Intrahousehold Efficiency and Individual Insurance in Ghana

Marcus Goldstein*

London School of Economics
m.p.goldstein@lse.ac.uk

DEDPS 38
June 2004

The Suntory Centre
Suntory and Toyota International Centres for
Economics and Related Disciplines
London School of Economics and Political Science
Houghton Street
London WC2A 2AE
Tel: (020) 7955 6674

* I would like to thank Michael Boozer, Alain de Janvry, Elisabeth Sadoulet, and Christopher Udry for guidance and support. During my fieldwork in Ghana I was fortunate to work with Owusu Abora, Oforiwa Adinku, Esther Adofo, Robert Afedoe, Kwabena Agyapong, Rita Allotey, Patrick Amihere, Stella Anim-Koranteng, Isaac Omane, Peter Ansong-Manu, Kwame Arhin, Lina Borde-Koufie, Ruby Owusu, Esther Sarquah and Margret Yeboah under the able supervision of Ernest Appiah. Research assistance was provided by Aasim Akhtar, Erlend Berg and Ingo Outes-Leon. I am very grateful for funding for the data gathering and writing from the Clair Brown Fellowship, the Economic and Social Research Council, the Fulbright Commission, the Institute for the Study of World Politics, the National Science Foundation, the Rocca Fellowship, the Social Science Research Council, and the World Bank. I also benefited from the comments of Richard Akresh, Oriana Bandiera, Imran Rasul, Tavneet Suri, Diana Weinhold, and seminar participants at Berkeley, Yale and LSE.

Abstract

I test a model of Pareto efficient risk sharing within households using consumption data from Ghana. The results reject this model despite showing that individual consumption is not significantly affected by both agricultural and illness shocks. Turning to transfer data, I find evidence that men share risks with both family members and non-family friends when faced with shocks and that women share risk with non-family friends. The form of these arrangements differ based not only on the gender of the individual, but also the type of shock and nature of the transfer.

Development Economics Discussion Paper Series

This series is published by the Economic Organisation and Public Policy Programme (EOPP) located within the Suntory and Toyota International Centres for Economics and Related Disciplines (STICERD) at the London School of Economics and Political Science. The programme was established in October 1998 as a successor to the Development Economics Research Programme. The work of the programme is mainly in the fields of development economics, public economics and political economy. It is directed by Tim Besley, Oriana Bandiera, Robin Burgess, Maitreesh Ghatak and Andrea Prat. Further details about the programme and its work can be viewed on our web site at http://sticerd.lse.ac.uk/research/eopp.

Our Discussion Paper series is available free of charge. To subscribe to DEDPS, please contact Leila Alberici on:

Telephone: UK+20 7955 6674
Fax: UK+20 7955 6951
Email: l.alberici @lse.ac.uk
Web site: http://sticerd.lse.ac.uk/dedps

> The fact that West African marriage bears so little resemblance to European marriage, in terms both of the domestic economy of the household, and of day to day social activities, receives insufficient emphasis in the literature. Spouses usually enjoy little everyday companionship except, perhaps, when they grow old: they rarely sit and converse; they eat separately; they tend to have separate ceremonial and recreational activities. Considering that they are rarely seen walking down a path together, it is no wonder that they seldom work jointly to produce crops which either party may sell, or toil alongside each other on the fields. Hill, 1975, p.124

1 Introduction

When economists and policy makers approach the analysis of microeconomic behavior of individuals, they often treat the household as a unitary actor. This paper focuses on responses to risk in a developing country and examines the question of whether or not we can treat the household as a unit in its response to risk. Using consumption data from Ghana, I show that husbands and wives do not insure one another in the face of agricultural and illness shocks to their income. The consumption results are confirmed by examining a variety of intrahousehold transfers in cash and kind. These results indicate that we can reject not only that the household acts as a unit, but also that it is not an efficient with respect to risk sharing thereby rejecting a wide class of intrahousehold allocation models.

Nonetheless, despite the fact that there is little evidence of intrahousehold risk sharing, individual private consumption seems to be fairly well protected against shocks. In an effort to identify the appropriate risk sharing group, I examine transfers received from individuals from various sources. The results indicate risk sharing arrangements that vary depending on the mode of assistance, type of shock and gender of the individual seeking to smooth their consumption. Men tend to receive cash and goods transfers from non-family friends in the face of an agricultural shock and labor assistance from family members when they experience an illness. I find no evidence in the mechanisms that I examine that women receive assistance for agricultural shocks, but women do receive assistance from non-family friends when they face an illness shock.

The paper is structured as follows. Section two reviews the relevant literatures exploring mutual insurance and the modeling of household allocation. Section three describes the model that will be used to test for insurance and to identify the mechanisms used to smooth consumption. Section four discusses the data that is used in estimation. Section five discusses the estimation strategy and presents results. Section six concludes.

2 Relevant Literature

Rural people in developing countries face not only the dilemma of poverty but poverty that is exacerbated by risk. Often starting from an income level close to subsistence, farmers face unexpected variations in income that can come from a variety of factors endemic to the environment. Their income is affected by variations in weather, pests, plant disease, theft, and other unforeseen events. This environment can also affect their livelihood more directly though the prevalence of diseases and illness that are associated with inadequate access to clean water and basic health care. The ability of these households to cope with these risks is critical not only to their continued productivity but sometimes to their very survival.

A large literature in economics has evolved to examine how households cope with risk. The first stage in this examination is to examine how significantly risk affects consumption. The initial theoretical work was provided by Diamond (1967) and Wilson (1968). Based on this work, Mace (1991), Cochrane (1991), and Townsend (1994) develop a test for the Pareto efficient allocation of risk. Their test, simply put, is to see if household consumption varies with idiosyncratic shocks while also comoving with average consumption (my model, developed in section II, will use a similar test and expand it to cover allocation within the household). Mace (1991) and Cochrane (1991), using data from the United States, find evidence that many subsets of consumption show evidence of efficient risk sharing, although Mace (1991) rejects this hypothesis for certain categories of consumption and preference specifications. Using data from rural India, Townsend (1994) rejects the hypothesis of perfect insurance but finds that own income does not have a large effect on consumption. After correcting for measurement error and other possible sources of bias, Ravallion and Chaudhuri (1997) find similar results for the same area. Deaton (1992a) also finds an absence of complete risk pooling in villages in Cote d'Ivoire. Grimard (1997) studies the same area as Deaton and uses similar techniques. However Grimard posits, based on anthropological evidence, that the correct risk pool is not the village but rather the ethnic group. He finds more risk pooling than Deaton but still does not find perfect risk pooling. In another approach to examining diverse patterns of risk pooling, Jalan and Ravallion (1999) show that in China the effect of shocks on consumption varies with wealth and that poorer households show greater variance in consumption. However, no group in their sample shows perfect insurance.

Another body of literature that examines the question of consumption smoothing centers around testing the permanent income hypothesis in both developed and developing countries. Alderman and Paxson (1992) discuss ways to distinguish between perfect insurance and the permanent income hypothesis, and Ligon (1998) provides a nested test of these two regimes as well as a private information regime including moral hazard.

How is this partial risk sharing achieved? A much more extensive literature examines the individual mechanisms that households use and I will only discuss selected papers here (Alderman and Paxson (1992) and Besley (1995) provide more comprehensive reviews). Transfers from relatives provide a likely candidate, particularly given the importance of extended family structures in developing countries and in West Africa in particular. Rosenzweig (1988) provides evidence that rural households in India use transfers to smooth consumption and that they prefer to use this mechanism instead of credit. Morduch (1991) also uses data from India and shows that transfers may reduce risk by forty to ninety percent. Rosenzweig and Stark (1989) show that the formation of insurance networks may affect the process of household formation. Using data from India, they show that spouses are often selected from other communities in order to provide a non-covariate risk pool.

Credit markets might provide another risk sharing mechanism. Udry (1994) uses data from Nigeria that shows state contingent repayment loans are used as an insurance mechanism. While this provides a significant buffer against consumption variation, Udry also rejects the hypothesis of perfect insurance. If we broaden the notion of credit to include precautionary savings or the use of savings as a self-insurance mechanism, we cross over to the case where behavior may be better characterized by the permanent income hypothesis. Deaton (1992b) uses this framework to examine savings patterns in Cote d'Ivoire. He concludes that savings may be used by farmers to smooth income over time but this is behavior more likely due to farmers having private information about their future than indicative of behavior in line with the permanent income hypothesis. Paxson (1992) shows that farmers in Thailand save more out of their transitory income in order to secure a smooth consumption path. Beyond credit, households could choose other options for dealing with risk. Rose (1995) and Kochar (1999) show that labor supply is used by farmers in India to smooth consumption in the face of agricultural shocks.

All of these analyses are conducted at the household level. If we believe that households act as a single unit (as in Becker (1993)), then it does not matter whether we analyze consumption and risk at the individual or the household level. However, a growing literature in economics questions and tests this assumption in both the less and more developed countries. Most of the alternatives that have developed to the unitary approach fall under the general rubric of collective household models. Bourguignon and Chiappori (1992) offer a succinct explanation: "the various contributions that follow the collective line share a fundamental option, namely that a household should be described as a group of individuals, each of whom is characterized by particular preferences, and among whom a collective decision process takes place." This class of models contains a wide range of possible decision process within the household, and makes only the assumption that the allocation process is Pareto efficient (Browning, et. al. (1994), Browning and Chiappori (1994), Chiappori, (1992), and Chiappori (1988)). Note that the broad class of collective models includes the unitary model as a particular case. While this general framework does not assume a particular form of preferences nor any prior hypotheses on the sharing rule, the theory does yield a testable result, i.e. that the Slutsky matrix need not be symmetric (as it would be for individuals).

A more restrictive class of collective models is comprised of those that represent intrahousehold allocation as the outcome of a cooperative bargaining process (Manser and Brown (1980), McElroy and Horney (1981), and McElroy (1990)). This approach begins to provide a more concrete framework for the analysis of power – as McElroy (1990) notes: "a key issue that separates bargaining from neoclassical models is the treatment of income: in neoclassical models only pooled family income matters; in the bargaining approach who has control over the various income sources matters." In this approach, individuals form a household when their utility from doing so is greater than their utility in isolation. To determine the distribution of the gains from union, individuals engage in a process of Nash bargaining. The opportunity cost of family membership, or threat point, determines the relative strength of a household member in the bargaining process. These threat points are determined by the extra environmental parameters (EEPs) which determine the utility attainable outside of marriage.

An alterative approach is provided by non-cooperative game theory. The non-cooperative approach is similar to the collective approach in that it also does not presuppose income pooling (Carter and Katz (1997), Lundberg and Pollak (1993, 1994, 1995)). It treats individuals as "autonomous subeconomies" who exchange transfers and also have a vector of commonly consumed goods. Individuals' actions are conditioned on the actions of the other household member and thus a Nash equilibrium is used as the solution concept. These models do not necessarily imply a Pareto optimal outcome (although it can be one possible equilibrium). Lundberg and Pollak (1993) use this literature to make an adjustment to the bargaining models. They note that the use of divorce as a threat point is an extreme and unrealistic argument. Instead they propose that the failure of a cooperative outcome will lead to one of a variety of non-cooperative equilibria.

The major way to empirically distinguish the unitary from other collective models of allocation is to use non-labor income. Most of the work in this area tends to reject the income pooling predicted by the unitary model. For example, using data from Brazil, Thomas (1990) shows that mother's and father's income do not have equal effects regarding nutrient intake, fertility, child survival, and child weight for height. In similar ongoing work on Taiwan, Thomas and a co-author also reject the unitary model based on consumption patterns. Early tests for Pareto efficiency, however, do not reject the hypothesis that intrahousehold allocations are efficient. Another rejection of the unitary model based on expenditures in Cote d'Ivoire can be found in Hoddinott and Haddad (1995). Lundberg, et. al. (1995) use a natural experiment – the shift of child benefit payments from father to mother – to examine the income pooling hypothesis in the United Kingdom. They reject the unitary model as evidence shows that the shift in recipient led to greater expenditure on women's and children's goods. Using consumption data, a number of papers have found grounds to reject the unitary model. Browning and Chiappori (1994) test household demands for symmetry in the Slutsky matrix. They find that this condition does not hold for two member households but does hold, as it should, for single member households. Browning, et. al. (1994) also reject the unitary model of the household with evidence that intrahousehold allocation is affected by relative ages, incomes, and the total expenditure of the household.

When the examination of intrahousehold models turns to production, it is easier to examine Pareto efficiency. Pareto efficient production implies that there would be no gains from redistributing household resources say, from men's fields to women's fields. Using data from Burkina Faso, and controlling for possible reallocations due to risk as well as measurement error, Udry (1996) and Alderman, et. al. (1995) find that allocations are not Pareto efficient and that the value of household output could be increased some 10 to 20 percent by reallocating existing inputs. This result provides for a rejection of not only the unitary model, but many of the collective models. More recent work has sought to test the efficiency of households by focusing on how risk is allocated. Dercon and Krishnan (2000) use data from Ethiopia to estimate the effects of health shocks on nutritional status. They reject full insurance at the household level. Doss (1998) uses rainfall data from Ghana to estimate transitory income and shows that these shocks affect household expenditures differentially based on who within the household sustains the shock.

The notion of a unitary household has long been questioned outside of economics. Papers such as Guyer and Peters (1987) indicate a number of ways in which to challenge the unitary model. Studying the particular case of rice farming in the Gambia, Carney and Watts (1990) provide a case study of the dynamics of intrahousehold bargaining and power. Much of the literature on West Africa indicates that men and women keep separate accounts and even operate in separate economies (see Hill (1975) for an overview). Zwarteveen's work in Burkina Faso (1996) documents separate asset streams and income areas for men and women. Karanja-Diejomaoh (1978) provides extensive detail on couples in Lagos, Nigeria and shows that they maintain separate bank accounts about which the spouse is almost always unaware, have incomes (often in the formal sector) that the spouse cannot estimate, and that males have little idea about the extent of their wives' contribution to household expenditures. The reasons for this often mutual ignorance seems to be to protect their own income from the demands of the spouse. Oppong (1971) indicates that the separation of economic activities and ignorance of each other's income is also a characteristic of households in Accra. She (in this and subsequent work) argues that: "...the financial aspect of the conjugal relationship exhibited two characteristics, *jointness* as regards husbands' and wives' financial provision for their households and *segregation* with regard to spouses' financial management and ownership of property" (184).

With whom then do men and women share information and economic activities with? The kin, especially the clan or lineage, is the oft-cited example. Indeed, this serves as the basis for Grimard's (1997) work and this explanation is cited by a number of non-economists who have worked directly on Ghana (see for example, Fortes (1950) and Feldman and Feldman (1978)). However, others such as Addai-Sundiata (1996) cite economic change as an important factor in the breakdown of some important aspects of the traditional kinship network. Economists who have considered transfers as insurance in the context of the dynamics of agricultural change also warn that we might see results like this. Rosenzweig (1988) in his work on India argues that technical change may change the distribution of risks. This would drive a wedge between family members who are farming different crops, while allowing for more robust contracting between members of the same farming (or income generating activity) cohort. In our area, the recent surge in pineapple production, with its vastly different production technology, could be generating this type of effect.

Organizations consisting of (not necessarily related) members of the same gender may provide the needed alternative to the clan in these times of economic change (see Wipper (1984) for a discussion of women's voluntary groups in Sub-Saharan Africa). Aryeetey's (1995) work on seed technology diffusion in the Ada area of Ghana provides a case where men transmit information mainly to each other and seem to have a separate and distinct network from women. In the area this paper studies there are a number of gender based organizations around production (for example a male farmers cooperative). Many of the women (but few of the men) generate off-farm income through marketing activities and the market provides an important social and economic locus for the women. These joint activities can spawn insurance networks. One example is an organization called the Women's Committee. Consisting of 120 members, one of its chief functions was to provide assistance to a member if a relative passed away (note that a funeral is a significant expense in Ghanian culture). In the end, though, such organizations are only indicative. Recall Hill's words (above), a woman is more likely to spend more of her time and activities with fellow women than her spouse or other men and the same is true for her husband, and so structured organizations may be unnecessary.

This section has discussed how a critical component in individual welfare might be measured and examined. Informal insurance provides a critical buffer for poor households in the risky agricultural environment of developing countries. What this paper will do is look behind the household door to see how individuals cope with risk. Households in West Africa are divided into male and female spheres and in order to better understand the welfare of their members it is necessary to understand to what degree they share risk. When I find that they do not share it with each other, I turn to the connections individuals may have outside of the household.

3 The Model

This section provides a discussion of the model of how efficient risk sharing would take place at the individual level, both within the household and as part of a larger group (e.g. individuals within a village) that builds most directly on the work of Townsend (1994). After identifying what behavior we might expect in consumption patterns, I turn to the most likely mechanism to achieve this, transfers.

3.0.1 The individual in the household

We have two individuals, i and j, living in the same household. There are S possible states of the world that occur with probability π_s. Over time, with a discount rate of β, we can write the individual's expected utility from consuming a vector of goods, c_{ist}, as:

$$\sum_{t=1}^{T} \beta^t \sum_{s=1}^{S} \pi_s U(c_{ist}) \tag{1}$$

Let λ_{hi} be the programming weight assigned to individual i in household h. If we denote the other member of the household as j, then a Pareto efficient allocation of risk within the household can be characterized by:

$$\max_{c_{hist}c_{hjst}} \lambda_{hi}(\sum_{t=1}^{T} \beta^t \sum_{s=1}^{S} \pi_s U(c_{hist})) + (1-\lambda_{hi})(\sum_{t=1}^{T} \beta^t \sum_{s=1}^{S} \pi_s U(c_{hjst})) \tag{2}$$

subject to the following constraint:

$$y_{hist} + y_{hjst} = c_{hist} + c_{hjst} \; \forall s, t \tag{3}$$

This program yields the first order condition:

$$\lambda_{hi} U'(c_{hist}) = (1-\lambda_{hi}) U'(c_{hjst}) \; \forall s, t \tag{4}$$

If we assume that each consumer has the following exponential utility function:

$$U(c_{hist}) = -\frac{1}{\sigma} e^{-\sigma c_{hist}} \tag{5}$$

Then the optimal consumption of both husband and wife at a given time is:

$$c_{hist} = c_{hjst} - \frac{1}{\sigma} \ln(\frac{1-\lambda_{hi}}{\lambda_{hi}}) \; \forall s \tag{6}$$

Thus consumption in the household should move directly together. We can represent their income at a given point in time as the sum of an average component and a shock, x, which is i.i.d. and has a mean of zero:

$$y_{hist} = \bar{y}_{hi} + x_{hist} \tag{7}$$

Equation (6) indicates that the value of this shock should not matter to the consumption of person i in state s. In order to test for perfect insurance, we can add this as an exclusion restriction to equation (6) which can now be written as:

$$c_{hist} = \alpha c_{hjst} + \beta(\bar{y}_{his} + x_{hist}) + \phi\frac{1}{\sigma}\ln(\frac{1-\lambda_{hi}}{\lambda_{hi}}) \tag{8}$$

Taking the difference of consumption over time, we have:

$$c_{hist} - c_{hist-1} = \alpha(c_{hjst} - c_{hjst-1}) + \beta(x_{hist} - x_{hist-1}) + \varepsilon \tag{9}$$

where ε is i.i.d measurement error. Given our theoretical results, the coefficient on the idiosyncratic shocks, β, should be zero if the individual has perfect insurance.

3.0.2 The individual within a group

Suppose that individuals instead pool risk with some group that may or may not include their spouse. For now, let all i's belong to group 1, and the j's to group 2 (the result is specific to the group whether or not it includes both i and j). The problem is now:

$$\max_{c_{hist}} \sum_{h=1}^{H} \lambda_{hi}(\sum_{t=0}^{T} \beta^t \sum_{s=1}^{S} \pi_s U(c_{hist}) \quad for\ i = 1, 2 \tag{10}$$

subject to:

$$\sum_{h=1}^{H} y_{hist} = \sum_{h=1}^{H} c_{hist} \tag{11}$$

and

$$0 < \lambda_{hi} < 1, \ \sum_{h=1}^{H} \lambda_{hi} = 1 \tag{12}$$

Using the exponential utility function, the optimal consumption for individual i is:

$$c_{hist} = \frac{1}{H}\sum_{h=1}^{H} c_{hjst} + \frac{1}{\sigma}(\ln\lambda_{hi} - \sum_{h=1}^{H}\ln\lambda_{hj}) \tag{13}$$

As before, we can add the restriction of income, and take the difference over time to arrive at:

$$c_{hist} - c_{hist-1} = \alpha(\bar{c}_{st} - \bar{c}_{st-1}) + \beta(x_{ist} - x_{ist-1}) + \varepsilon \tag{14}$$

where $\bar{c}_{st}$ is the average consumption for each separate group. The extension to a variety of groups is straightforward. The results indicate that consumption should be unaffected by idiosyncratic shocks and vary with average clan consumption. In theory, we can use this regression (the individual analog of Townsend's household level result) to test insurance within a variety of groups. In practice, as I will discuss in the empirical section, we cannot estimate this equation as it stands, but have to use a variation of it.

3.1 Coping Mechanisms

The most likely mechanism for coping with risks across states at a given time is transfers[1]. Transfers, whether in cash or kind, provide an ideal contemporaneous insurance mechanism as they allow for individuals to adjust their consumption in the period of the shock and avoid variation of consumption over time.

3.1.1 Transfers within the household

In order to incorporate transfers into the model, we can rewrite (7) as:

$$y_{hist} = \bar{y}_{hi} + x_{hist} + \tau_{hist} \tag{15}$$

where τ_{is} is person i's net transfer to his or her spouse in state s. Solving the optimization problem as before, the optimal level of transfers within the household is

$$\tau_{hist} = \frac{1}{2}(y_{hjst} - y_{hist}) + \frac{1}{2}\sigma \ln(\frac{\lambda_{hi}}{1-\lambda_{hi}}) \quad \forall s, t \tag{16}$$

where y includes both the transitory (x) and permanent parts of income. We can see then that transfers should compensate directly for any idiosyncratic shocks to income (in this case at $\frac{1}{2}$ of the shock). Taking the difference of this equation over time gives the equation to be estimated:

$$\tau_{hist} - \tau_{hist-1} = \frac{1}{2}(x_{hjst} - x_{hjst-1}) - \frac{1}{2}(x_{hist} - x_{hist-1}) \quad \forall\ s \tag{17}$$

3.1.2 Transfers within the community

We can now rewrite (7) as:

[1] Udry (1990, 1994) indicates that credit may provide a valuable contemporaneous insurance mechanism in the West African village setting. Future versions of this paper will examine this.

$$y_{hist} = \bar{y}_{hi} + x_{hist} + \omega_{hist} + \tau_{hist} \tag{18}$$

Where ω represents transfers from persons outside of the household. Adding up across households and solving for the optimal level of transfers we have:

$$IH \cdot (\tau_{hist} + \omega_{hist} + \bar{y}_{hi} + x_{hist}) = \sum_{l=1}^{H} \sum_{j=1}^{I} \tau_{jlst} + \omega_{jlst} + \bar{y}_{jl} + x_{jlst} + K_{jk} \tag{19}$$

where K is again the difference in programming weights. We can rewrite this as:

$$(\tau_{hist} + \omega_{hist}) = \frac{1}{IH} (\sum_{l=1}^{H} \sum_{j=1}^{I} \tau_{jlst} + \omega_{jlst} + \bar{y}_{jl} + x_{jlst} + K_{jk}) - \bar{y}_{hi} - x_{hist} \tag{20}$$

which indicates that the transfers that one receives are a function of the difference of the individual shock from the average.

Taking the difference over time we have:

$$(\omega_{hist} - \omega_{hist-1}) + (\tau_{hist} - \tau_{hist-1}) = \beta(x_{hist} - x_{hist-1}) + \alpha(\bar{x}_{st} - \bar{x}_{st-1}) + \varepsilon \tag{21}$$

where $\bar{x}_{st}$ is the group mean. This is the equation to be estimated.

4 The Data

In order to estimate the changes in consumption and transfers as a result of shocks, we need data on these over time. All the data used in this paper comes from a two year rural household survey in southern Ghana supervised by Christopher Udry and myself. Before discussing the data that I will use in estimation, it is worth discussing the study area and the broader design of the survey.

The survey was carried out from November 1996 to October 1998 in the Aukapim South District of the Eastern Region of Ghana. This area is a dynamic agricultural region. In addition to the staple maize and cassava crops that make up the bulk of agricultural production, many farmers have started to grow pineapple for export and domestic processing. The staple crop agricultural system is based on two seasons, a major season, stretching from March to July, and a minor season from

September to December. Pineapple does not need to adhere to this growing season, and hence it shows a less pronounced seasonal variation.

Within this area, we identified four village clusters with a variety of market conditions and cropping patterns. Within each village, we randomly selected 60 married couples (or triples) to be interviewed (in those villages where there was more than 60 resident couples). Enumerators then interviewed the male and female respondents separately. Each person was interviewed 15 times during the course of 2 years. A list of the rounds, their dates, and the questionnaires administered is available at www.econ.yale.edu/~cru2//ghanadata.html.

4.1 Consumption

In order to estimate consumption, I use data from 3 expenditure questionnaires administered thrice during the two years of survey work. These questionnaires covered food consumed from own farms, purchased food, and other (family) expenses. This provides expenditure information but not assigned consumption. However, a number of goods are clearly assignable in that their consumption is private. These are alcoholic beverages, non-alcoholic pre-packaged beverages, prepared food (from kiosks), personal care products, hair cuts, public transport, petrol, car repairs, books, newspapers, entertainment, lottery tickets, and kola nuts. Table 1 presents summary statistics on total expenditure on these goods, by round. These data do not include village 1 because I discovered that the enumerator conducting the interviews for round 4 and round 8 consistently under-covered certain expenditure categories.

Table 2a provides total monthly household expenditure. This includes all expenditures as well as food harvested from the household farms[2]. Given an average household size of 5.6 and an exchange rate of approximately 2100 cedis to one dollar, annual expenditure per capita is around $600. Table 2b contains estimates of total household food expenditure (again including own harvests). Food expenditure accounts for about 65 percent of total expenditure.

In an effort to capture information flows within the household, we asked both spouses to provide not only their own expenditure but also estimates of their spouses' expenditure. The male enumerators initially encountered problems implementing this, so coverage is not complete. Nonetheless, we have at least two (own and female) and sometimes three estimates of each expenditure. Thus, Tables 2a and 2b also provide esti-

[2] This includes harvest and expenditure from household members other than the husband and wife — which is quite small.

mates of total and food expenditure constructed using only the women's reports. Note that the female reports are much lower, which seems to be because they were reporting only the expenditure they knew about. This may be indicative of the level of private information within the household[3].

4.2 Shocks

I have two different measures of shocks. First, there are illnesses. We asked respondents to recall major illnesses[4] and the cost of any related treatments. We asked for this information at two points: first in March 1998 (round 11) and then again in August-September 1998 (round 15). The second measure of shocks is unexpected agricultural shocks. These include pests, plant diseases, theft, and other events. We asked the respondents about these at three different times during the survey; two of these corresponded with the questions on illness, the third was in July 1997 (round 6). Thus, I construct the two periods of shocks to roughly correspond to the administration of the expenditure questionnaires. I use illness in the period spanned by rounds 1 to 4 and rounds 8 to 12. I use agricultural shocks in the period from round 1 to 6[5] and from round 8 to 12.

In rounds 11 and 15, we asked respondents to describe the shock, its severity (ranked from 1 to 5), the proportion of the plot affected and the estimated value of the damage. The value of the damage provides the needed monetary measure of a shock to compare to the change in consumption. Unfortunately, we did not ask for the value of the shock in the period up to round 6. Thus, in terms of the model, I have the value of x_{it} but not the value of x_{it-1}. However, I can use the data from the later rounds to estimate the value of the shocks. In order to do this, I posit that the value of the damage is a function of the severity of the shock, the village where it occurred, the primary crop on the field, the toposequence of the field affected, and the soil type. I estimate this value damage function using the plots which reported a shock in either the round 11or round 15 questionnaires. The results of this estimation are in Table 3. Using these results, I can create an estimated value of

[3]We can rule out the hypothesis that the higher own report totals are caused by double counting as men and women report significantly different structures to expenditure.

[4]We defined major illnesses as those that resulted in medical expenses and/or resulted in missed work.

[5]This leads to the inclusion of shocks beyond the consumption period, which may create noise and lower the reliability of the results.

the shock for x_{it-1}. Using the coefficients provided by the first stage estimation, we have the estimated value of damage due to agricultural shocks to round 6. This, as well as reported values for the other shocks is in table 4[6]. As we can see from the statistics, mean shocks can represent a significant proportion of the mean household expenditure. Moreover, if we add one standard deviation to the mean, shocks can represent in excess of one month's total household expenditure in the first six rounds, and approximately 80 percent of expenditure in the round 8 to 12 period.

The estimation of the early shocks leads to the problem that x_{it-1} is now measured with error. I can treat this as a problem of errors in variables and calculate the reliability ratio from the first stage to adjust the standard errors in the second stage. However, since the regressions I estimate use a differenced regressor, the standard reliability ratio does not apply. Appendix 1 explains how I derive the reliability ratios for these differenced regressors for use in multivariate regressions.

4.3 Transfers

We collected an extensive panel of data on spouse to spouse transfers. The major transfer between husband and wife is "chop money." This is almost always a male to female transfer that is meant for household food and expenses. The amount is usually determined by the husband, although some of them did indicate that they consulted their wives. Another (more indirect) source of transfers is when the respondent sells produce from their spouse's farm. We collected this data from the respondents over the course of 7 rounds, spaced about six weeks apart. Table 5 shows the mean value of these transfers by round. As we can see, chop money accounts for approximately one tenth of monthly household expenditure. Note though, that as with expenditures, we received different accounts of the amount depending on whom we asked. Men indicated the amount was higher.

Unfortunately, we did not collect data on inter-household transfers as frequently. We can use the gifts and transfer questionnaire from rounds 5 and 11 to compare with our shock panel. Recall that our shock data extends from round 1 to 6 and from 8 to 12. This will yield four rounds of shock data preceding each measure of transfers (with two additional rounds in the first period). The gifts data allows us to distinguish between family and non-family transfers but the earlier

[6] While the round 1 to 6 and 8 to 12 shocks seem to have vastly different values, a large part of the differences seems to be driven by different levels of incidence. There was a much higher number of overall shocks reported in round 6 (289 to 171), and much a higher proportion of these were reported by men.

gifts data does not have a complete listing of the gender of the giver. Table 6 shows the mean values of the transfers for the week preceding the interview. Relative to the monthly spouse to spouse transfers these are small. However, they do have a large range as the maximum and minimum values indicate. [see 2252 conshok2.do to do this]

In addition to direct transfers of cash, we can look at transfers in kind. Within the household, one form of this would be for one household member to increase their expenditure on goods that she and her spouse share when her spouse has a shock. To this end, I examine expenditures on children including school related expenses and clothing (I restrict this examination only to goods that can be clearly assigned and hence exclude food). Table 7 shows the summary statistics of spending by men and women on children's goods.

Finally, a common form of transfer in kind in these villages is labor provided either by family or friends. Table 8 shows the breakdown of labor by source and whether paid or unpaid on individual's plots averaged over the entire two year period of the survey. As the table shows, the cultivator is the major source of labor on these farms for both men and women. Outside of this, men engage in a fair amount of labor hiring, which is in line with the facts that they tend to cultivate larger areas as well as grow the main cash crop in the area, pineapple. Non-remunerated labor also plays an important role, accounting for around 25 percent of male, and 30 percent of female, total labor usage. Women get most of their unpaid labor from their family (72 percent of unpaid labor) while men get it mostly from their spouse (42 percent of their unpaid labor). In the sections that follow, we will examine whether or not these labor patterns respond to the shocks the cultivator receives.

5 Estimation

This section examines the implications of the theory on both intra-household and broader insurance using our data. I start with a direct examination of consumption co-movement and insurance. This is followed by a look at various forms of transfers as an insurance mechanism.

5.1 Intrahousehold consumption

In order to examine insurance within the household, we can estimate equation 9. Table 9 presents the results. These results indicate that agricultural shocks have virtually no impact on private consumption. The estimated coefficient is positive, but insignificant, and the 95 percent confidence interval indicates that at most, consumption falls by 3 percent of the agricultural shock. The illness shock (proxied here by illness cost) is also close to zero, but less precisely estimated. At most consumption falls by 47 percent of the illness shock cost. Hence, from the impacts of shocks on consumption, individuals look as if they are well insured against income shocks. However, these results also indicate that the locus of insurance is not the household. The coefficient on spouse's consumption, which the theory predicts to be equal to 1, is negative and not significant. The 95 confidence interval does not encompass one. The final line of table 9 reports the F-test of coefficients predicted by equation 9, and based on this we can reject full insurance within the household, despite the fact the individuals experience little change in their private consumption as a result of their shocks. This leads to the conclusion that the household is the wrong unit of analysis for risk pooling. Despite the fact that husbands and wives farm separate plots and engage in separate economic activities and thus could provide very efficient risk diversification, they do not insure each other. This conclusion may well reach beyond risk. Given the absence of a Pareto efficient pooling of risk within the household, there may be inefficiencies in other areas of household consumption and production. Despite the fact that households do not share risk in a pareto efficient manner, individual consumption seems fairly well insured to shocks, suggesting that while households may be inefficient sharers of risk, individuals may satisfy this elsewhere. Before turning to an examination of what the risk sharing group might be, however, we need to examine how robust these results are.

One possible explanation for these results is that either consumption or shocks are measured with error. I turn first to shocks. In addition to our shock data, we have separately gathered information on income. This is collected through a combination of farm output questionnaires (collected in each of the 14 rounds, with both starting and terminal standing crops valued by the farmer) and a non-farm income questionnaire (administered thrice). Using these data, we can check to see if our measures of shocks really do matter, at least in terms of income. Panel A of table 10 shows the results for the change in total income regressed against the change in both illness and agricultural shocks. Agricultural shocks have a negative and significant coefficient of 0.53, indicating that a little more than half of the value of the shock is reflected in an income change. This gives some independant verification that shocks matter in ways that suggest they are not pure measurement error. Illness shocks, measured here by the value of health related expenses, have no significant impact on income. When we disaggregate these results by plot and off-farm income (panels B and C respectively) we see that this result seems to come from plot income, which further substantiates the conclusion that these shocks matter to income in ways that we would expect.

Turning to the other side of the story, we also must ask if our consumption data are measured with error. The model predicts that the coefficient on spouse's consumption should be one. The results indicate that this coefficient appears to be significantly different from one at the 95 percent level. In order to take a closer look at the comovement of own consumption with one's spouse, table 11 shows a panel regression of own consumption against one's spouse. The coefficient here confirms our earlier results, the coefficient is negative and significant at the 5 percent level, indicating no comovement of own and spouse consumption. Nonetheless, this result could be caused by measurement error. Suppose that consumption was reported with error so that the consumption observed here is true consumption plus some error, u:

$$c = c * +u, \quad u \sim N(0, \sigma_u^2) \tag{22}$$

As a result of this error, the estimate of α (the coefficient on consumption) will be biased towards zero when there are no covariates as follows (Judge, et. al. 1988):

$$plim\, \hat{\alpha} = \frac{\alpha \sigma_{c*}^2}{\sigma_{c*}^2 + \sigma_u^2} \tag{23}$$

We also know that:

$$\sigma_c^2 = \sigma_{c*}^2 + \sigma_u^2 \tag{24}$$

where ${\sigma_c}^2$ is the variance of the observed consumption. In order to estimate the extent of the measurement error needed to obtain the result in table 11, we can solve equation 23 using our estimate of α from the regression results and the fact that the model predicts that α should be 1. Substituting these values in for $\hat{\alpha}$ and α, respectively, I can solve for $\sigma^2{}_{u:}$

$$\sigma_u^2 = 1.09\sigma_c^2 \tag{25}$$

which is impossible. Thus, I rule out the hypothesis that these results are due to measurement error. So if husbands and wives are not sharing risk with one and another, then with whom are they pooling? The following section examines alternate configurations of the risk pool.

5.2 Group Consumption

In order to ascertain the correct group outside of the household that individuals insure with, we would like to estimate equation 14. However, as Deaton (1990) argues, the presence of the mean of the dependant variable as an independent variable is likely to yield uninformative results (he also shows how this holds for the left-out mean). What Deaton shows is that the average values of the α's in equation 14 are mechanically defined to be 1, and hence this estimation strategy is likely not to produce useful information.

Instead, Deaton advocates the use of the following equation (adapted for my notation):

$$\Delta c_{ig} = \sum_{j=1}^{G} \gamma_j \delta_{ig} + \beta \Delta x_{ig} + \varepsilon \tag{26}$$

where gi denotes an individual i who is a member of group g, and δ is a dummy corresponding to group g. As before, we would expect β to be zero if individuals are completely insured. If there are village level changes in income, we would expect γ to be significant, and assist us in the identification of the appropriate risk sharing group. When I estimate equation 26 I obtain the results that, as in the household level estimates, β is close to zero. However, the village (or any other a priori relevant group) dummies are not significant, which fits with our casual observation that these villages experienced no aggregate shocks during the two years in which we worked with them. In sum, we cannot identify the appropriate risk sharing group, other than observing that it is *not* the household from these consumption data. However, I will endeavor to identify some potential risk-sharing groups from the transfer data, to which I now turn.

5.3 Transfers within the household

Transfers between spouses are much more frequent and, on average, much larger than any other transfers individuals in these villages receive. Thus, these might provide a likely vehicle for insurance. However, as shown earlier, there seems to be no insurance at the intra-household level. I examine this question using an estimation of equation 17, including lagged shocks and round dummies. As these data exhibit significant autocorrelation, I estimate this regression using GLS with correction for an AR(2) process and report semi-robust standard errors clustered on the individual. The data I use includes round by round spouse to spouse transfers (reported separately by the husband and wife) as well as the agricultural shocks reported by each respondent for each round. For this panel of agricultural shocks, values were provided directly by the respondent, so there is no need to use the errors-in-variables correction.

Table 12A provides the results of estimating equation 17 using the male reports of different transfers and the respondents' own reports of the value of agricultural shocks. The first panel shows the results using the change in net chop money received as the dependent variable. The results indicate that all of the coefficients are not significantly different from zero, and the confidence intervals show that these are fairly tightly estimated. As discussed earlier, in addition to the direct cash transfers, spouses sometimes take goods from each other's farms. This form of transfer shows some responsiveness to shocks, with the woman's shock in the previous period resulting in an increase (significant at the 10 percent level) in the net chop money that the man receives. However, the sign on this coefficient is the opposite we would expect with insurance, as her shock leads to an increase in the net transfer that he receives (and indeed, this is what we might expect if there was less on his farms for her to receive). The coefficient on men's own shocks, lagged one period, is closer to what we would expect if there was intrahousehold insurance, but it is not significant at the 10 percent level (although close).

Table 12B provides similar estimates using the woman's report of the transfers that take place between her and her husband. In the first panel, we see a significant (at better than the 5 percent level) response of the transfers she receives as a function of her shocks two periods before. Again, this sign is the opposite of that predicted by intrahousehold insurance, her net transfers decrease as the value of the shock increases. The second panel shows the responsiveness of produce transfers to shocks. Here, the impact of a shock on the man's farm is clear, both lagged shocks are significant and negative (at the 5 percent level). While this is to be expected, as the shocks affect his agricultural output, the signs (combined with the lack of a compensatory cash transfer) confirm the absence of intrahousehold insurance. In sum, these transfer results confirm our consumption results, indicating that there is no intrahousehold risk sharing taking place through these types of transfers.

Another form of transfer that may be taking place is through common household expenditures. Husbands and wives may be reducing their contribution to household public goods in response to their own shocks, with the expectation that their spouse will increase their contribution in a form of insurance. Table 13 reports estimates for a variation of equation 17 where transfers are represented by spending on children's goods. The change in own agricultural shocks are significant (at the 10 percent level) and positive, i.e. as the shocks increase, so does spending on children, which is the opposite prediction of intrahousehold insurance.

Spouse shocks are not significant. While these results are heartening in that they show that children do not seem to be negatively impacted by parent's shocks, it also shows that intrahousehold insurance does not take place in one of the central forms of pooled consumption.

5.4 Transfers from outside of the household

Spouses are not insuring with one another, yet they appear to be insuring with someone. This section examines potential broad groups in the context of cash and kind transfers from individuals outside of the household. We first turn to cash and consumption good (e.g. foodstuff) transfers from different groups. In order to do this, we estimate equation 21 for a variety of groups. Since our data does not permit us to identify individual family and friend connections in the shock data, we use the village average shock as the group average consumption. Table 14 presents the results of equation 21 estimated separately for men and women. Panel A presents the results for the change in total non-spouse transfers. For men, transfers respond positively and significantly (at better than the 5 percent level) to own agricultural shocks, indicating that men receive higher transfers in response to their shocks. Transfers to women, on the other hand, show no significant response to agricultural or illness shocks. In an effort to identify the group that provides support, we are able to disaggregate transfers into those received from the family and those received from non-family. Results for these two groups can be found in panels B and C. These show that the support for men comes from non-family friends, a surprising result given the attention in the literature to family support networks in Africa. While the coefficient on non-family transfers is small, it is important to keep in mind that data restrictions limit us to using transfers from the past week. Shocks on the other hand, span a 4 to 6 round period (approximately 24 to 36 weeks). Hence, if we aggregate up this response, it would seem that men receive significant support from non-family members when faced with an agricultural shock.

Another form that transfers can take is through labor. As table 8 indicated, a substantial portion of the labor individuals use on their plots is free labor. One form of insurance may be an increase in the amount of labor that is unpaid either in absolute terms or relative to paid labor. Hence, we can estimate an equation similar to 21 for individual labor. The equation I estimate is:

$$L_{lit} = \beta_1 x_{igt} + \beta_2 \bar{x}_{gt} + \beta_3 \sum_{j \neq l} L_{jit} + \varepsilon \tag{27}$$

where L_{lit} is labor of type l used by individual i in round t, x_{igt} is the shock received by individual i in round t, $\overline{x}_{gt}$ is the relevant mean group shock (either village or spouse) in round t, and $\sum_{j \neq l} L_{jit}$ is the sum of all other labor types at time t used by individual i on all of her plots, introduced as a control for overall farming activity. The estimation includes round dummies to control for seasonality and other time effects and as well as village fixed effects to control for potentially different labor markets across our four villages[7]. I also include individual and group average shocks lagged 3 periods. The structure of the data allow us to estimate this as a panel, we have data on labor for each round as well as illness and agricultural shocks by date. Using our agricultural data, we have shock data spanning rounds 8 to 15, while the illness data stretches back to round 2.

Table 15 provides the results for GLS estimates of equation 27, corrected for an ar(3) process. In the interests of brevity, I report only the coefficients on own and group average shocks for each type of labor. Note that spouse labor has to estimated somewhat differently, as I use the spouse's shocks rather than the group average. This leads to smaller observations for these regressions.

Table 15A shows the results for an illness shock (represented by a dummy). In the first panel we can see that the only significant and positive response for men (at the 10 percent level) is a lagged response from family labor. The size of this coefficient is large, amounting to well over half of the average family labor that men use in the average round (see table 8). Men seem to decrease their use of paid labor in response to a shock 1 period in the past, while they face a cutback in labor from their spouse in the period that they receive an illness shock. These are also fairly large, around one-third of the average labor use of each type in the average round. For women, the significant response comes from non-family labor in the same period that the illness occurs. The coefficient here is close to double the average use of 1 hour of this type of labor by women in a given round. Thus, while non-family non-compensated labor does not seem to play an important role in women's production overall, it seems to play a more important role when a woman is faced by a shock.

Table 15B shows the estimates for an agricultural shock (measured in thousands of cedis). The results for men show a significant and positive response of paid labor in the same period that they have a shock, but the shocks of one period before have a negative and significant coefficient. This may suggest that men initially use paid labor to cope with a agricultural shock but then return their paid labor to more of a

[7] Our estimation here does include village one, since it is only the private consumption data that are not usable.

steady state level when the initial damage has been controlled[8]. Thus, a one standard deviation in the value of a shock (the by-round standard deviation for men is 65,119 cedis) would result in an increase in a 10.4 hour increase in paid labor for shocks in the same period, and a decline of 4.6 hours for shocks one period earlier. The labor that men receive from their spouse is negative and significant in response to an agricultural shock 2 rounds ago. Women respond to agricultural shocks by increasing (in the same round as the shock) their dominant source of labor, their own. Thus, a one standard deviation (22,005 cedis) for women would result in an increase of their own labor of 5.9 hours. Women who experience a shock also face a decline in family labor (from a shock 2 periods ago) and in labor received from their spouse (in the same period as the shock). The decline in spouse labor in response to a one standard deviation increase in the value of the shock would result in about a 1.5 hour decline in spouse labor and a 1.3 hour decline in family labor.

These results show a variety of insurance arrangements through labor markets in these villages. Men and women seem to insure differently from each other as well as in different ways for different types of shocks. Faced with an illness, men seem to get help from their family. Men receive no insurance through labor in the face of an agricultural shock, instead they seem to cope through an increased use of paid labor. Women, on the other hand, receive a significant increase in non-remunerated labor from non-family members when faced with an illness. They also tend to cope with agricultural shocks on their own, although they resort to own labor rather than hired labor. All of these results also confirm our earlier results on spouse to spouse insurance, in no instance is there a significant increase in spouse labor in response to a shock[9].

6 Conclusion

This paper provides some insights into how individuals cope with risk in an informal-insurance system. The household, despite apparent advantages for information and enforcement, is not the locus of any insurance. These results indicate that the private consumption of wife and husband do not move together, although this consumption is not affected by shocks. Data on the main intrahousehold transfer, chop money, as well as transfers in kind (produce and labor) show no responsiveness to

[8]Some of the shocks received by these indivduals are partially reversible, but for the most part labor may be increased to contain the damage (e.g. pest/disease spreading).

[9]Here the controls for spouse shocks are instructive – for both men and women in the agricultural shock regressions, the spouse reduces labor supply in response to a shock on her/his own plot, *not* that of the cultivator.

shocks in ways that would be indicative of risk pooling. We can also rule out that such risk pooling takes place through shifting expenditure burdens for children.

Instead of insuring within the household, individuals are pooling risk with groups outside of the household. These groups vary with not only the gender of the person receiving the shock, but also the source of the risk they face. Men receive significant assistance from non-family friends in the form of cash or (non-labor) kind transfers when they face an agricultural shock. Both men and women receive additional non-remunerated labor when they face an illness. For women, the support comes from non-family friends, while men receive additional labor from family members.

These results indicate that we need to look within and beyond, but not at, the household when we seek to understand informal insurance or make policy. Husbands and wives in this part of Ghana do not share risk with one another, rather they choose a variety of risk pooling groups based on the type of shock they face. While these results show that these groups are different by gender, further work needs to be done to understand what underlies individuals different choices of risk pooling groups and mechanisms.

The main contribution of this paper is to show that informal insurance arrangements are best viewed at the individual level but also that these insurance arrangements are more complex than the literature to date has shown. While individuals seem to protect their consumption well against income shocks from agriculture and illness, the result that men and women insure differently for different shocks indicates that we need to undertake further work to understand this so that we can make appropriately targeted policy, and avoid policy where none is needed.

Appendix 1: Constructing a reliability ratio for the difference measure of shocks

For the purpose of this discussion, let me disaggregate the shock vector (X) into agricultural shocks (S) and illness shocks (L). Recall that the value of agricultural shocks is reported in period t (S_t) and is estimated in period t-1 (S_{t-1}). In a non-differenced, univariate case, we could construct the reliability ratio from the r-squared of the regression of the estimated damage on the reported damage in period t.

However, I use the following variable for estimation:

$$\Delta S_t = S_t - S_{t-1} \tag{28}$$

Where shocks at t are measured without additional error and shocks at time t-1 are measured with an additional, estimable error component (v_{t-1}) so, given that $S \equiv S^*_{t-1}$:

$$S_{t-1} = S^*_{t-1} + v_{t-1} \tag{29}$$

Thus ΔS_t is:

$$\Delta S_t = S^*_t - S^*_{t-1} - v_{t-1} \tag{30}$$

and the variance is:

$$\sigma^2_x = \sigma^2_{S_t} + \sigma^2_{S_{t-1}} - 2cov(S^*_t, S^*_{t-1}) + \sigma^2_v \tag{31}$$

assuming that the variance in true reported shocks is constant over time, the true variance of X is:

$$\sigma^2_{X^*} = \sigma^2(S^*_t - S^*_{t-1}) = 2\sigma^2_S - 2cov(S^*_t, S^*_{t-1}) \tag{32}$$

Thus, the reliability ratio of ΔS_t is:

$$RR\ \Delta S_t = \frac{\sigma^2_{X^*}}{\sigma^2_x} \equiv \lambda \tag{33}$$

Now,

$$let\ \rho \equiv \frac{cov(S^*_t, S^*_{t-1})}{\sigma^2_S} \tag{34}$$

So,

$$\lambda = \frac{2(1-\rho)\sigma^2_{S^*}}{2(1-\rho)\sigma^{S^{*2}} + \sigma^2_v} \tag{35}$$

and

$$\lambda^{-1} = 1 + \frac{\sigma_v^2}{\sigma_{S^*}^2 2(1-\rho)} \tag{36}$$

Let us define λ_0 as:

$$\lambda_0 \equiv \frac{\sigma_{S^*}^2}{\sigma_{S^*}^2 + \sigma_v^2} \tag{37}$$

which we can also write as:

$$1 - \lambda_0 = \frac{\sigma_v^2}{\sigma_{S^*}^2 + \sigma_v^2} \tag{38}$$

We can now rewrite (36)

$$\lambda^{-1} = 1 + \frac{1-\lambda_0}{2\lambda_0(1-\rho)} = \frac{2\lambda_0 - 2\lambda_0\rho + 1 - \lambda_0}{2\lambda_0(1-\rho)} \tag{39}$$

which reduces to:

$$\hat{\lambda} = \frac{2\hat{\lambda}_0(1-\tilde{\rho})}{1 + \hat{\lambda}_0 - 2\hat{\lambda}_0\tilde{\rho}} \tag{40}$$

We can estimate the various variables in (40) through univariate regressions as follows:

$$S_t^* = \hat{\rho}\hat{S}_{t-1} \tag{41}$$

and

$$S_t^* = \hat{\lambda}_0\hat{S}_t \tag{42}$$

We can then insert these into (40) and then control for the multivariate nature of the regression as follows:

$$\lambda_1 = \frac{\hat{\lambda} - R^2}{1 - R^2} \tag{43}$$

Where R^2 is the r-squared statistic from the following regression:

$$S_t - S_{t-1} = \alpha(L_t - L_{t-1}) + \beta(\bar{c}_t - \bar{c}_{t-1}) \tag{44}$$

References

[1] Abel, Andrew and Laurence Kotlikoff. 1988. Does the Consumption of Different Age Groups Move Together? A New Nonparametric Test of Intergenerational Altruism. National Bureau of Economic Research Working Paper No. 2490, Cambridge, MA.

[2] Abu, Katherine. 1983. The Separateness of Spouses: Conjugal Resources in an Ashanti Town." In C. Oppong, ed. Female and Male in West Africa. London: George, Allen and Unwin", pages 156-168.

[3] Addai-Sundiata, J. 1996 "Family Dynamics and Residential Arrangements in Ghana." In E. Ardayfio-Schandorf, ed. The Changing Family in Ghana. Accra: Ghana Universities Press.

[4] Alderman, Harold, John Hoddinott, Lawrence Haddad and Christopher Udry. 1996. "Gender Differentials in Farm Productivity: Implications for Household Efficiency and Agricultural Policy." Food Consumption and Nutrition Division Discussion Paper No. 6. Washington, D.C.: International Food Policy Research Institute.

[5] Alderman, Harold, Pierre-Andre Chiappori, Lawrence Haddad, John Hoddinott, and Ravi Kanbur. 1995. "Unitary versus Collective Models of the Household: Is It Time to Shift the Burden of Proof?" World Bank Research Observer 10, No. 1 (February):1-19.

[6] Alderman, H. and C. Paxson. 1992. "Do the Poor Insure? A Synthesis of the Literature on Risk Sharing Institutions in Developing Countries." Mimeo.

[7] Altonji, J., F. Hayashi and L. Kotlikoff. 1992. "Is the Extended Family Altruistically Linked? Direct Tests Using Micro Data." American Economic Review 82, No. 5: 1177-1198.

[8] Aryeetey, E. Bortei-Doku. 1995. "The Significance of Gender in Seed Transfer Patterns Among Farmers in South-East Ghana." Paper presented at the OAU/SAFGRAD Regional Workshop on Technology Options and Transfer Systems for Food Grain Production in Sub-Saharan Africa, Abidijan, 24-30 April.

[9] Becker, Gary. 1974. "A Theory of Social Interactions." Journal of Political Economy 82, No. 6: 1063-1093.

[10] Behrman, Jere. 1992. "Intra-Household Allocation of Nutrients and Gender Effects: A Survey of Structural and Reduced-Form Estimates." Chapter 10 in S. R. Osmani, editor, Nutrition and Poverty: 287-322. Oxford: Clarendon Press.

[11] Behrman, Jere and Anil Deolalikar. 1990. The Intrahousehold Demand for Nutrients in Rural South India: Individual Estimates, Fixed Effects and Permanent Income." Journal of Human Resources 25, No. 4: 665-695.

[12] Bergstrom, Theodore. 1994. "A Survey of Theories of the Family."

Unpublished manuscript, Department of Economics, University of Michigan.

[13] Bernheim, Douglas and Oded Stark. 1988. "Altruism Within the Family Reconsidered: Do Nice Guys Finish Last?" American Economic Review 78, No. 5(December):1034-1045.

[14] Besley, T. 1995. "Savings, Credit and Insurance." Chapter 36 in J. Behrman and T. N. Srinivasan, eds. Handbook of Development Economics, Vol III. Amsterdam: Elsevier Science: 2123-2207.

[15] Bourguignon, Francois and Pierre-Andre Chiappori. 1992. "Collective Models of Household Behavior: An introduction." European Economic Review 36:355-34.

[16] von Braun, Joachim and Patrick Webb. 1989. "The Impact of new Crop Technology on the Agricultural Division of Labor in a West African Setting." Economic Development and Cultural Change 37, No. 3 (April): 513-534.

[17] von Braun, Joachim. 1988. "Effects of Technological Change in Agriculture on Food Consumption and Nutrition: Rice in a West African Setting." World Development 16, No. 9: 1083-1098.

[18] Browning, Martin, Francois Burguignon, Pierre-Andre Chiappori, Valerie Lechene. 1994. "Income and Outcomes: A Structural Model of Intrahousehold Allocation." Journal of Political Economy 102, No. 6: 1067-1096.

[19] Browning, Martin and Pierre-Andre Chiappori. 1994. "Efficient Intra-Household Allocations: A General Characterization and Empirical Tests." Unpublished manuscript.

[20] Carney, J. and M. Watts. 1990. "Manufacturing Dissent: Work, Gender and The Politics of Meaning in a Peasant Society." Africa, 60 (2): 205-241.

[21] Chiappori, Pierre-Andre. 1992. "Collective Labor Supply and Welfare." Journal of Political Economy 100, No. 3: 437-467.

[22] Chiappori, Pierre-Andre. 1991. "Nash-Bargained Household Decisions: A Rejoinder." International Economic Review 32, No. 3: 761-763.

[23] Chiappori, Pierre-Andre. 1988. "Rational Household Labor Supply" Econometrica 56, No. 1 (January):63-89.

[24] Chiappori, Pierre-Andre. 1988. "Nash-Bargained Households Decisions: A Comment." International Economic Review 29, No. 4 (November): 791-796.

[25] Cochrane, J. 1991. "A Simple Test of Consumption Insurance." Journal of Political Economy 99,No. 5: 957-976.

[26] Deaton, A. 1992a. "Household Saving in LDCs: Credit Markets, Insurance and Welfare." Scandinavian Journal of Economics 94, No.

2: 253-273.

[27] Deaton, A. 1992b. "Savings and Income Smoothing in Cote d'Ivoire." Journal of African Economies 1, No. 1: 1-23.

[28] Deaton, Angus. 1987. "The Allocation of Goods Within the Household: Adults, Children and Gender." Living Standards Measurement Survey Working Paper Number 39. Washington, D.C.: The World Bank.

[29] Deaton, Angus and John Muellbauer. 1986. "On Measuring Child Costs: With Applications to Poor Countries." Journal of Political Economy 94, No. 4: 720-744.

[30] Dercon, S. and P. Krishnan. 2000. "In Sickness and in Health: Risk-Sharing within Households in Rural Ethiopia" Journal of Political Economy 108, No. 4: 688-727.

[31] Diamond, P. 1967. "The Role of a Stock Market in a General Equilibrium Model with Technological Uncertainty." American Economic Review 57, No. 4: 759-776.

[32] Doss, C. 1998. "Is Risk Fully Pooled Within the Household? Evidence from Ghana" Mimeo, Economics Department, Williams College.

[33] Doss, C. 1996. "Intrahousehold Resource Allocation in an Uncertain Environment." American Journal of Agricultural Economics 78: 1335-1339.

[34] Feldman, H. and M. Feldman. 1978. "Continuity and Change in the Use of the Kin Group as a Resource Among Ghanaians." In C. Oppong, G Adaba, M. Bekombo-Priso, and J. Mogey, eds. Marriage, Fertility and Parenthood in West Africa. Changing African Family Project Monograph Series; No. 4. Canberra: Australian National University.

[35] Fapohunda, Eleanor R. 1983. Female and Male Work Profiles in C. Oppong, ed. Female and Male in West Africa. London: George, Allen and Unwin", pages 32-53.

[36] Folbre, Nancy. 1986. "Cleaning House: New Perspectives on Households and Economic Development." Journal of Development Economics 22: 5-40.

[37] Folbre, Nancy. 1984. "Household Production in the Philippines: A Non-neoclassical Approach." Economic Development and Cultural Change 32, No. 2: 303-330.

[38] Fortes, M. 1950. "Kinship and Marriage Among the Ashanti." In A. Radcliffe-Brown and D. Forde, eds. African Systems of Kinship and Marriage. London: Oxford University Press.

[39] Fortin, Bernard and Guy LaCroix. 1993. "A Test of the Neoclassical and Collective Models of Household Labor Supply." Cahier

de recherche numero 93-24 du Groupe de Recherce en Politique Economique. Montreal: Laval University Department of Economics.

[40] Foster, Andrew and Mark Rosenzweig. 1995. "Imperfect Commitment, Altruism and the Family: Evidence from Transfer Behavior in Low-Income Rural Areas." Unpublished manuscript, Department of Economics, University of Pennsylvania.

[41] Grimard, F. 1997. "Household Consumption Smoothing Through Ethnic Ties: Evidence from Cote d'Ivoire." Journal of Development Economics 53: 391-422.

[42] Guyer, J. and P. Peters. 1987. "Introduction: Conceptualizing the Household: Issues of Theories and Policy in Africa." Development and Change 18 (2): 197-214.

[43] Guyer, Jane. 1986. "Intra-Household Processes and Farming Systems Research: Perspectives from Anthropology." Chapter 5 in Joyce Moock, editor, Understanding Africa's Rural Households and Farming Systems. Boulder: Westview Press.

[44] Haddad, Lawrence, John Hoddinott and Harold Alderman. 1994. Intrahousehold Resource Allocation: An Overview. Policy Research Working Paper No. 1255. Washington D.C.: The World Bank,

[45] Hill, P. 1975. "The West African Farming Household." In J. Goody, ed. Changing Social Structure in Ghana: Essays in the Comparative Sociology of a New State and an Old Tradition. London: International African Institute.

[46] Hoddinott, John and Lawrence Haddad. 1995. "Does Female Income Share Influence Household Expenditures? Evidence from Cote d'Ivoire." Oxford Bulletin of Economics and Statistics 57, No. 1 (February): 77-96.

[47] Jalan, J. and M. Ravallion. 1997. "Are the Poor Less Well Insured? Evidence on Vulnerability to Income Risk in Rural China." Mimeo, The World Bank.

[48] Jones, Christine. 1986. Intra-Household Bargaining in Response to the Introduction of New Crops: A Case Study from North Cameroon. Chapter 6 in Joyce Moock, editor, Understanding Africa's Rural Households and Farming Systems. Boulder: Westview Press.

[49] Jones, Christine. 1983. "The Mobilization of Women's Labor for Cash Crop Production: A Game Theoretic Approach." American Journal of Agricultural Economics 65 (December): 1049-1054.

[50] Judge, G. et. al. 1988. Introduction to the Theory and Practice of Econometrics. Second Edition. New York: John Wiley and Sons.

[51] Karanja-Diejomaoh, W. M. 1978. "Disposition of Incomes by Husbands and Wives: An Exploratory Study of Families in Lagos." In

C. Oppong, G Adaba, M. Bekombo-Priso, and J. Mogey, eds. Marriage, Fertility and Parenthood in West Africa. Changing African Family Project Monograph Series; No. 4. Canberra: Australian National University.

[52] Kochar, A. 1999. "Smoothing Consumption by Smoothing Income: Hours of Work Responses to Idiosyncratic Agricultural Shocks in Rural India." Review of Economics and Statistics 81, No. 1: 50-61.

[53] Mace, B. 1991. "Full Insurance in the Presence of Aggregate Uncertainty." Journal of Political Economy 99, No. 5: 928-956.

[54] Ligon, E. 1998. "Risk Sharing and Information in Village Economies." Review of Economic Studies 65: 847-864.

[55] Lundberg, Shelly and Robert Pollak. 1995. "Bargaining and Distribution in Marriage." Institute For Economic Research Discussion Paper 95-16. Seattle: University of Washington.

[56] Lundberg, Shelly, Robert Pollak, and T. Wales. 1995. "Do Husbands and Wives Pool Their resources? Evidence form the U.K. Child Benefit." Unpublished manuscript.

[57] Lundberg, Shelly and Robert Pollak. 1994. "Noncooperative Bargaining Models of Marriage." American Economic Review 84, No. 2: 132-137.

[58] Lundberg, Shelly and Robert Pollak. 1993. "Separate Spheres Bargaining and the Marriage Market." Journal of Political Economy 101, No. 6: 988-1010.

[59] Manser, Marilyn and Murray Brown. 1980. "Marriage and Household Decision-Making: A Bargaining Analysis." International Economic Review 21, 1 (February): 31-44.

[60] McElroy, Marjorie. 1990. "The Empirical Content of Nash-Bargained Household Behavior." Journal of Human Resources 25, No. 4: 560-584.

[61] McElroy, Marjorie and Mary Jean Horney. 1990. "Nash-Bargained Household Decisions: Reply." International Economic Review 31, No. 1: 237-242.

[62] McElroy, Marjorie and Mary Jean Horney. 1981. "Nash-Bargained Household Decisions: Toward a Generalization of the Theory of Demand." International Economic Review 22, No. 2 (June): 333-349.

[63] McLean, Keith. 1994. "Can a Better Understanding of the Dynamics of Intrahousehold Allocation Improve the Effectiveness of Targeting?" MA Dissertation, University of Sussex.

[64] Morduch, J. 1991. "Consumption Smoothing Across Space: Tests for Village Level Responses to Risk." Mimeo, Harvard University.

[65] Oppong, C. 1971. "Joint Conjugal Roles and Extended Families:

A Preliminary Note on a Mode of Classifying Conjugal Family Relationships." Journal of Comparative Studies 2, No. 2 (Autumn): 178-187.

[66] Paxson, C. 1992. "Using Weather Variability to Estimate the Response of Savings to Transitory Income in Thailand." American Economic Review 82, No.1: 15-33.

[67] Pitt, Mark, Mark Rosenzweig and Md. Nzmul Hassan. 1990. "Productivity, health and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries." American Economic Review 80, No. 5 (December): 1139-1156.

[68] Ravallion, M. and S. Chaudhuri. 1997. "Risk and Insurance in Village India: Comment." Econometrica 65, No. 1: 171-184.

[69] Rose, E. 1999. "Consumption Smoothing and Excess Female Mortality in Rural India." Review of Economics and Statistics 81, No.1.

[70] Rosenzweig, M. and O. Stark. 1989. "Consumption Smoothing, Migration, and Marriage: Evidence from Rural India." Journal of Political Economy 97, No. 4: 905-926.

[71] Rosenzweig, M. 1988. "Risk, Implicit Contracts and the Family in Rural Areas of Low-Income Countries." The Economic Journal 98: 1148-1170.

[72] Rosenzweig, Mark. 1986. "Program Interventions, Intrahousehold Distribution and the Welfare of Individuals: Modeling Household Behavior." World Development 14, No. 2: 233-243.

[73] Schultz, T. Paul. 1990. "Testing the Neoclassical Model of Family Labor Supply an Fertility." Journal of Human Resources 25, No. 4: 599-632.

[74] Strauss, John and Duncan Thomas. 1995. "Human Resources: Empirical Modeling of Household and Family Decisions." Chapter 34 in J. Behrman and T.N. Srinivasan, eds. Handbook of Development Economics, Volume IIIA: 1885-2023. Amsterdam: Elsevier Science.

[75] Thomas, Duncan. 1994. "Like Father, Like Son; Like Mother, Like Daughter: Parental Resources and Child Height." Journal of Human Resources 29, No. 4 (Fall): 950-988.

[76] Thomas, Duncan. 1990. "Intra-Household Resource Allocation: An Inferential Approach." Journal of Human Resources 25, No. 4: 635-664.

[77] Townsend, R. 1994. "Risk and Insurance in Village India." Econometrica 62, No. 3: 539-591.

[78] Udry, C. 1996. "Gender, Agricultural Production and the Theory of the Household." Journal of Political Economy 104, No. 5: 1010-1046.

[79] Udry, C. 1995. "Risk and Saving in Northern Nigeria." American

Economic Review 85, No. 5: 1287-1300.
[80] Udry, C. 1994. "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria." Review of Economic Studies, 61.