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Risk and Saving in Northern Nigeria

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This paper uses data collected by the author to examine the extent to which households in northern Nigeria use asset stocks to smooth their consumption over time in the face of production shocks. The primary question is simple: do households dissave when their farms suffer from negative production shocks? Evidence is presented in support of the thesis that households use their assets as buffer stocks against the receipt of idiosyncratic shocks. Households reduce their saving by economically significant amounts when they receive an adverse shock on their upland plots. In this agricultural economy, asset stocks are used directly in production. A standard model of intertemporal choice is modified in order to account for these direct linkages between saving and production and the consequent implications of consumption-smoothing behavior for households' portfolio choices. In accordance with the model, it is saving in the form of grain stocks (rather than livestock) which is reduced when households are affected by adverse shocks. Moreover, a significant portion of this response is increased net sales of grain contingent upon the realization of an adverse shock. Finally, it is shown that households forecast the receipt of near-future adverse shocks and that they increase current savings in anticipation.

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Risk and Saving in Northern Nigeria - Christopher Udry

Executive Summary

People who live in the rural areas of poor countries often must cope not only with severe poverty but with extremely variable incomes. The study of the implications of this variability for individual utility, production decisions and the evolution of economic institutions has been a central theme of recent work in development economics. However, income variability implies consumption variability only if households do not use *ex post* mechanisms to insulate consumption from the income fluctuations. One such mechanism is risk pooling across households within a village through insurance. The complementary mechanism is the use of saving behavior to smooth income fluctuations over time.

In earlier work, I have described implicit insurance arrangements used by rural households in northern Nigeria which permit a surprising degree of risk pooling. Nevertheless, I find that complete pooling of risk within the village is not achieved. There are some shocks which are unique to single households ("idiosyncratic shocks") which in principle could be insured against by village insurance arrangements which, however, are not insured. Moreover, the insurance arrangements do not extend across village boundaries and thus can contribute little to households' efforts to cope with aggregate village-level shocks.

The next logical step in this research program, therefore, is an analysis of the extent to which households use their asset stocks to smooth their consumption over time in the face of production shocks. The primary question is simple: do households dissave when their farms suffer from negative production shocks?

This paper presents evidence in support of the thesis that households use their assets as buffer stocks against the receipt of idiosyncratic shocks. Households reduce their saving by economically significant amounts when they receive an adverse shock on their upland plots. A standard model of saving behavior, appropriately modified to account for incomplete rental markets and diminishing returns to some assets, implies that consumption smoothing should be effected through adjustments in saving in assets not subject to diminishing returns. In northern Nigeria, the relevant asset available for consumption smoothing is grain. In accordance with the implications of the modified model, there is no evidence that household saving in livestock is affected by the receipt of adverse shocks. In contrast, and again in accordance with the modified model, grain savings are substantially reduced when a household receives an adverse shock on its upland plots. Moreover, a significant portion of this response appears to be increased net sales of grain contingent upon the receipt of an adverse shock. Finally, it is shown that households forecast the receipt of near-future adverse shocks and that they increase current savings in anticipation.

An examination of grain market transactions provides no evidence in support of the widespread perception that poor farmers are forced to sell their grain immediately after harvest, when prices are low, in order to repay loans taken from grain merchants. Moreover, there is no evidence that grain sales contingent upon the receipt of adverse idiosyncratic shocks are made at a discount. The grain market seems to play a valuable role in facilitating farmers' responses to the receipt of adverse shocks.

1. Introduction

People who live in the rural areas of poor countries often must cope not only with severe poverty but with extremely variable incomes. The study of the implications of this variability for individual utility, production decisions and the evolution of economic institutions has been a central theme of recent work in development economics.[1] However, income variability implies consumption variability only if households do not use *ex post* mechanisms to insulate consumption from the income fluctuations. One such mechanism is cross-sectional risk pooling through insurance. In earlier work, I have examined the credit-*cum*-insurance arrangements used by rural households in northern Nigeria.[2] The complementary *ex post* mechanism is the use of saving behavior to smooth income fluctuations over time. This paper provides an analysis of the extent to which the same Nigerian households use their assets to cope with risk.

When insurance markets are incomplete, saving and credit transactions assume a special role by allowing households to smooth their consumption streams in the face of random income fluctuations. This observation, of course, is the basis of much of the literature on the intertemporal allocation of consumption.[3] Recently, empirical studies of saving and credit behavior in LDCs have begun to take explicit account of intertemporal consumption-smoothing in the face of income shocks (see the reviews by Gersovitz [1988] and Alderman and Paxson [1992]). If credit markets are imperfect, then households may use their asset holdings as buffer stocks to smooth their consumption paths.[4] The first goal of this paper, therefore, is to examine the

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[1]See the review by Besley (1992).

[2]Udry (1990, 1992).

[3]Eswaran and Kotwal (1989) provides an extension of this theoretical work to joint production and consumption decisions in agriculture in less developed countries.

[4]Deaton (1991a) shows that a high degree of smoothing can be achieved with remarkably low levels of asset stocks, even when asset stocks are subject to non-negativity constraints. This

hypothesis that households dissave when confronted with adverse shocks to their incomes. If different types of assets are differently suited for use as buffer stocks, then this motive for saving may affect the composition of households' portfolios.[5] The second goal of this paper is to examine the relative responsiveness of stocks of different assets to household income variation.

One strand of recent research on *ex post* smoothing in poor countries has been to test some of the implications of Pareto efficient risk pooling within sets of households using panel data on income and consumption. Townsend (1991) provides evidence that the allocation of risk in a set of Indian villages is close to that implied by Pareto efficiency.[6] Lim (1991) and Morduch (1990) have begun the difficult task of using the same data to distinguish consumption smoothing over time by individual households from mutual insurance arrangements.

A parallel research program examines the implications of models of intertemporal choice for household consumption and saving behavior (see Deaton [1991b]; Paxson [1992]). Deaton (1992a) provides the only previous attempt to address this issue in an African context.[7] Rosenzweig and Wolpin (1993) extend this research through an examination of the consequences for the income and consumption processes of using productive assets as buffer stocks. Rosenzweig (1990) draws these literatures together by estimating the effects of income shocks on borrowing, asset divestiture and net transfers between households in rural India.

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demand for assets as buffer stocks has implications not only for individual consumption paths but also for aggregate saving behavior.

[5]Dahl and Hjort (1976), for example, argue that herders accumulate livestock to serve as a buffer stock in the case of drought and underinvest in other assets, such as land improvements, which may have a higher expected return.

[6]This surprising conclusion is questioned by Ravallion and Chaudhuri (1991).

[7]This study applies methodology developed by Campbell (1987) to a two-year rolling panel of data on income and saving from Côte d'Ivoire. Deaton finds evidence that households save in anticipation of declines in income, but that the amount that is saved is difficult to reconcile with the PIH.

I have begun the investigation of the *ex post* mechanisms through which rural households in northern Nigeria cope with their risky environment by examining cross-sectional risk pooling in the region. In this region, implicit insurance arrangements are embedded within credit market transactions, permitting households within a village to insure each other directly against idiosyncratic risk. The institutional form of these joint credit/insurance transactions is such that the repayment owed on a loan depends upon random production and consumption shocks received by both the borrower and the lender. These state-contingent loan contracts permit direct risk pooling between borrowers and lenders - each party insures the other against some portion of their idiosyncratic risk. With simultaneous credit transactions among multiple partners, households can spread their consumption risk widely through the village. Nevertheless, a fully Pareto efficient pooling of risk within the village is not achieved through these credit transactions. Moreover, the credit transactions occur almost exclusively within village boundaries and thus can contribute little to households' efforts to cope with aggregate village-level shocks.

If a full set of insurance markets is not available, then households may use their asset stocks to smooth their consumption over time in the face of production shocks. The primary question is simple: do households dissave when their farms suffer from negative production shocks? I explore this issue using a unique data set which includes household level information on the receipt of random production shocks over the course of a single agricultural year. The availability of this direct measure of transitory shocks means that shocks need not be inferred from the residual between actual income and some measure of permanent income. This paper, therefore, is closely related to the important work of Paxson [1992], which uses rainfall data to identify transitory income shocks affecting households, which are in turn used to measure the

marginal propensity to save from transitory income.[8] The advantage of the current dataset is that the measures of exogenous production shocks are available at the household level, rather than the level of the community or region.

A further advantage of this dataset is that saving need not be measured as the residual between measured consumption and measured income. Instead, net saving can be defined as the change in a household's ownership of assets. Because information is available on stocks of particular assets, it is possible to quantify the differing responsiveness of stocks of different assets to household risk and thus to begin examining the portfolio effects of smoothing consumption through the use of buffer stocks. There are a number of different reasons to expect such portfolio effects. The sale or purchase of some assets may be subject to significant transaction costs, and others may have important indivisibilities. In this paper I focus attention on an alternative explanation: the extent to which different assets are used as buffer stocks may depend on the direct links between the ownership of assets and production which may exist in this agrarian economy.

In addition, there is data on each household's transactions in asset markets. These data permit an examination of the mechanisms through which households adjust the level of their wealth, i.e., does the realization of random production shocks affect the timing of asset sales and purchases, or are asset stocks drawn down directly through consumption of stored grain or livestock? This research, therefore, includes an analysis of the role of particular asset markets in the risk management strategies of rural households.[9]

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[8]The converse approach was developed by Wolpin (1982), who uses cross-sectional variation in average weather to identify an exogenous component of permanent income and its effect on consumption.

[9]This question touches on a number of issues of interest to policy-makers in less developed countries. For instance, is the land market driven by distress sales of land, as hypothesized by Binswanger and Rosenzweig (1986)? Are small farmers caught in a vicious cycle of selling grain

I provide a brief description of the study area, survey methodology and the resulting data set in section 2. In section 3, I modify the standard PIH to account for the possibility of direct linkages between saving and production and discuss the implications of consumption-smoothing behavior for households' portfolio choices. In section 4, I examine the responsiveness of overall saving to the realization of random production shocks. Section 5 describes the portfolio effects of income shocks. In accordance with the modified PIH, it is saving in the form of grain stocks (rather than livestock) which is reduced when households are affected by adverse shocks. In section 6, it is shown that a significant portion of this saving response is increased net sales of grain contingent upon the realization of an adverse shock. I examine the hypothesis that these are "panic sales" made at a discount. Section 7 explores the issue of the exogeneity and unpredictability of the measures of productions shocks. Section 8 concludes the paper.

2. Data and Geographical Setting

The study is based on household level data I collected during a 1988-89 survey near the city of Zaria in northern Nigeria. The Zaria area is in the heart of one of the most dynamic and promising agricultural regions of Africa. Over the past decade there have been significant changes in cropping patterns and input use. The use of bullock and tractor plowing has become more prevalent, though only a minority of farmers use them.[10]

There is a moderate degree of involvement in the market both for the purchase of agricultural inputs and the sale of outputs. 73 percent of the sample households produce

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after harvest when prices are low, then forced to buy when prices are high (Clough [1986])?

[10]Neither animal traction nor tractor plowing was in use during Norman's 1966-67 survey of three villages in the same area (Norman, 1972). Currently, 15% of cultivated area (7% of plots) is plowed at least once by a tractor, and another 14% (9%) by bullock plow. Longhurst (1985) found heavier use of animal traction (45% of cultivated area) in a 1976 survey of one village near this area.

vegetables and non-food cash crops for the market, and 53 percent of all labor used on the sample household farms was wage labor. 95 percent of cultivated land was treated with modern chemical fertilizers.

Every household in the research villages operates a farm, usually composed of multiple plots (an average of 5 plots per household). Two to five different crops are generally intercropped on each plot. Upland plots are interspersed with those of other village residents on the broad fields surrounding each village. Farming activities on these plots are concentrated during the rainy season, which lasts for five to six months. Households also cultivate lowland plots bordering streams on which dry-season irrigated farming is possible. Activity on these plots generally continues year-round. A large variety of non-agricultural occupations also exists. These include trading, the provision of transport services (via vans, motorcycles, bicycles, or donkeys), and small-scale industries such as carpentry, house building, or tailoring. The settlements are nucleated rather than dispersed, and the four villages included in the study range in size from 138 to 916 households. See Table 1 for a summary of the data used in this study.

I undertook a nine-round survey of 200 households in four villages from February 1988 to February 1989.[11] The size of the sample was kept small in an effort to reduce non-sampling error on matters that are notoriously sensitive (most importantly, great care is required in collecting information on asset stocks).[12] The survey consisted of a series of interviews with each of the household heads and (separately) his wives. The questionnaires were designed to

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[11]Fifty households were randomly selected from each of four randomly chosen villages in two purposely selected districts near the city of Zaria.

[12]The small sample size enabled me to meet all of the male respondents over the sample year and I was able to intervene immediately when an enumerator sensed that a respondent was becoming less cooperative. I spent a day a week in each of the four villages and thus kept a high profile during the course of the survey. I was in regular contact with the leadership of each village and was readily accessible to any of the respondents.

yield a complete picture of each household's asset and debt position; an account of its credit, labor, product, asset, and asset-rental transactions over the previous month; and a range of demographic and background data. Consumption and income data were not collected. Further details on the study area and survey methodology are available in Udry (1991).

The survey was designed to yield reliable and uniquely detailed data concerning wealth and asset market transactions, as well as information about the incidence of random production shocks. These categories of data are described in the paragraphs which follow.

Saving - There is data on each household's stock of grain and farm inputs, livestock, and goods for trading at three points during the survey year (denote these by $A_{j,p}$, $p \in \{0,1,2\}$). There is also data on the household's miscellaneous assets (such as furniture, farm equipment and housing), but these were collected only at the start of the survey, so no measure of saving can be constructed for these assets. In addition, I have data on each household's cash holdings for each round of the survey, but this information must be considered very unreliable and is therefore excluded from the measure of saving used in this paper. Finally, there is data on each household's landholdings and land market transactions. A land market is available in these villages (see Ega, 1984). In fact, 25 percent of the land farmed by sample households was purchased by its cultivator. It is possible, therefore, that land might be bought and sold in response to the receipt of random shocks to a household's income. However, there is not enough evidence to test for such behavior in this dataset. Only one plot was sold by a sample household during the course of the survey year, and only four plots were purchased. This paper, therefore, focuses on assets which are more liquid than land.

Net saving for any period, therefore, is defined as the sum of the changes in the value of a household's stocks of grain and farm inputs, livestock, and goods for trading over that period. Saving can be defined for two periods for each household: $S_{jt} = A_{j,t} - A_{j,t-1}$ for $t \in \{1,2\}$. Period 1 runs

from April to September and period 2 covers September to February. Histograms of saving over the two periods are presented in Figures 1 and 2 and summary statistics are reported in Table 1. Mean saving is strongly seasonal, as can be expected in an agrarian economy, although it is positive in each period.

The saving measure generated by data on changes in asset ownership is complemented by data on the households' participation in asset market transactions. The survey collected monthly data on each household's major sales and purchases of grain and livestock over the course of the year. All of the sample households participated in the grain market and 68 percent participated in the livestock market over the course of the survey year. I made no attempt to collect information on all of the small magnitude purchases, sales, consumption for daily needs of this material. Moreover, I did not collect data on grain harvests. The transactions data, therefore, cannot directly be reconciled with the stock data.

Random Shocks to Income - The data on the realization of adverse production shocks on the sample households' farms is based on a count of specific incidences of discrete adverse events such as flooding, wind damage, or animal invasions on each plot. These events are transitory in nature and should not affect income after the current harvest. Dates of the events were not recorded, but for most events an approximate date can be inferred (for instance, wind damage to maize only occurs late in the season; poor germination of millet occurs early). The events are divided into early (May-August) (Z_{j1}) or late (September-December) (Z_{j2}) occurrences. In each period, the index of self-reported adverse shocks is a weighted average of the number of these negative events and the weights are the sizes of the plots on which they occur. Two indices of adverse shocks are constructed for each household, for each period, with the shocks differentiated according to the type of land (upland or lowland) on which they occurred. The index of shocks on (the much smaller) lowland plots is multiplied by 10 to bring the scales of the two indices into

closer accord.

Timing - The relative timing of the receipt of random shocks, the realization of the effect of these shocks on income, and measured saving behavior is important for the interpretation of the results. The harvest period begins in period 1, when early-planted millets on upland fields mature and lowland garden crops are harvested. Harvesting continues into period 2, when most upland grains are harvested. The effects of late period shocks (Z_{j2}) are realized on income in period 2, and thus should be reflected in period 2 saving if assets are used as buffer stocks. I attempted to define early period shocks (Z_{j1}) so that their impact on income would be realized in period 1, but the imprecise nature of the data implies that, in addition, period 2 income might be affected by Z_{j1}. If this is the case, then the effect of Z_{j1} on period 1 saving becomes ambiguous.[13] I provide a test for this possible effect in section 4.

There are two major shortcomings of the data used in this study. First, they were collected over the course of a single year. Therefore, it is impossible to distinguish between the effects of seasonality and aggregate shocks on saving behavior. Second, there is no data on household income. It is impossible, therefore, to quantify the responsiveness of saving to income shocks. All that is possible is to test for the existence and direction of such responsiveness.

3. Responses of Saving to Income Shocks

I begin with a simple model of intertemporal choice.[14] At the start of period t, a household has its wealth in the form of N different assets. Let A_{it} be the value of the household's stock of asset i in period t. Each of these assets receives a gross return of $(1+r_{it})$

[13]If an adverse shock in period 1 lowers period 2's expected income, as well as period 1 income, then period 1 consumption should fall. Period 1 saving might fall or rise, depending upon the size of the effect of the shock on period 1 income.

[14]As set forth, for example, in Deaton (1992b).

over the course of period t, and the household also receives farm income y_t, which for now we consider to be an exogenous random variable. After production in period t, therefore, the household has a total wealth of

$$(1) \qquad W_t = \sum_i A_{it}(1 + r_{it}) + y_t$$

This wealth is allocated between current consumption and next period's asset stocks:

$$(2) \qquad \sum_i A_{i,t+1} = W_t - c_t.$$

Given (1), (2), and wealth in period t W_t, the household's consumption and saving behavior maximizes expected utility over the remainder of its lifetime:

$$(3) \qquad U_t = E_t \sum_{\tau=t}^{T} \beta^{\tau-t} u(c_\tau) .$$

The period t value function for the problem satisfies

$$(4) \qquad V_t(W_t) = \underset{A_{i,t+1}}{Max}\ u(W_t - \sum_i A_{i,t+1}) + \beta E_t V_{t+1}(\sum_i A_{i,t+1}(1+r_{i,t+1}) + y_{t+1})$$

Optimization and the envelope condition imply that for each of the i assets

$$(5) \qquad u'(c_t) = \beta E_t u'(c_{t+1})\ (1+r_{i,t+1}) .$$

The standard permanent income hypothesis imposes the assumptions that the asset returns are certain and that $(1+r_{i,t+1}) = (1+r) = 1/\beta\ \forall\ i$, so that assets are indistinguishable and

$$(6) \qquad u'(c_t) = E_t u'(c_{t+1}) .$$

Thus marginal utility follows a martingale process. If life is long enough, so that transitory shocks to current income have virtually no effect on the expected value of lifetime income, then marginal utility and therefore consumption will be maintained at an almost constant level, with transitory income fluctuations completely compensated for by saving and dissaving.

This is the model estimated by Paxson (1992), and it is where I begin. Saving by

household j in period t (S_{jt}) is assumed to be a linear function of a vector of household characteristics (X_j) which determine the level and variance of the household's permanent income, and which indicate the stage of the household in its life cycle. Saving may also depend on the season of the year and on aggregate-level shocks to income; both of these sources of saving variation are captured by an indicator of the period (d_t). Finally, (6) implies that saving will respond to the receipt of transitory idiosyncratic production shocks (Z_{jt}):

$$(7) \quad S_{jt} = d_t\alpha + X_j\beta + Z_{jt}\gamma + d_tX_j\delta + \lambda_j + v_{jt}.$$

The vector X_j includes indicators of the village of residence, the amount of land owned by the household, the wealth of the household when it was first formed, measures of the human capital of the household head, the age of the household head, the number of wives in the household, the number of dependents, and the number of males aged 10-60, who can provide agricultural labor.[15] The inclusion of demographic variables, land ownership and human capital as determinants of permanent income would be unacceptable in a model of long term saving decisions, where they would have to be treated as endogenous. Here, however, I am concerned with very short term responses of savings to income shocks.

The control for seasonal and aggregate income shock variation, d_t, is a dummy variable which is equal to 1 if t=2. Because the data cover only one year, the effects of seasonality and aggregate shocks are collinear. In order to disentangle the effects of these different sources of income and saving variation a time series spanning different years would be required. The effects of seasonality or aggregate shocks on saving might depend on household characteristics, hence I have included interactions between X_j and d_t. For instance, one might expect the extent of land holdings to have an effect on seasonal variation in saving (larger landholders would be expected

[15]In Islamic northern Nigeria, *shari'a* law is interpreted to forbid women working outside of the household's compound.

to save more than smaller landholders during a period which spans the harvest relative to their saving during the farming season). Similarly, an aggregate shock to rainfall might have a larger effect on the saving of larger landholders. In the empirical work, only the components of δ which correspond to the landholding elements of X_j are permitted to differ from zero.

λ_j is a household fixed effect on saving (obviously, β and λ_j cannot be separately identified). γ is the composition of the effect of adverse idiosyncratic shocks on transitory income and the effect of transitory income on saving. If assets are used as buffer stocks against the receipt of adverse shocks, then $\gamma<0$.

This formulation requires the assumption that idiosyncratic shocks across the two periods are independently (though not necessarily identically) distributed.[16] The realization of the shock in period 1 therefore provides no information about the shock due to occur in period 2. If this is so, then the shocks are transitory and the simple behavior described in equation (1) can capture the use of assets as buffer stocks. Aggregate shocks can be correlated over time without affecting the results, for their influence on saving is captured in α and δ.

It is clear, however, that at least some of the assumptions underlying this formulation of intertemporal choice are unjustified for this economy. Most importantly, a subset of the assets held by households are used directly in production. Approximately one-half the value of the portfolios of these households is composed of livestock.[17] The return to livestock production is constituted mainly of the off-take of animals from the herds, but value is also generated by the production of milk and eggs and the use of manure as fertilizer. Livestock production in the farm

[16]This strong assumption is tested in section 4.

[17]The proportion varies from about 30 percent soon after harvest is completed to 68 percent early in the harvest season. 2 percent of the value of portfolios are held in the form of stocks of goods for trading; the remainder of the households' portfolios are held in the form of grain stocks.

systems of the study villages requires inputs of land for grazing and household labor for herding, watering and gathering supplemental food for the animals.[18] There are not complete rental markets for livestock. There is a history of livestock tenancy in this region, in which farmers let out cattle to specialized herders (see Stenning, 1959; Baier, 1980; Frantz, 1975). However, such contracts were not common during the study year - less than 5 percent of the value of livestock owned by these households was kept in such arrangements. Given household characteristics, therefore, ownership of livestock is subject to diminishing returns. The important alternative asset held by these households is grain. The return to holding grain is not subject to diminishing returns. Given the predominant storage technology (in-room storage of dried, bagged grain), the most important determinants of the return to ownership of grain stocks are the seasonal change in its price and the direct loss of stored grain to pests, each of which are constant per unit of grain stored.[19] Given diminishing returns, the amount of livestock held by the household is determined by considerations of productive efficiency, and consumption-smoothing is effected through the sale or purchase of only those assets (mostly grain) not used in production (and not, therefore, subject to diminishing returns).[20]

A simple modification to the standard intertemporal choice model will make this argument obvious. Suppose that farm income depends on the household's holding of a particular asset A_c:

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[18]Despite the existence of active agricultural labor markets in these villages, there were no instances in the sample of labor being hired to care for animals. Presumably, this pattern results from the potential for moral hazard in the care of animals.

[19]Hays (1975) describes storage technologies in nearby villages.

[20]This argument obviously depends upon the existence of assets which are not subject to diminishing returns and the unimportance of liquidity constraints. When stocks of the constant return asset are drawn down to zero (as for instance after a series of adverse shocks) behavior changes and productive assets will be used as buffer stocks. Rosenzweig and Wolpin (1993) describe the dynamic effects of the use of productive assets (bullocks) as buffer stocks by Indian farmers. The prevalence of bullock transactions in response to income fluctuations is an indicator of the lack of alternative assets not subject to diminishing returns available to these farmers.

$$(8) \qquad y_t = F(A_{ct}) + e_t,$$

where F() is an increasing and strictly concave function and e_t is an exogenous source of farm income. The return to holding A_{ct} is summarized by F(), so $r_{ct}=0$. Retaining the assumption that for the other N-1 assets, $1+r_{it}=1/\beta=(1+r)$ ($\forall$ i$\neq$c), equation (5) still holds. For asset c, we find

$$(9) \qquad u'(c_t) = \beta E_t u'(c_{t+1}) (1+F'(A_{ct})).$$

If, in analogy to the standard permanent income model $F'(A_{ct})$ is certain, then (5) and (9) imply

$$(10) \qquad F'(A_{ct}) = r_i = r \quad \forall i \neq c,$$

and holdings of asset c are determined by considerations of technical efficiency. These asset stocks will not be used to smooth consumption in the face of random income. More reasonably, if the return to the asset used in production is random, then if life is long enough that transitory shocks to income do not (substantially) effect expected lifetime income, then (10) (approximately) holds in expectation.

If a subset of the assets held by households are used directly in production and there are not complete rental markets for those assets, then investment in these assets is subject to diminishing returns and they will not be used for consumption smoothing as long as alternative asset stocks are available. The question of interest becomes the relative responsiveness of different asset stocks to the receipt of exogenous shocks to income. In section 5, the detailed asset stock data available in this dataset are used to estimate analogues of equation (7) for disaggregated components of the households' portfolios.

4. Estimating the Responsiveness of Overall Saving to Income Shocks

Feasible generalized least squares estimates of (7), imposing the additional assumption

that $\lambda_j=\lambda$ for all j are presented in Table 2.[21] The null hypothesis that net saving is unaffected by the receipt of adverse idiosyncratic shocks can be rejected. The Wald test of the joint significance of the two shock variables is distributed as $\chi^2(2)$ and has a value of 8.00 (p=.02). The results are consistent with simple models of consumption smoothing: saving is lower in those households subjected to adverse idiosyncratic shocks on their upland plots, though there is no statistically significant relationship between shocks on lowland plots and saving. Moreover, the responsiveness of saving is large. The receipt of a one standard deviation adverse shock on a farmer's upland plots is associated with dissaving of N1,584 (mean saving per period is N2,746).[22] As noted above, however, in the absence of data on income it is impossible to test the implication of the simple PIH that the dissaving associated with the receipt of a transitory income shock is equal to the effect of that shock on income.

In Udry (1992), I show that there is much stronger evidence of insurance (through state-contingent credit transactions) against shocks on lowland plots than against shocks on upland plots, probably as a result of the better availability of information concerning shocks on lowland plots. The differential effects on saving of shocks on upland and lowland plots, therefore, may reflect the relative availability of insurance against these different types of idiosyncratic shocks.

The effects of seasonality and aggregate shocks on saving are mediated by land ownership. Owners of additional upland land save significantly more during the second period relative to the first period, while owners of additional lowland land save significantly less. This is consistent with

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[21]A Goldfeld-Quandt test of the hypothesis that the variance is the same for observations in periods 1 and 2 yields a strongly significant F(182,182) test statistic with a value of 2.07. The FGLS estimates presented in Table 2 are based on the standard two-step procedure. In the first step, OLS residuals are used to estimate the standard deviation of the errors in the two periods. The second step is WLS using the inverses of these estimates as the weights.

[22]The Nigerian currency is the Naira, which ranged in value from $1=N4 in February 1988 to $1=N7 in February 1989.

the different timing of input application and harvests on the two types of land. The main farming expenses on upland plots occur during period one, while the main upland harvest occurs during period two. In contrast, much of the value of lowland harvests is accrued during period one. Savings display significant variation across villages. Households which had been wealthier in the past (when the household head first married, on average 16 years before the survey) have significantly higher current saving.

The preceding estimates maintained the assumption that $\lambda_j=\lambda$ for all j. However, there may be persistent unobservable household characteristics which influence the saving decision and which are correlated with the quality of the household's land, and with its wealth, demographic composition and other characteristics, rendering the estimates of the coefficients in the regressions presented above inconsistent. Fortunately, data are available on saving over two different periods during the survey year, so any persistent unobservable characteristics can be removed by the blunt instrument of estimating fixed effects. The conditioning variables (other than those interacted with the seasonal indicator) are stable over the year, so they are also removed by this procedure. The variables of interest are the change in saving over two periods and the change in the receipt of adverse shocks over the two periods. The question becomes: do those households which receive an adverse shock during the farming season have lower growth in saving over the year than those households which did not receive an adverse shock?

OLS fixed effects estimates of (6) are presented in Table 3. The results are generally similar to those of Table 2, although the point estimates imply a stronger response of saving to the receipt of shocks on upland plots. The hypothesis that there are no household fixed effects cannot be rejected: the Hausman test statistic is $\chi^2(4)$ and has a value of only 1.086 (p=0.90).[23]

[23]Under the null hypothesis of $\lambda_j=\lambda$ and heteroskedasticity across the two time periods, FGLS is efficient, while the first-difference estimator is consistent but inefficient. Under the alternative of fixed effects, the first-difference estimator is consistent but the FGLS estimator is not.

The measures of income shocks used in this study manifestly are imperfect. They are simply counts of discrete, high visibility events which occur on the sample households' farms. Does this error in the measurement of income shocks substantially effect the results presented here? The first clue that measurement error is not playing a central role in these results is provided by the results reported in Tables 2 and 3. In the presence of classical measurement error, both the FGLS and fixed effects estimators of γ in (6) are biased toward zero, but the fixed effect estimates are more biased than the FGLS estimates. However, the FGLS estimates of the relationship between the receipt of adverse shocks and saving are virtually identical to the fixed effect OLS estimates of the same relationship.

A second approach to testing for measurement error is provided by the availability of valid instruments for the measures of adverse shocks. I collected data on the final yield on the households' upland and lowland farms. The yield data are contaminated by significant measurement error, as they are based on fairly long recall (the questions were asked at the end of the survey, five to six months after the first harvests on upland plots and almost a year after some harvests on lowland plots). If this measurement error is classical and if the yield achieved on a farm depends on the shocks received in both periods, then this measure of yield provides a valid instrument for shocks in both periods. Results of the instrumental variables procedure are presented in Table 4. The estimated coefficient on the receipt of adverse shocks on upland plots remains negative, but it loses its statistical significance, providing a clue that yield is a relatively poor instrument for the receipt of adverse shocks.[24] A Hausman specification test for the presence of measurement error is distributed as $\chi^2(17)$ and has a value of 0.882, so the null

[24]The R^2 on the first stage regression explaining the receipt of adverse upland shocks is 0.42. Upland yield is significantly (negatively) related to the receipt of adverse shocks: the t-statistic is -4.18. The analogous regression for lowland shocks has an R^2 of only 0.08 and the t-statistic on lowland yields is -1.88.

hypothesis of no measurement error cannot be rejected.

As discussed in section 2, it is possible that the relative timing of the receipt of random shocks and the realization of their effect on income is not consistent with that demanded by the theory. It is clear that the effects of period 2 shocks are realized in period 2, but it is possible that period 1 shocks effect both period 1 and period 2 income. If this is so, then the permanent income hypothesis no longer provides an unambiguous prediction regarding the effect of period 1 shocks on saving. In order to test for this possibility, I re-estimate equation (7) permitting the coefficients on Z_{it} to vary across the two time periods. Table 5 reports the results of FGLS estimates of the determinants of saving. In each of the two periods, the receipt of idiosyncratic shocks on a household's upland plots is associated with a reduction in saving by the household. The null hypothesis that the effect of idiosyncratic shocks on savings is constant across periods cannot be rejected - the Wald $\chi^2(2)$ test statistic is 3.86 (p=0.15). When attention is limited to the effect of shocks on upland plots the Wald $\chi^2(1)$ test statistic becomes 3.71, which is on the border of conventional significance levels. Adverse shocks on upland plots have a stronger effect on saving in period 2 than in period 1, indicating that some of the effect of period 1 shocks may be realized in period 2 income.

The results of this section provide evidence that saving by these Nigerian households responds to the receipt of idiosyncratic shocks. In an agrarian economy, the use of assets as buffer stocks may have implications for the composition of households' portfolios. I now turn to the disaggregated saving data which are available to examine more carefully the effect of diminishing returns to the ownership of livestock.

5. Portfolio Effects of Income Shocks.

Data are available on the composition of the households' portfolios, so it is possible to

quantify the responsiveness of saving in different assets to the receipt of production shocks. Household saving is defined as the sum of the changes in the household's holdings of grain and farm inputs, livestock, and goods for trading over the relevant period. Equation (7) can be estimated for each of the disaggregated components of saving (the equation of one of the three components is redundant - saving in trading stocks is dropped). FGLS estimates (which permit heteroskedasticity across the two periods) of the determinants of saving in grain and livestock are reported in Table 6.

Livestock saving is not affected by idiosyncratic shocks. In fact, the point estimates of the effect of shocks are positive, albeit insignificant.[25] The effect of the receipt of adverse shocks on saving is realized through changes in grain stocks. It is possible to reject the null hypothesis that saving in the form of grain is unaffected by idiosyncratic shocks; the Wald $\chi^2(2)$ test statistic is 16.46 (p=.00). Grain stocks grow less rapidly in those households subjected to an adverse idiosyncratic shock on their upland plots. The point estimate implies that a one standard deviation shock is associated with a N2,146 reduction in saving in the form of grain (the mean of grain savings per period is N991).

It was shown in Table 2 that households which had been wealthier in the past have higher current saving. The current results indicate that these wealthier households are accumulating livestock rather than grain stocks.

When households receive transitory shocks to their incomes, they respond by reducing their grain saving, but livestock saving is unaffected. This pattern is consistent with the model developed in section 3. According to this model, household decisions regarding livestock are governed by considerations of productive efficiency, and variations in grain stocks are used to smooth consumption in the face of income fluctuations. The results of this section are also

[25]The Wald test of their joint significance is $\chi^2(2)$ with a value of 2.02 (p=0.36).

consistent with a number of other mechanisms which could cause shifts in the composition of households' portfolios contingent upon the receipt of an unanticipated income shock. Two of the more obvious mechanisms are indivisibilities or transaction costs associated with livestock. Neither of these mechanisms, however, are likely to be at work in these data. On average, seventy percent of the value of the livestock held by these households is composed of small ruminants and fowl - mostly sheep and goats. The price of these animals ranges (depending upon the animal's condition and the season) between N50 and N200. Recall that the estimates presented in Table 6 imply that a one standard deviation adverse idiosyncratic shock is associated with a decline in grain saving of approximately N2146. Indivisibilities would not seem to be a hinderance to the use of livestock to smooth consumption. Nor do transaction costs seem to be higher for goats and sheep than grain. They are exchanged in different sections of the same market, and both livestock and grain transactions are extremely frequent in these markets (in the larger markets, several dozen goat and sheep transaction occur per hour). Nor are transportation costs of small livestock and grain to the markets significantly different. It should be noted, however, that I do not have data on the amount of time spent negotiating transactions, and it is possible that there is more negotiating associated with livestock transactions.

6. The Grain Market

The finding that grain saving responds to idiosyncratic risk raises an issue that has been a major concern of journalists, policy makers and academics in Nigeria and other parts of Africa. There is a widespread perception that poor farmers are often forced to sell their grain immediately after harvest, when prices are low, in order to repay loans taken from grain merchants. The same farmers then must borrow in order to purchase grain for consumption

during the farming season, when prices are high, generating a vicious cycle of poverty.[26] This perception often provides an intellectual justification for government intervention into grain markets in sub-Saharan Africa (though the Nigerian government has not made any recent serious effort to control grain markets). There is no evidence for this particular sequence of events in these villages. Udry (1990) documents the absence of loans from traders to farmers in these villages. Nor is there any correlation between the wealth of a farmer and the average price at which he sells grain over the course of the year, so there is no evidence that poor farmers are forced to make a higher proportion of their grain sales during periods in which the grain price is low. Moreover, there is no evidence that households sell grain in order to repay loans. Households are no more likely to sell grain in months during which they repay loan than they are in other months. In a fixed effect regression of grain sales on a set of month dummy variables and a dummy variable indicating that a loan repayment was made in the current month, the coefficient of the loan repayment variable is -1.14 with a t-statistic 0.52. So this data set provides no evidence in support of the existence of the particular vicious cycle of poverty and indebtedness described above.

However, the finding that the growth of grain stocks is strongly diminished when a household receives an adverse shock on its upland farms raises the possibility of panic sales of grain to meet emergency needs. Data on grain market transactions enables us to investigate this hypothesis. The monthly net grain sales figures for each household are aggregated into three periods, corresponding to the periods for which there is information on the receipt of shocks. Period zero runs from February to April. No adverse shocks were recorded during this period, which ends before the upland farming seasons begins (so $Z_{j0}=0 \ \forall j$). Periods 1 and 2 are defined

[26]See Clough (1981,1986) and Shenton (1986, chapters 4 and 7) for forceful statements of this point of view.

as they were in section 2. Actual net grain purchases are not observed because households were instructed to report only "important" sales or purchases of grain. This results in censoring of reported net grain purchases when actual purchases are near zero. 37 percent of the observations on grain purchases are zero (43 percent are negative, and 21 percent are positive). Each household's interpretation of "important" may be different, hence the degree of censoring may vary across households. Let λ_j^s be a household fixed effect on grain purchases when observed purchases are negative, and λ_j^p be the household fixed effect when observed grain purchases are positive. The degree of censoring in reported net grain purchases by household j depends on $(\lambda_j^s - \lambda_j^p) \geq 0$ (there is no censoring if $\lambda_j^s = \lambda_j^p$). Observed net grain purchases in period t (T_{jt}) are

$$11. \quad T_{jt} = \begin{cases} d_t\alpha + Z_{jt}\gamma + d_tX_j\delta + \lambda_j^p + \upsilon_{jt} & \text{if } d_t\alpha + Z_{jt}\gamma + d_tX_j\delta + \lambda_j^p + \upsilon_{jt} > 0 \\ 0 & \text{if } -\lambda_j^p > \upsilon_{jt} > -\lambda_j^s \\ d_t\alpha + Z_{jt}\gamma + d_tX_j\delta + \lambda_j^s + \upsilon_{jt} & \text{if } d_t\alpha + Z_{jt}\gamma + d_tX_j\delta + \lambda_j^s + \upsilon_{jt} < 0. \end{cases}$$

Figure 3 summarizes the econometric specification.[27] The vector d_t contains two elements which indicate period 1 and period 2. As in equation (7), only the landholding elements of X_j are included in the interaction with the seasonal dummy variables d_t. Table 7 reports the results of the estimation of (11).[28] The hypothesis that coefficients of the model are equal when the household sells grain and when it purchases grain is firmly rejected (the $\chi^2(8)$ Wald test statistic is 246), therefore the results are reported separately for the two cases in Table 7A. However, the hypothesis that the coefficients of the idiosyncratic shock variables are the same in the two cases

[27]See Rosett (1959) for the first formulation of a similar model in the case of a single cross-section.

[28]The procedure followed is to first censor all observed net grain purchases from below at zero (all $T_{jt} < 0$ are set to zero). The resulting fixed effect Tobit model is estimated using Honoré's (1992) trimmed least squares estimator for censored models with fixed effects. Second, all observed net grain purchases are censored from above at zero, and again the resulting fixed effect Tobit model is estimated. These two estimators, one for $T_{jt} \leq 0$ and the other for $T_{jt} \geq 0$, are reported in Table 7A. The household fixed effects are not estimated.

cannot be rejected (the $\chi^2(2)$ test statistic is 1.05). The two estimators of these coefficients, therefore, are optimally combined to yield the estimates reported in Table 7B (see Hansen [1982]). The point estimate indicates that a one standard deviation adverse shock on a household's upland farm is associated with an N4,668 increase in grain sales during that period (recall that the estimate of the reduction in grain saving associated with the receipt of a shock is N2146). An important aspect of the reduction in grain saving contingent upon receiving an adverse shock on upland plots, therefore, is additional sales of grain stocks.

Do these additional sales qualify as "panic" sales of grain? These grain sales do not predominately occur during months in which the grain price is low, so it is not surprising that there is only a very slight negative correlation (-0.04) between the average price received for grain sales (over the year) and the receipt of a random shock by a household (at any point during the year). Nor is there strong evidence of a decline in the price received by those households making grain sales during a period in which they are subject to a shock. A regression of the price received for grain sales on the occurrence of adverse production shocks, the time period ($t \in \{0,1,2\}$ as in Table 7) and a set of household characteristics is reported in Table 8. The point estimate indicates that households subject to a one standard deviation adverse shock on their upland plots receive a price for their grain approximately 3 percent lower than the average price, but the coefficient is not significantly different from zero. The strong seasonal movements in the price of grain are reflected in the coefficients on the time dummy variables. In addition, there are significant village effects in grain prices. Finally, owners of large amounts of upland land receive significantly higher prices for their grain. The point estimate implies that a one standard deviation increase in upland land is associated with a 6 percent increase in the price received by the household for its grain. There are a variety of possible explanations for the latter finding which are difficult to differentiate using these data. It may reflect the reduced unit cost to traders

of engaging in larger transactions, the superior bargaining power of larger farmers, or search costs with a fixed component.

7. Do Households Save in Anticipation of Shocks?

Thus far, I have assumed that production shocks are unpredictable.[29] However, the possibility that my measures of shocks are predictable cannot be discounted *a priori*. It may be that such events as local flooding can be foreseen by the farmers. If this is the case, then the permanent income hypothesis implies that the household would have saved in advance of the occurrence of the shock. Saving would predict the shock, rather than *vice-versa*. This is the insight behind Campbell (1987) and provides the opportunity for a joint test of consumption smoothing and the unpredictability of the shocks. If information concerning the possible receipt of shocks in the latter half of the season (period 2) becomes available during period 1, then

$$12.\quad \begin{aligned} S_{j1} &= X_j\beta + Z_{j1}\gamma + Z_{j2}\gamma_2 + \upsilon_{j1} \\ S_{j2} &= \alpha + X_j\beta + Z_{j2}\gamma + X_j\delta + \upsilon_{j2} \end{aligned}$$

where $\gamma_2>0$. Equation (12) can be applied both to overall saving and to saving in the form of grain. FGLS estimates (which account for heteroskedasticity across periods) of the determinants of overall saving and grain saving are presented in Table 9. There is no evidence that either current or anticipated shocks on lowland plots are associated with changes in saving behavior. The relationship between the realization of idiosyncratic shocks on upland plots and current saving remains significantly negative and of the same magnitude as reported in Tables 2 and 6. Moreover, in period 1 both overall saving and grain saving are significantly effected by anticipations of period 2 shock on upland plots. Both estimates provide evidence that households increase their saving in anticipation of future shocks on upland plots. The point estimates imply

[29]This assumption also is maintained in Udry (1990, 1992).

that the responsiveness of saving to anticipated shocks is quite large. A one standard deviation shock on upland plots in period 2 is associated with increased saving in period 1 of N1512 overall and N1864 in grain. These quantities are of the same order of magnitude as the dissaving which occurs contingent upon the realization of an adverse shock. Recall from Tables 2 and 6 that a one standard deviation adverse shock on upland plots is associated with a reduction in saving of N1584 overall and N2146 in grain. It appears that near-future upland "shocks" are foreseen and that, in anticipation, households increase their current saving.

8. Conclusions

It has often been suggested that an important motivation for saving in poor agricultural societies is to use asset stocks to stabilize consumption in the face of uncertain incomes. Households dissave when they suffer an adverse shock and save more when they are favored with a positive shock. This paper has presented evidence to support this thesis among agricultural households in northern Nigeria. Using detailed data on saving and the receipt of adverse idiosyncratic shocks by a sample of 196 households over the course of one year, it is possible to reject the hypothesis that overall saving is not responsive to the realization of shocks. Households reduce their saving by economically significant amounts when they receive an adverse shock on their upland plots.

Standard models of intertemporal choice, appropriately modified to account for incomplete rental markets and diminishing returns to some assets, imply that consumption smoothing should be effected through adjustments in saving in assets not subject to diminishing returns. In northern Nigeria, the relevant asset available for consumption smoothing is grain. In accordance with the implications of the model, there is no evidence that household saving in livestock is affected by the receipt of adverse shocks. In contrast, grain savings are substantially

reduced when a household receives an adverse shock on its upland plots. Moreover, a significant portion of this response appears to be increased net sales of grain contingent upon the realization of an adverse shock. Finally, it is shown that households forecast the receipt of near-future adverse shocks on upland plots and that they increase their current saving in anticipation of the realization of these shocks.

Households in northern Nigeria use their assets as buffer stocks as one component of an overall risk-coping strategy. The complementary *ex post* mechanism is cross-sectional risk pooling. In Udry (1992), evidence is presented that credit *cum* insurance transactions are used to pool the idiosyncratic risks faced by households within a village, but that a fully Pareto efficient allocation of risk is not achieved. These households use their asset stocks to smooth over time the remaining idiosyncratic risk, and presumably transitory aggregate risk as well. Unfortunately, the short time period covered by the data makes it impossible to identify separately the effects of seasonality and aggregate shocks on saving.[30] A more thorough investigation of the role of saving in households' strategies for coping with risk in northern Nigeria and Africa more generally will be possible when data become available from a broader cross-section (so that regional shocks can be identified) or from a longer panel.

[30]The only other paper concerned with the use of saving behavior to smooth risk in Africa (Deaton, 1992) also suffers from the lack of a long panel. This is a difficulty which has been endemic to empirical microeconomics in Africa, where the collection of individual- and household-level data has been uncommon (relative to other parts of the world) until recently.

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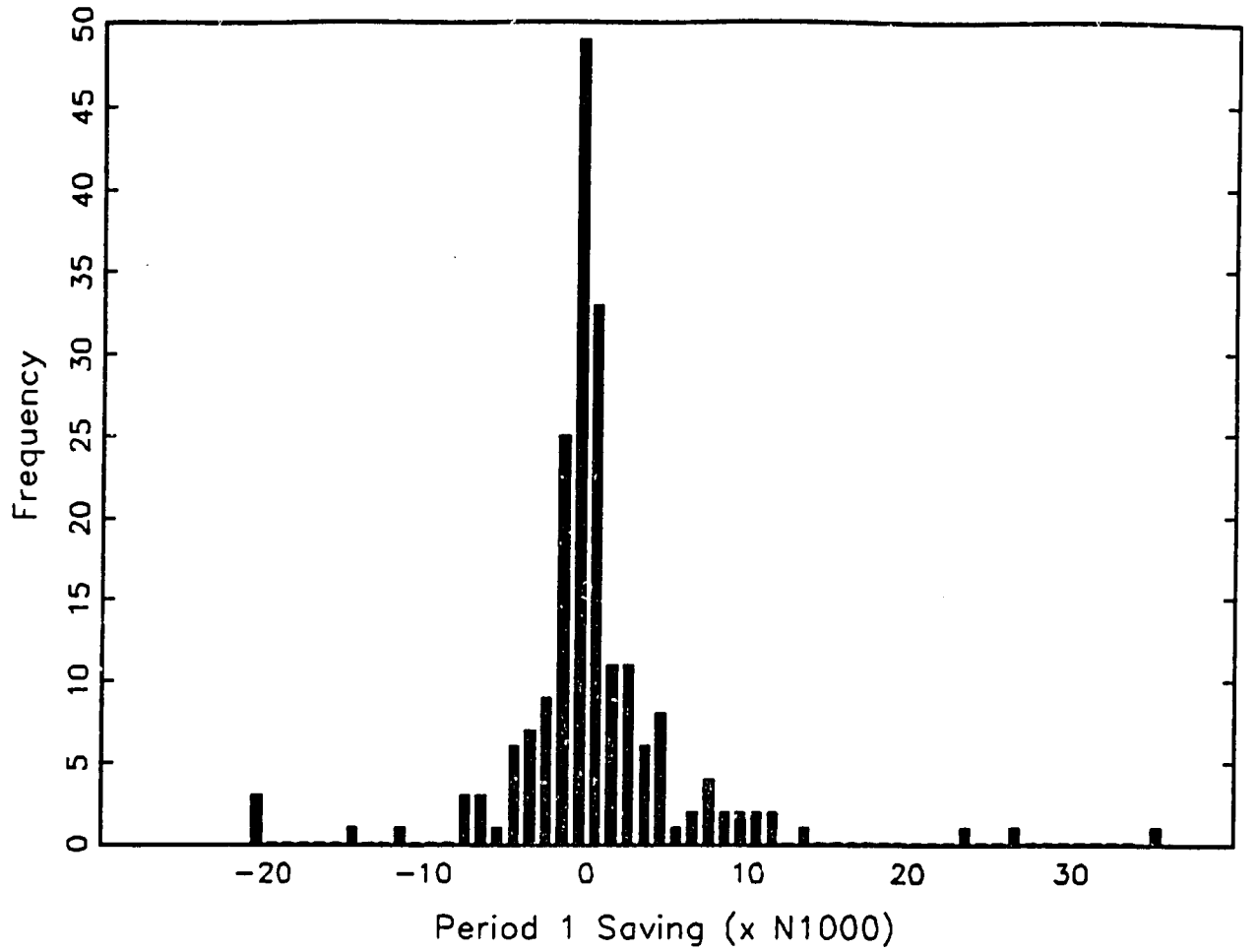

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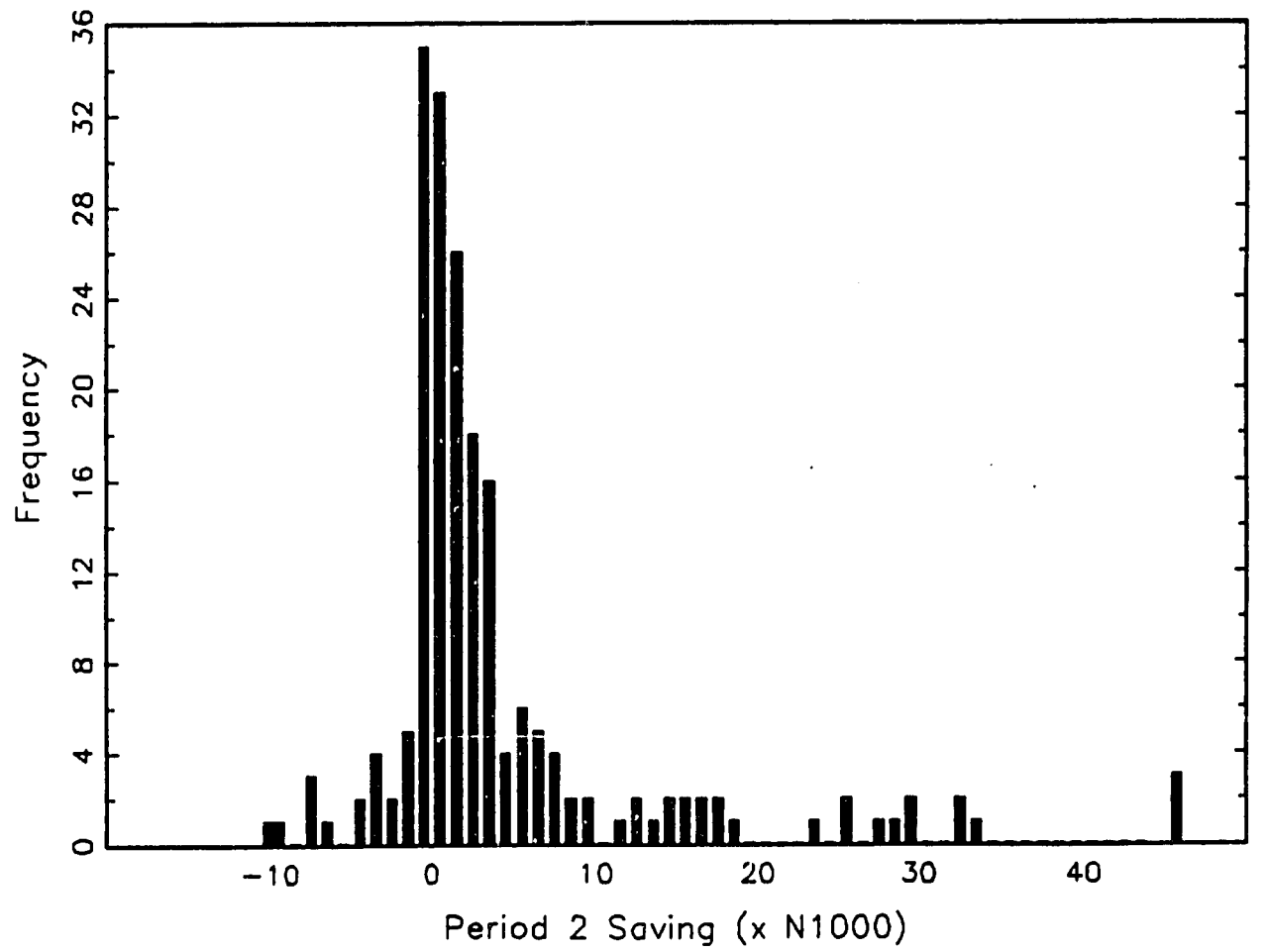

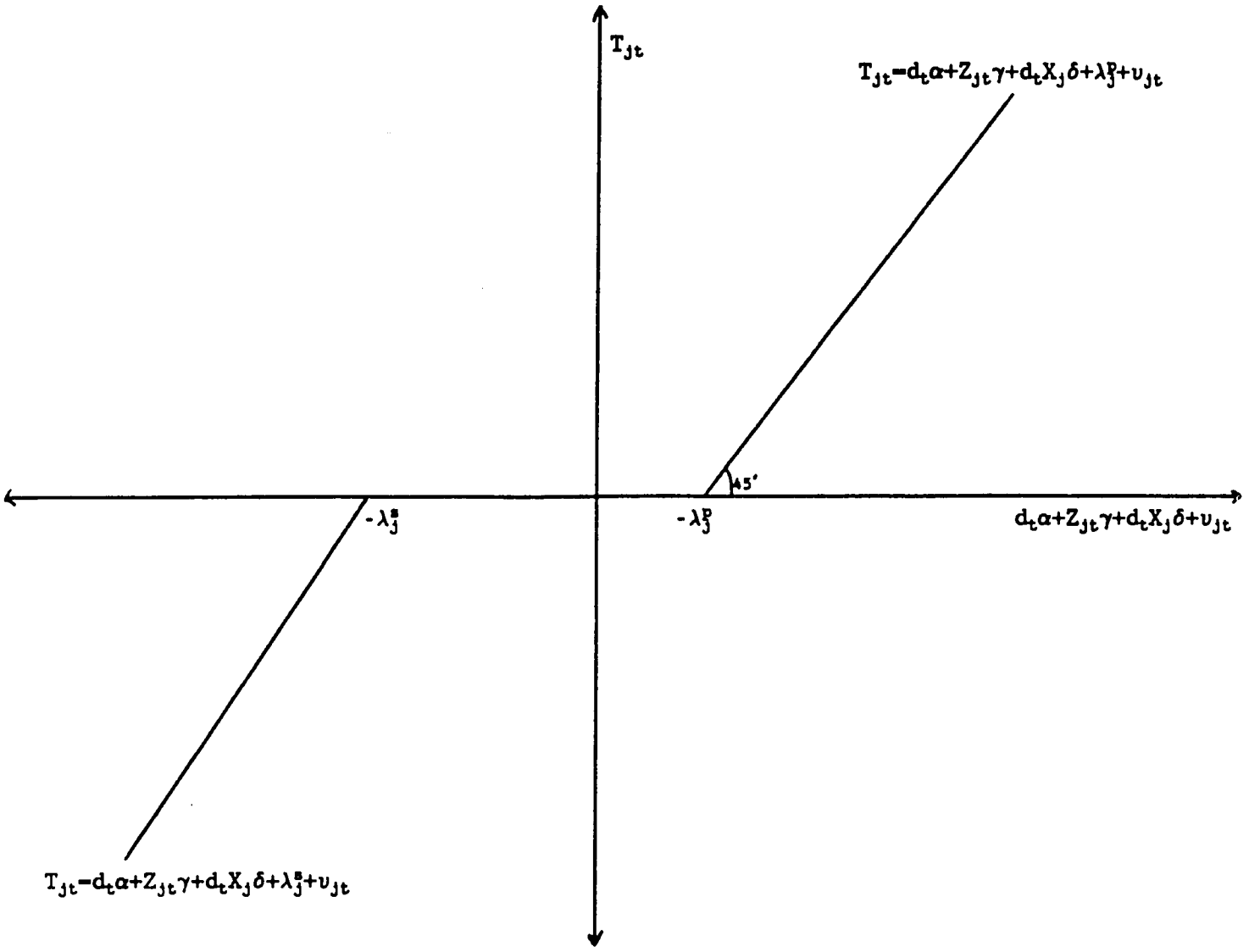
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Figure 3

TABLE 1
Descriptive Statistics

	Mean	Std. Dev.
Overall Saving (x N1000)	2.75	14.13
Period = 1	0.77	8.27
Period = 2	5.42	17.82
Saving in grain and farm inputs (such as fertilizer)	0.99	1.14
Period = 1	-2.48	8.02
Period = 2	4.46	13.17
Saving in livestock	1.76	9.65
Period = 1	2.56	5.80
Period = 2	0.96	12.33
Saving in stocks of goods for trading	-0.01	0.49
Period = 1	-0.01	0.39
Period = 2	-0.01	0.56
Index of Adverse Idiosyncratic Shocks:		
On Upland Plots	1.88	7.92
Period = 1	3.06	10.85
Period = 2	0.70	2.33
On Lowland Plots	0.21	1.77
Period = 1	0.34	2.24
Period = 2	0.19	0.81
Household Characteristics:		
Wealth at the time the household was formed (x N10000)	8.60	114.11
Age of the household head	40.64	12.21
Number of wives	1.52	0.79
Number of males 10-60 in the household	2.53	1.57
Number of dependents	3.67	2.61
Presence of a member of the household with a special skill (dummy variable)	0.60	0.24
Upland land owned in hectares	3.24	4.69
Lowland land owned in hectares	0.44	1.04

Table 2
Generalized Least Squares Estimates of the Determinants of Saving

Variable	Parameter Estimate	T-Ratio	*n=392*
Intercept	-0.556	-0.25	
Season = 2	-2.526	-1.80	
Upland Shock	-0.197	-2.65	
Lowland Shock	-0.156	-0.84	
Village = 1	4.081	2.54	
Village = 2	0.952	0.63	
Village = 3	0.547	0.36	
Past Wealth	0.022	4.80	
Age of Household Head	0.008	0.16	
Number of Wives	-0.021	-0.02	
Number of Males Aged 10-60	0.269	0.74	
Number of Dependents	0.103	0.41	
Household with Special Skill	-0.580	-1.01	
Upland Land Owned	-0.354	-1.93	
Lowland Land Owned	0.282	0.42	
Upland Land * Season = 2	2.598	9.72	
Lowland Land * Season = 2	-2.795	-2.42	

Table 3
First-Difference Estimates of the Determinants of Saving

Variable	Parameter Estimate	T-Ratio	*n=196*
Season = 2	-2.277	-1.24	
Upland Shock	-0.351	-2.12	
Lowland Shock	-0.146	-0.56	
Upland Land * Season = 2	2.427	6.45	
Lowland Land * Season = 2	-2.898	-1.94	

Table 4
IV Estimates of the Determinants of Saving

Variable	Parameter Estimate	T-Ratio	*n=392*
Intercept	-4.286	-1.00	
Season = 2	1.827	0.38	
Upland Shock	-0.618	-1.09	
Lowland Shock	2.456	0.86	
Village = 1	6.829	2.93	
Village = 2	1.173	0.59	
Village = 3	1.369	0.65	
Past Wealth	0.018	2.85	
Age of Household Head	-0.012	-0.17	
Number of Wives	0.458	0.37	
Number of Males Aged 10-60	0.336	0.69	
Number of Dependents	0.212	0.52	
Household with Special Skill	-0.781	-1.02	
Upland Land Owned	0.079	0.11	
Lowland Land Owned	0.622	0.56	
Upland Land * Season = 2	2.255	3.47	
Lowland Land * Season = 2	-3.608	-2.18	

Table 5
Test of the Stability of the Responsiveness of Saving to Shocks

Variable	Parameter Estimate	T-Ratio	*n=392*
Intercept	-0.716	-0.32	
Season = 2	-2.468	-1.76	
Upland Shock * Season = 1	-0.174	-2.31	
Upland Shock * Season = 2	-1.031	-2.35	
Lowland Shock * Season = 1	-0.210	-0.93	
Lowland Shock * Season = 2	0.00002	0.00	
Village = 1	4.269	2.66	
Village = 2	0.952	0.63	
Village = 3	0.607	0.39	
Past Wealth	0.022	4.83	
Age of Household Head	0.015	0.29	
Number of Wives	-0.227	-0.24	
Number of Males Aged 10-60	0.299	0.83	
Number of Dependents	0.127	0.50	
Household with Special Skill	-0.522	-0.91	
Upland Land Owned	-0.383	-2.08	
Lowland Land Owned	0.244	0.36	
Upland Land * Season = 2	2.808	9.75	
Lowland Land * Season = 2	-2.877	-2.50	

Table 6
GLS Estimates of the Determinants of Saving in Grain and Livestock

Variable	Grain Saving Parameter Estimate	Grain Saving T-Ratio	Livestock Saving Parameter Estimate	Livestock Saving T-Ratio
Intercept	-0.273	-0.13	-0.388	-0.26
Season = 2	2.017	1.63	-4.544	-4.57
Upland Shock	-0.271	-3.85	0.070	1.41
Lowland Shock	-0.181	-1.07	0.018	0.14
Village = 1	3.757	2.56	1.125	1.02
Village = 2	0.093	0.07	0.928	0.89
Village = 3	0.103	0.07	0.410	0.39
Past Wealth	0.000	0.11	0.023	7.35
Age of Household Head	-0.060	-1.31	0.053	1.55
Number of Wives	-0.239	-0.28	0.159	0.25
Number of Males Aged 10-60	0.306	0.93	0.088	0.36
Number of Dependents	0.430	1.87	-0.260	-1.51
Household with Special Skill	-0.702	-1.34	0.158	0.40
Upland Land Owned	-0.438	-2.52	0.094	0.77
Lowland Land Owned	0.637	0.99	-0.488	-1.09
Upland Land * Season = 2	1.347	5.68	1.238	6.56
Lowland Land * Season = 2	-0.781	-0.77	-1.965	-2.40

n=392

Table 7A
Fixed Effect Tobit Estimates of the Determinants of Grain Sales and Purchases

Variable	Net Sellers ($T_{jt} \leq 0$) Parameter Estimate	T-Ratio	Net Purchasers ($T_{jt} \geq 0$) Parameter Estimate	T-Ratio
Season - 1	17.944	1.02	-3.532	-0.39
Season - 2	0.697	0.10	-99.107	-1.49
Upland Shock	-7.624	-2.05	-5.724	-3.12
Lowland Shock	-0.554	-0.11	-23.139	-0.95
Upland Land * Season - 1	-0.439	-0.07	39.531	5.06
Upland Land * Season - 2	-3.172	-0.80	44.938	20.55
Lowland Land * Season - 1	-12.905	-0.60	-83.132	-5.72
Lowland Land * Season - 2	-4.991	-0.39	-35.649	-1.95

Table 7B
Optimally Combined Estimates of the Determinants of Net Grain Purchases

Variable	Parameter Estimate	T-Ratio
Upland Shock	-7.168	-12.33
Lowland Shock	-1.139	-0.23

Table 8
OLS Estimates of the Determinants of the Price Received for Grain

Variable	Parameter Estimate	T-Ratio	*n=392*
Intercept	2.846	18.93	
Season - 1	0.359	2.38	
Season - 2	0.332	2.39	
Upland Shock	-0.012	-1.33	
Lowland Shock	0.003	0.17	
Village - 1	-0.255	-1.63	
Village - 2	-0.373	-2.46	
Village - 3	0.053	0.16	
Upland Land Owned	0.039	2.04	
Lowland Land Owned	0.010	0.15	

Table 9
Tests of the Predictability of Shocks

	Determinants of:			
	Overall Saving		Grain Saving	
Variable	Parameter Estimate	T-Ratio	Parameter Estimate	T-Ratio
Intercept	-0.164	-0.07	0.146	0.07
Season - 2	-2.482	-1.77	2.073	1.68
Upland Shock	-0.209	-2.83	-0.285	-4.11
Lowland Shock	-2.288	-0.79	-2.797	-1.11
Village - 1	3.676	2.29	3.204	2.20
Village - 2	0.908	0.60	0.048	0.03
Village - 3	0.342	0.22	-0.106	-0.08
Past Wealth	0.022	4.83	0.000	0.05
Age of Household Head	-0.002	-0.03	-0.068	-1.50
Number of Wives	0.252	0.27	0.083	0.10
Number of Males Aged 10-60	0.213	0.59	0.229	0.70
Number of Dependents	0.064	0.25	0.373	1.63
Household with Special Skill	-0.666	-1.16	-0.807	-1.56
Upland Land Owned	-0.473	-2.49	-0.588	-3.30
Lowland Land Owned	0.393	0.59	0.787	1.25
Upland Land * Season - 2	2.722	9.98	1.501	6.22
Lowland Land * Season - 2	-2.870	-2.50	-0.875	-0.87
Future Upland Shock	0.649	2.10	0.800	2.76
Future Lowland Shock	-1.583	-0.43	-2.232	-0.68

n=392