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Do Households Fully Share Risk? Evidence from Ghana

by

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Intrahousehold analyses provide new insights into how households make economic decisions. Much of the work in economics has traditionally treated the household as a single economic actor, but a number of studies are providing evidence that the dynamics among household members affect the outcomes of household economic decisions. This paper contributes to our understanding of such models by incorporating the variability of individual incomes into the analysis of intrahousehold resource allocations, using detailed household survey data from Ghana.

The intrahousehold literature provides evidence that households do not pool all of their income. Recent analyses by Phipps and Burton (1993) and Hoddinott and Haddad (1995) suggest that the income earned by women has a different effect on household expenditure patterns than income earned by men. Studies by Thomas (1993), Schultz (1990), and Thomas and Chen (1993)

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provide evidence against a unified model of the household[2] by demonstrating that women's unearned income affects household labor and resource allocation decisions in different ways from men's unearned income.

Both cooperative and noncooperative bargaining models have been developed which take the policy and social environment into consideration. In these models, factors that affect individual bargaining power influence household economic decisions. However, even the few models that incorporate dynamic elements (e.g. Ott, 1995) do not incorporate the seasonal and annual variability that characterizes incomes in developing countries.

Much of the literature on income variability focuses on household strategies to minimize household income fluctuation. These models assume that the decision-making unit is the household and that all individuals within the household have the same interest in minimizing household income variability and will benefit equally from actions to do so. The underlying presumption is that by smoothing household income, individual consumption will also be smoothed. Researchers have identified a number of different strategies that households use to minimize household income variability, including diversification of household income sources, intermarriage with people in areas where the weather shocks may be different, and migration. (Alderman and Paxson 1992; Townsend 1995a; and Morduch 1995 discuss this literature.) These are all important household strategies.

The intrahousehold literature, however, encourages us to be much more thoughtful about relationships and dynamics *within* households. Total household welfare may increase by

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[2] In a unified model of the household, individual preferences and incomes are aggregated into a household utility function and budget constraint.

encouraging different members of the household to diversify the household portfolio of income-generating activities. However, if household members are not certain that the household will remain intact, or if some individuals receive fewer benefits from sharing income risk, then some household members may focus on reducing the variability of their individual incomes rather than household income. Strategies used by individuals to smooth income may involve choices of risk sharing with individuals from other households.

If one of the functions of households is to share at least some risk among members, we would not expect that all resource allocations are made on the basis of realized individual incomes in a given year. We would expect to find consumption smoothing across individuals and across time. Resource allocations may be based, in part, on the expected incomes of individuals in a given period rather than their actual income. Thus, we may obtain biased results regarding the intrahousehold allocation of resources if we simply use a static framework that does not take into account the income variability of both individual and household income.

Risk Sharing Networks

Much of the recent research on peasant risk management focuses on how risk is shared among people other than household members. Members of villages, kin groups, and households may all share risk. In a risky environment, community or village systems may develop to insure peasants against risk. Solidarity systems provide some means of smoothing consumption within villages. But even when looking at risk sharing networks at the village or business level, it may be important to ask whether the smallest unit of analysis is appropriately the household or the individual.

A number of researchers have asked whether villages provide insurance to households within the village. If the village provides full insurance, in the sense that households in the village pool all of their risk and provide for the consumption needs of all households, the consumption of individual households would be based only on initial endowments and preferences and on aggregate shocks, not on household earnings in any given year. Townsend (1994), using data from three poor, high-risk villages in semi-arid southern India, statistically rejects the full insurance model, claiming that villages display considerable but imperfect risk sharing. Similarly, he rejects full insurance for ten villages in northern Thailand (Townsend 1995b).

An alternative hypothesis is that at the village level, there are partial insurance mechanisms, rather than full insurance mechanisms. For example, Scott (1976) suggests that a "moral economy" guarantees subsistence to individuals but does not provide full insurance. Some of the means of guaranteeing subsistence may not be observable in most household survey data. For example, the community may provide short-term labor assistance on a field for someone who is ill; providing labor may be less costly than allowing the crops to fail and then providing the means of subsistence. Fafchamps (1993) uses the theory of infinitely-repeated games to suggest that cooperation can be sustained and that a "moral economy" system may be a rational means for peasants to manage risk.

Partial risk sharing may be implemented through state contingent credit contracts, as Udry (1990) finds in Northern Nigeria. Repayments of credit within the village are dependent on the realization of random shocks of both borrowers and lenders. Fafchamps (1994) finds similar state contingent contracts in the commercial sector of Ghana; clients share risk with their suppliers.

Finally, we expect that households act to share risk among their members. Certainly, we expect that households provide some insurance for those who cannot provide for themselves -- the very old, the very young, the ill, and the disabled. Discussions of household strategies for risk management implicitly assume more. They assume that risk is pooled within the household, even among those who are able to provide for themselves. Empirical analyses often use the household as the smallest unit of analysis. In part, this is due to data constraints, but it is also due to the implicit acceptance of unified household models. If the unified models do not hold, then it is important to reexamine issues of risk sharing. For example, Rosenzweig (1992) notes that households in rural India sell livestock as one means of smoothing consumption. But the intrahousehold literature suggests that such sales may have different effects on household outcomes depending on whether women or men own the livestock and receive this income.

Thus, although it is important to see how risk is shared within villages, kinship groups, and households, it is also important to see the individual household members as actors who are trying to ensure their own well-being. Risk sharing networks may be networks of individuals -- not necessarily of households -- with households serving as one component of an individual's risk-sharing strategy. For example, Fafchamps' (1994) example of risk sharing in the commercial sector examines relationships among clients and suppliers. We would not necessarily expect the boundaries of these commercial units to overlap exactly with those of households.

Especially in places such as West Africa, where households are relatively fluid, individuals may try to minimize their individual exposure to risk. Individuals want to protect themselves from the economic risks involved with the dissolution of the household due to divorce or the death of a household member.[3] For example, it is common in some areas of Ghana for a woman to want to own her own house even when she lives in a house owned by her spouse. Among some ethnic groups, when a man dies, his wife (or wives) do not inherit the house; instead the house passes to the man's sons or brothers. Especially if she did not produce sons, the wife may not be allowed to remain in the house where she and her husband lived and raised their children.

In addition, the structure of households may depend in part on economic forces. For example, Doss, Levison and Benefo (1996) find significant changes in household structure during the period of structural adjustment in Ghana (1984-1992). During this relatively short period of time, the average number of people within each household decreased significantly. If individuals change the household to which they belong, and especially if they do so in response to economic factors, then the household may not be the appropriate unit of analysis for theories of risk sharing.

Household Survey Data From Ghana

This analysis provides a preliminary test of the full risk sharing hypothesis using data from the 1991-92 Ghana Living Standards Survey (GLSS3).

The GLSS3 data offers a unique opportunity to study intrahousehold issues in Africa, since the income, consumption, and expenditure data are unusually detailed. In many cases, income and asset holdings can be disaggregated to the level of individual household members. Other large-scale surveys, including the 1987-88 and 1988-89 rounds of the Ghana Living Standards Survey, do not include questions about individual control of agricultural revenue.

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[3] Of the 10,832 adults interviewed in the 1991-92 Ghana Living Standards Survey, more women than men reported being divorced or widowed: 211 men reported their marital status as divorced and 75 as widowed while 520 women reported their status as divorced and 553 as widowed.

One of the challenges in analyzing intrahousehold issues in West Africa is determining the boundaries of the household. Especially in rural areas, people live in compounds that may or may not reflect production and consumption units. Nuclear or extended family units may also not coincide with production and consumption units. For the purposes of the GLSS3 a household was defined as a group of people who had usually slept in the same dwelling and had taken their meals together for at least 9 of the 12 months prior to the survey. People who had been away from the household for more than three months were not considered household members, except for the person identified as the head of the household, newly-born children, and students and seasonal workers who had not been part of another household (Republic of Ghana Statistical Service, 1990).

Interviewers for the GLSS3 were asked to identify the head of each household that they interviewed. To incorporate important structural characteristics of the household for the the analysis in this paper, households are defined as potentially having both a male head and a female head which are the persons defined in the survey as the head and his or her spouse. Over half of the households reported having both a male and a female head. Households reporting only a female head present comprised 32 percent of the households in the survey.

Using the GLSS definitions of households, household size ranged from one to thirty. Mean household size was 4.5 individuals. Six percent of households were polygynous, with most of them reporting two wives present, although up to five wives were reported by some households.

GLSS3 contains detailed information on expenditure and income. Data on frequent expenditures, both food and nonfood, were collected at two-day intervals for rural households over a period of 14 days and at three-day intervals for urban households over a 30-day period. Thus, the information is detailed enough to include, for example, a rural household's expenditures on pepper and charcoal every two or three days.

Annual expenditures were obtained for other goods, including education. For items infrequently purchased, monthly expenditures were calculated from expenditures over a three-month or twelve-month period, depending on each household's frequency of purchase of that particular item. Imputed values were calculated for housing, where appropriate, and for consumer durable goods.

In addition to cash expenses, the survey collected data on the value of certain home-produced goods, including food. It was possible to calculate total monthly expenditures for consumption by including the cash expenses and imputed value of goods produced and consumed by the household. (Expenses on agricultural inputs were not included.) The imputed value of food produced and consumed by the household was calculated based on the household's report of the price obtainable by selling the items in the market.

In contrast to previous surveys in Ghana and Côte d'Ivoire, much of the income data in

GLSS3 can be assigned to individuals. Each individual who held land reported detailed information on each plot held, including answers to questions about who made decisions about which crops to grow, who decided the level of inputs to use, and who kept the revenue from the crops on that plot. Thus, the revenue from agriculture can be assigned to the individual who made the decisions and kept the revenue. Using this information for each of the plots and the information on which crops were harvested from each plot, almost all of the value of food produced and consumed by the household can also be assigned to individuals. This person is not necessarily the head of the household or the holder of the land. In addition, wage income was collected on each individual household member over the age of seven. The person responsible for agricultural processing activities and non-farm enterprises is also identified in the data.

Consumption data cannot be disaggregated. Medical expenses in the two weeks prior to the survey and education expenses are the only categories of expenses in GLSS3 that can be assigned to individuals. For many household expenditures, it is theoretically impossible to determine which household member received the goods, especially for shared goods such as housing and utilities. Thus, this analysis examines the effects of shocks to men's and women's crop incomes on household expenditure patterns.

Theoretical Framework of Risk Sharing Within Households

The following framework provides a model of households in which individuals maximize utility independently but can share all, none, or some of their individual income risk with other household members. In this framework, it is possible to test the hypothesis that household members share all of their income risk. Full risk sharing within households is consistent with a unified household model and with the literature examining household strategies for risk management. The finding that households do not fully share risk would cause us to question the current framework for understanding risk management in developing countries and encourage us to develop theories that see individuals as the primary actors, working within the context and constraints of their households.

In the proposed model, each person maximizes his or her own utility facing a budget constraint which is composed of permanent income, transitory income, and net transfers from other household members.[4]

Each household member *j* maximizes his or her utility *u* according the following:

$$\max_{x^j} U^j = u^j(x^j \mid \alpha^j,\ \beta^j,\ T^j) \tag{1}$$

where x^j is a vector of goods consumed by *j* which may include both purchased and home produced goods; α^j is the proportion of income risk that individual *j* shares with other household members; β^j is the amount of the household transitory income received by individual *j*; and T^j is the net transfers to individual *j*. Individuals are subject to a budget constraint:

$$px^j = \bar{y}^j + \theta^j + T^j \tag{2}$$

where:

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[4] The use of permanent and transitory income in this context follows Paxson's (1992) terminology, which is based on Friedman (1957). An alternative term for permanent income would be expected income (or average income over a relatively short number of years). In this paper, permanent income should not be interpreted as lifetime income, since life-cycle patterns are not incorporated into the framework.

$$\theta^j = s^j(1-\alpha^j) + \beta^j \sum_{k=1}^{K} \alpha^k s^k$$
$$s^j = y^j - \bar{y}^j \qquad (3)$$
$$0 \leq \alpha \leq 1$$
$$y^j \sim N(\bar{y}^j, \sigma^2)$$

p is the vector of prices corresponding to x; $\bar{y}^j$ is the permanent income of individual j; θ^j is the transitory income of individual j; s^j is the shock to j's individual income; k indexes all household members; and y^j is the total income earned by individual j.

The proportion of risk that is pooled by individual j is α^j. The level of α^j determines to what extent an income shock to individual j is shared among all household members. If any income risk is pooled among household members, shocks to total household income will in general be proportionally less than shocks to individual income. If α^j=1 for all members of the household, all income risk is pooled and each individual's consumption depends on his or her permanent income, transfers, and household transitory income. If α^j=0 for any member j, then that individual's consumption depends only on his or her permanent income, net transfers, and his or her individual income shocks. If α^j is between 0 and 1, then the individual is sharing some of his or her income risk with household members and both shocks to his or her income and shocks to other household members will affect his or her consumption.

This is expressed formally in the definition of transitory income, θ^j, which is the sum of two components. The first term is the portion of j's shock that is not pooled with other household members. This portion of *j*'s shock directly affects his or her transitory income. The second term is *j*'s portion of household transitory income. Each individual's shock is the difference between their earnings in a given period and their permanent income. The sum of the pooled portions of the shocks of all household members is the household transitory income.

The determination of T^j, α^j, and β^j can be modelled as being the result of a bargaining process. For example, Carter and Katz (1992) use a cooperative bargaining model to determine the levels of transfers among household members. This paper does not detail the implications of determining these parameters within a household bargaining process.

Estimating Shocks to Crop Income

Estimating the shocks to household income poses a number of theoretical and empirical challenges. First, much of the variance in household income is endogenous. Changes in earnings due to illness may reflect past decisions about medical expenditures or the allocation of nutrients among household members. Individual choices to participate in risky but potentially lucrative activities are also made within the household. Thus, variation in income is to a large extent an endogenous outcome of the household decision process. To test the hypothesis of full risk pooling, it is necessary to test the effects of exogenous shocks on household economic decisions. Rainfall variability is used in this analysis as an exogenous shock. By examining whether rainfall shocks to men's and women's crop incomes differently affect household expenditures, we can test whether household members ENDFIELD fully insure one another.

Rainfall data were provided by the Ghana Meteorological Services Department. Fifteen different rainfall areas are defined, based on their administrative region and ecological zone.[5] Using time-series data from 1961-1992, the mean and variance for each location are calculated for this period.[6]

Using time-series rainfall data combined with detailed information on the crops grown and inputs used, crop incomes for the survey year are predicted for both men and women in each household. Permanent crop incomes are calculated by substituting average rainfall over the thirty-year period into the same equations (details provided below). Shocks to crop income are defined as the difference between the crop incomes for the survey year and the permanent crop incomes.

Table 1 provides information on the instruments used to predict crop income. The crop incomes of men and women are treated as separate observations. Measures of rainfall for each region are interacted with a set of dummy variables indicating whether or not each of 11 major crops was grown. Since the timing of rainfall is important to crop production, the measures of rainfall used are rainfall in March (the initial month of the rainy season), the sum of rainfall for the quarter consisting of April, May and June, and the sum of rainfall for the quarter consisting of July, August, and September. The squared values of these measures of rainfall are also included to allow for nonlinear effects.

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[5] Ghana has 10 regions for administrative purposes and three distinct ecological zones -- coastal, forested, and savanna. Many of the administrative zones fall into more than one ecological zone. Additional rainfall data was available, but it could not be matched with the GLSS data.

[6] Some stations did not have complete information over the 30 year period. In these cases, all of the data that were available were used.

Since different households were interviewed during the different seasons, it is necessary to determine the appropriate rainfall season for each household. For staple grains, field crops, and cash crops, the survey asked about the production and value of crops harvested and sold within the prior twelve months. The rainfall measures that are used for these crops are the rainfall data for the year prior to the last harvest (R^1, R^2, and R^3). By contrast, root crops, fruits, vegetables and other crops are harvested piecemeal. Data were collected on the harvest of these crops for the two weeks prior to the survey. Thus, the rainfall measures that are appropriate for these crops are the rainfall data for the year prior to the survey (R^4, R^5, and R^6).

For other crops, rainfall data from different time periods are used. Specifically, the dummy variable for whether cocoa is grown is interacted with the total annual rainfall since the timing of rainfall is less important for cocoa. Annual rainfall is interacted with the dummies indicating whether any of the plots were irrigated and whether any fertilizer was used. Finally, normalized annual rainfall[7] is interacted with the amount of area planted to crops. These different variables provide more detailed information about the effect of rainfall on crop income. The crop and input dummy variables also capture some of the differences in land quality, since land of different types and quality may be planted to different crops and receive different combinations of inputs.

It is not possible to determine how much area was planted to each of the specific crops. Most of the land is intercropped, frequently with several crops, and thus the survey did not ask farmers to estimate how much land was planted to each crop. The approach used in this paper

[7] Annual rainfall is normalized as follows: (previous year's rainfall - mean annual rainfall) / variance of annual rainfall. This captures the deviation from average rainfall.

does not try to capture the relative amounts of land planted to different crops.

Table 2 provides the results of the regression used to predict crop income for the survey year. Crop income (y^i, where i indexes men and women) is predicted using the rainfall variables R^1-R^6. Using the same coefficients presented in Table 2, permanent crop income ($\bar{y}^i$) was predicted using average rainfall over the thirty year time series instead of rainfall prior to the survey date. Since average rainfall over a thirty year period is used, it is not necessary to differentiate between the appropriate rain cycle for crops harvested annually and those harvested piecemeal: R^7 was substituted for R^1 and R^4, R^8 was substituted for R^2 and R_5, and R^9 was substituted for R^3 and R^6.

Shocks to crop incomes (s^i) are calculated as the difference between crop income in the survey year and permanent crop income:

$$s^i = y^i - \bar{y}^i \tag{4}$$

Using this approach, about half of the households have positive shocks to their crop incomes and half have negative shocks. This distribution allows the analysis to examine the effects of both positive and negative shocks.

Crop income represents only a portion of total household income. For all households in the sample, crop income represents an average of 30 percent of total household income. For households that had land planted to crops, crop income is an average of 49 percent of household income.

Empirical Framework to Test Risk Sharing Within Households

The theoretical model described above provides a framework to empirically test whether shocks to individual household members' incomes affect household expenditures differently. With cross-section data, to observe differences in the influence of individual shocks on household expenditures, it must be the case that individuals with similar preferences can be grouped. If preferences are randomly distributed throughout the population, we would not see any patterns even if individual shocks do affect household expenditures. However, there is evidence that men and women spend income differently.[8] Thus, we can examine whether shocks to men's and women's incomes affect expenditures differently.

In addition, we might expect that positive shocks affect household expenditure patterns differently from negative shocks. A spline function is used to allow the estimated coefficients to differ for positive and negative shocks (Greene, 1991). This approach requires that the function be continuous but allows a kink at the point where shocks equal zero.

The following model was estimated:

$$\omega_g = \beta_1(s^m) + \beta_2(s^f) + \beta_3(s^m * d^m) + \beta_4(s^f * d^f) + \beta_5(Y - s^m \qquad (5)$$

where:

ω_g is household budget share on a category of goods, such as food,

s^i is the shock to crop incomes,

$$d^i = \begin{cases} 1 \text{ if } s^i > 0 \\ 0 \text{ if } s^i \leq 0 \end{cases} \qquad i = m, f$$

Y is total household income, and

[8] For example, Hoddinott and Haddad (1995), Phipps and Burton (1993), Dwyer and Bruce (1988).

Z is a vector of demographic, location, and education variables.

The *Z* vector includes variables indicating the number of household members in each of twelve age and gender categories, dummy variables indicating the education levels of the male and female household heads, dummy variables indicating the month in which the household was interviewed, whether the household was located in an urban (not Accra), semi-urban, or rural area (located in Accra was the omitted category), whether both a male and female head were present in the household, and whether the household farmed any land. Descriptive statistics of these are presented in Table 3. Household income, excluding shocks to crop income, is also included. This term controls for the permanent income and non-rainfall shocks to the incomes of all household members.

To test the hypothesis of full risk sharing in households, the coefficients on men's shocks and women's shocks can be examined. If the estimated coefficients on negative shocks, β_1 and β_2, are significantly different, then we would reject the full risk sharing model. Similarly, if the estimated slopes for the positive shocks (for men the slope is $\beta_1+\beta_3$ and for women the slope is $\beta_2+\beta_4$) are different, we reject full risk sharing. These results would suggest that shocks to men's and women's crop incomes affect household expenditure patterns differently. If households fully share risk among members, then it should not matter whether the shocks from rainfall variability accrues to men or women within the household.

Results

OLS estimates are used to determine the impact of shocks to men's and women's crop incomes on seven different commodity groups. These groups represent commodities over which we might expect men and women to have different preferences. They include: food, alcohol, clothing, education, recreation, remittances, and tobacco. The estimates are summarized in Table 4.

Negative shocks to men's crop incomes are associated with significantly higher household budget shares on alcohol and tobacco and with lower budget shares on clothing and education. Negative shocks to women's crop incomes are associated with higher budget shares on education and with lower budget shares on alcohol. This suggests that when negative shocks occur, the household does not cut back on alcohol and tobacco relative to other goods when the shock accrues to men and that the household does not cut back on education relative to other goods when the shock accrues to women. However, the household decreases the relative proportions of clothing and education when the negative shocks accrue to men and the relative proportions of alcohol when the shocks accrue to women.

Positive shocks to men's crop income are associated with significantly increased budget shares on remittances, tobacco, and food and lower budget shares for clothing. Positive shocks to women's crop incomes are associated with increased budget shares for food and decreased budget shares for tobacco. Table 5 summarizes the results.

Two features emerge from these results. First, there are important differences in the effects of income shocks for men and women.[9] Men and women have different priorities and preferences and use resources under their control differently. In addition, these results suggest

[9] When the effects for men and women are significantly different from zero and have different signs, they must also be significantly different from each other.

that men and women do not fully share income risk within households. Second, positive and negative shocks have different effects on some commodity groups and these effects also differ for men and women.

It should be noted that the effects of shocks to men's and women's crop incomes on food expenditures are statistically indistinguishable. Negative shocks have no statistically significant effect on the budget share on food while positive shocks increase the budget share spent on food. The fact that crop income includes the value of food produced and consumed at home may account for this increase, which on the face of it appears to contradict Engel's law. It suggests that households that have a good year disproportionately increase the value of their food consumption regardless of whether male or female household members received the benefits.

Conclusion: Risk Sharing Within Households

These results demonstrate that shocks to crop incomes earned by men and women have different effects on household expenditure patterns. Although many of the magnitudes of the coefficients are small, all of the consumption items except food represent a small portion of the household budget. Further research that examines the shocks to all forms of income, rather than just to crop income, may provide stronger results. By doing so, we can ask whether the effects of the shocks are small because the shocks to crop incomes represent a small portion of household income or because households pool the majority of their income risk.

The results presented here provide evidence that it is important to examine how individuals manage risk as well as how households manage risk. Households are one form of risk-sharing network for individuals, but each individual will have a set of networks that may not correspond with those of other household members. In particular, it will be useful to understand how men's and women's risk sharing networks differ and whether they have different effects on consumption smoothing for men, women, and children. Although this paper showed that men's and women's income shocks have similar effects on household food expenditure, data on individual food consumption, if available, would allow us to analyze whether shocks to men's and women's incomes differently affect the allocation of food among household members.

If household members do not fully share risk, we may find situations in which individuals prefer to minimize the variability of their own income rather than to participate wholly in a strategy of minimizing household income variability. Individuals may prefer not to fully specialize, but to engage in a larger number of activities, even at the cost of reduced efficiency. Individuals are making decisions, within the context and constraints of the household, to insure themselves against both risk from shocks to income and risk from the dissolution of the household.

This analysis suggests that men and women make different decisions about how to allocate their resources when experiencing shocks to crop income. By examining household expenditure data in which the income of household members has been aggregated and consumption is being smoothed over seasons and annual cycles, we may obtain an incorrect picture of intrahousehold resource allocation.

Table 1 Descriptive Statistics on Variables Used to Predict Crop Incomes, Ghana 1991-92.

Variable	Mean	Standard Deviation
Crop income	56,265.17	118,598.24
Area	5724	13.21
Area*normalized annual rainfall	-0.154	13.45
Irrigated (dummy variable)	0.011	0.10
Fertilizer used (dummy variable)	0.072	0.26
Normalized annual rainfall	0.021	1.00
Annual rainfall	1212.81	296.17
R^1 Rainfall in March, year prior to harvest	76.904	47.00
R^2 Rainfall in April, May, and June, year prior to harvest	570.827	125.69
R^3 Rainfall in July, Aug. and Sept., year prior to harvest	417.338	176.61
R^4 Rainfall in March, year prior to survey	63.406	43.79
R^5 Rainfall in April, May, and June, year prior to survey	553.919	134.25
R^6 Rainfall in July, Aug. and Sept., year prior to survey	417.338	176.61
R^7 Average rainfall in March	91.718	39.04
R^8 Average rainfall in April, May, and June	480.90	101.52
R^9 Average rainfall in July, Aug., and Sept.	395.735	130.64
Cocoa$^+$	0.157	0.36
Yams$^+$	0.380	0.49
Rice$^+$	0.090	0.29
Sorghum/millet$^+$	0.142	0.35
Maize$^+$	0.667	0.47
Tomatoes$^+$	0.338	0.47
Cassava$^+$	0.656	0.48

Table 1 (continued).

Variable	Mean	Standard Deviation
Plantain[+]	0.410	0.49
Cocoyam[+]	0.383	0.49
Groundnut[+]	0.193	0.40
Okro[+]	0.406	0.49
Pepper[+]	0.525	0.50

[+] Dummy variables indicating whether or not the crop was grown.

Source: Compiled from Ghana Living Standard Survey, 1991-92.

Note: Men's and women's plots are treated as separate observations.

N=2,529.

Table 2 OLS Estimates Used to Predict Crop Incomes.

Variable	Estimated Coefficient	T-Statistic
Intercept	14046	3.200
Area	2754.359	14.738
Area*Normalized annual rainfall	234.150	1.123
Irrigation*Annual rainfall	-19.097	-1.228
Fertilizer*Annual rainfall	4.368	0.685
Normalized annual rainfall	-913.633	-0.262
Cocoa*Annual rainfall	77.497***	14.272
Yams*R^4	-36.604	-0.104
Yams*R^5	92.146	0.690
Yams*R^6	-10.899	-0.107
Yams*R^4*R^4	0.370	0.159
Yams*R^5*R^5	-0.117	-0.760
Yams*R^6*R^6	-0.012	-0.136
Rice*R^1	3048.761**	2.543
Rice*R^2	986.149***	3.497
Rice*R^3	-774.991***	-4.725
Rice*R^1*R^1	-13.938**	-2.175
Rice*R^2*R^2	-1.242***	-4.313
Rice*R^3*R^3	0.609***	3.919
Sorghum/millet*R^1	2083.895	0.574
Sorghum/millet*R^2	-768.245	-1.539
Sorghum/millet*R^3	258.425	0.545
Sorghum/millet*R^1*R^1	-15.543	-0.647
Sorghum/millet*R^2*R^2	0.894	1.499

Table 2 (continued).

Variable	Estimated Coefficient	T-Statistic
Sorghum/millet*R^3*R^3	-0.210	-0.640
Maize*R^1	193.157	0.832
Maize*R^2	-22.720	-0.169
Maize*R^3	98.942	0.983
Maize*R^1*R^1	-0.877	-0.776
Maize*R^2*R^2	-0.054	-0.348
Maize*R^3*R^3	-0.060	-0.640
Tomatoes*R^4	149.167	0.514
Tomatoes*R^5	-215.166	-1.398
Tomatoes*R^6	62.088	0.575
Tomatoes*R^4*R^4	-0.613	-0.395
Tomatoes*R^5*R^5	0.311*	1.712
Tomatoes*R^6*R^6	-0.047	-0.471
Cassava*R^4	-183.760	-0.591
Cassava*R^5	371.592**	2.554
Cassava*R^6	-189.077*	-1.672
Cassava*R^4*R^4	-0.518	-0.279
Cassava*R^5*R^5	-0.416**	-2.525
Cassava*R^6*R^6	0.127	1.299
Plantain*R^4	-399.906	-1.054
Plantain*R^5	-31.628	-0.184
Plantain*$R^6$6	56.272	0.390
Plantain*R^4*R^4	1.497	0.625
Plantain*R^5*R^5	0.062	0.315
Plantain*R^6*R^6	-0.054	-0.447

Table 2 (continued).

Variable	Estimated Coefficient	T-Statistic
Cocoyam*R^4	317.562	0.825
Cocoyam*R^5	-318.044*	-1.801
Cocoyam*R^6	293.338*	1.981
Cocoyam*R^4*R^4	-1.223	-0.515
Cocoyam*R^5*R^5	0.267	1.313
Cocoyam*R^6*R^6	-0.188	-1.539
Groundnut*R^1	-274.502	-0.467
Groundnut*R^2	194.162	1.018
Groundnut*R^3	-168.982	-1.360
Groundnut*R^1*R^1	4.944	1.190
Groundnut*R^2*R^2	-0.156	-0.702
Groundnut*R^3*R^3	0.134	1.23
Okro*R^4	869.350**	2.395
Okro*R^5	-108.428	-0.694
Okro*R^6	-26.223	-0.237
Okro*R^4*R^4	-3.234	-1.324
Okro*R^5*R^5	0.068	0.377
Okro*R^6*R^6	0.012	0.116
Pepper*R^4	-681.640*	-1.966
Pepper*R^5	104.966	0.640
Pepper*R^6	60.637	0.537
Pepper*R^4*R^4	1.836	0.848
Pepper*R^5*R^5	-0.109	-0.569
Pepper*R^6*R^6	-0.065	-0.631

*, ** and *** denotes significance at the 0.10, 0.05 and 0.01 levels, respectively.

R^1 = Rainfall in March, year prior to harvest

R^2 = Rainfall in April, May and June, year prior to harvest

R^3 = Rainfall in July, August, and September, year prior to harvest

R^4 = Rainfall in March, year prior to survey

R^5 = Rainfall in April, May and June, year prior to survey

R^6 = Rainfall in July, August, and September, year prior to survey

N=2,528   R-square = 0.300   F-value=14.6

Table 3 Descriptive Statistics on Variables Used to Estimate the Effects of Shocks to Men's and Women's Crop Incomes on Budget Shares.

Variable	Mean	Standard Deviation
Total household income (cedis)	84,998.13	376,916.39
Dummy if grew crops	0.555	0.50
Shock to women's crop income	-469.494	10,316.68
Shock to men's crop income	-970.164	22,176.92
# of male children (age 5-9)	0.400	0.68
# of male youth (age 10-14)	0.329	0.63
# of male adults (age 15-49)	0.916	0.91
# of male older adults (age 50-64)	0.158	0.37
# of male elders (age 65+)	0.083	0.28
# of female infants (age 0-4)	0.359	0.61
# of female children (age 5-9)	0.361	0.64
# of female youth (age 10-14)	0.306	0.58
# of female adults (age 15-49)	1.056	0.93
# of female older adults (age 50-64)	0.183	0.41
# of female elders (age 65+)	0.093	0.30
Male head--completed 4 years primary education	0.40	0.49
Male head--attended secondary school	0.30	0.46
Male head--completed "0" level	0.06	0.23
Female head--completed 4 years primary education	0.33	0.47
Female head--attended secondary school	0.09	0.28
Female head--completed "0" level	0.01	0.11
Male and female head present	0.501	0.50

Table 3 (continued).

Variable	Mean	Standard Deviation
Budget Shares:		
Food	0.558	0.170
Alcohol	0.023	0.043
Education	0.021	0.040
Clothing	0.076	0.055
Recreation	0.035	0.037
Tobacco	0.007	0.023
Location:		
Accra	0.102	0.302
Other urban	0.248	0.432
Semi-urban	0.207	0.405
Rural	0.651	0.477

Source: Compiled from Ghana Living Standards Survey, 1991-92.

N=4,517

Table 4 Effects of Shocks to Crop Incomes on Household Budget Shares for Different Commodities, Ghana, 1991-92.

	Negative shocks to men's crop incomes	Negative shocks to women's crop incomes	Positive shocks to men's crop incomes	Positive shocks to women's crop incomes
Food	0.112	-0.015	0.651***	0.694*
	(0.14)	(0.30)	(0.19)	(0.36)
Alcohol	-0.142***	0.145*	0.039	-0.125
	(0.04)	(0.09)	(0.05)	(0.10)
Clothing	0.116**	0.125	-0.119*	0.182
	(0.05)	(0.11)	(0.06)	(0.13)
Education	0.088***	-0.231***	-0.083	0.153
	(0.03)	(0.07)	(0.09)	(0.17)
Recreation	0.012	0.103	-0.0001	-0.104
	(0.03)	(0.07)	(0.09)	(0.8)
Remittances	0.001	-0.026	0.129*	-0.200
	(0.06)	(0.07)	(0.07)	(0.08)
Tobacco	-0.068***	0.060	0.024*	-0.110*
	(0.02)	(0.05)	(0.03)	(0.06)

*, ** and *** denote significance at the 0.10, 0.05 and 0.01 levels respectively.
Note: Standard errors are in parentheses. All coefficients and standard errors x 10^{6} .

Table 5 Summary of Effects of Men's and Women's Shocks to Crop Incomes on Budget Shares.

Positive Shocks to Women's Crop Incomes:

Food +
Tobacco -

Negative Shocks to Women's Crop Incomes:

Alcohol -
Education +

Positive Shocks to Men's Crop Incomes:

Remittances +
Tobacco +
Food +
Clothing -

Negative Shocks to Men's Crop Incomes

Alcohol +
Tobacco +
Clothing -
Education -

Note: Only shocks that are statistically significant are included on this table.

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