for the coefficient estimates and for its standard error). With larger number of mass points on unobserved heterogeneity, the estimation procedure never converged and we were forced not to push too far this check for robustness.

informal insurance) are usually considered less important at the village level. We then analyze the possibility that sharecropping, a formal contract providing some risk sharing between a landlord and a sharecropper, completes markets. The empirical results suggest that households participating in these sharecropping contracts manage to better insure themselves against agricultural income risk. These results show that formal and informal institutions allowing households to share risk are linked. Since the complete markets hypothesis is accepted for the group of sharecroppers and not for others, it means that either sharecropping indirectly improves the functioning of risk sharing informal mechanisms for those participating to sharecropping or it directly generates some state contingent security impossible to replicate with other available securities. In both cases, we can say that sharecropping do complete markets in these rural areas of Pakistan[24].

Finally, the structural estimates of preference parameters and in particular of the relative risk aversion parameter allow to test directly the importance of risk aversion in contractual choices which is central in Principal-Agent models of sharecropping (Chiappori and Salanié, 2001). Moreover, the empirical relevance of this risk sharing motive has been controversial. Here, the results show that risk aversion plays actually an important role in determining the form of contracts and are consistent with the sake of risk sharing in the choice of sharecropping rather than fixed rent.

5. Appendix

5.1. Data Construction

The data provided by IFPRI consist in 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 with the individual data available. Household food consumption was initially available for each good in quantity and value or quantity with price. Food consumption consists 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.

With respect to incomes, the agricultural incomes correspond to cash income from all household

[24] Modelling formal and informal contracts thus seems an interesting issue suggested by these results and formally studied by Dubois, Jullien and Magnac (2001).

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 corresponds 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 coming from an Indian nutritional study (see 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.

5.2. Full Insurance Tests

Table 5.1: Results of within and between village full insurance tests

	Dependent variable : $\Delta \ln \widetilde{c}_{it+1}$							
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
θ: z_{it+1}								
Number of children	0.083	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

5.3. Instrumental Variables

Let's derive the form of instruments under the Null Hypothesis of Full Insurance. We have the following equation

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}\right] \theta + \Delta \widetilde{z}_{it+1} \alpha + v_{it+1} \tag{5.1}$$

or equivalently

$$\Delta \ln c_{it+1} = \left[-z_{it+1} \Delta \ln c_{it+1} - \ln c_{it} \Delta z_{it+1}\right] \theta + \Delta \widetilde{z}_{it+1} \alpha + v_{it+1} \tag{5.2}$$

Besides the variables $[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}]$ 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, 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

$$\ln c_{it} = \frac{1 + z_{it-1}\theta}{1 + z_{it}\theta} \ln c_{it-1} + \frac{\Delta \widetilde{z}_{it} \alpha}{1 + z_{it}\theta} \tag{5.3}$$

Then

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

$$\ln c_{it+1} = \frac{1 + z_{it-1}\theta}{1 + z_{it+1}\theta} \ln c_{it-1} + \frac{\Delta^2 \widetilde{z}_{it+1} \alpha}{1 + z_{it+1}\theta} \tag{5.4}$$

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

But according to (5.2), $[-z_{it+1} \ln c_{it+1} + z_{it} \ln c_{it}]\, \theta = \Delta \ln c_{it+1} - \Delta \widetilde{z}_{it+1} \alpha$, using (5.3) and (5.4), we get:

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

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

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

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

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

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

After some rearrangements and simplifications, we obtain

$$
\begin{aligned}
&[-z_{it+1}\ln c_{it+1}+z_{it}\ln c_{it}]\theta \underset{\theta=0}{\sim} \text{-}\Delta z_{it+1}\theta\ln c_{it-1}+[z_{it}\Delta\widetilde{z}_{it}-z_{it+1}\Delta^2\widetilde{z}_{it+1}]\alpha\theta \\
&+\Delta z_{it+1}\left(z_{it+1}+z_{it}-z_{it-1}\right)\theta^2\ln c_{it-1}+[z_{it+1}^2\Delta^2\widetilde{z}_{it+1}-z_{it}^2\Delta\widetilde{z}_{it}]\alpha\theta^2
\end{aligned}
\tag{5.5}
$$

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.

5.4. Instrumental regressions

As shown and recommended by theoretical research on estimation methods with instrumental variables, it is important to present first stage 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 5.2 corresponds to the first step regressions of column (5) of Table 3.2). Each column of Table 5.2 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 5.3. They correspond to the first step estimation of column (7) in Table 3.2. Again, all dummy variables are also not shown in these Tables.

Table 5.2: 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}			$z_{it+1}^2\Delta^2 z_{it+1} - z_{it}^2\Delta z_{it}$			
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 5.3: 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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