

## Dynamic Savings Decisions in Agricultural Environments with Incomplete Markets

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## **Abstract**

We develop a methodology for examining savings behavior in rural areas of developing countries that explicitly incorporates the sequential decision making process in agricultural. We use this methodology to examine the relative importance of alternative forms of savings and credit activity in the presence and absence of formal financial intermediaries. In particular, we estimate a profit function that is conditional on planting stage inputs and use the resulting coefficient estimates to construct a measure of the stochastic component of agricultural production. Our results provide evidence that the presence of financial intermediaries importantly influences the composition of savings behavior and that transfers play an important role as a form of savings. We also estimate a series of savings functions by production stage that incorporate income for the entire production cycle, as is common in the literature. The evidence indicates that the bias associated with evaluations of the savings-income relationship that are inattentive to the dynamics of agricultural production within the year can be significant.

## 1. Introduction

Mobilization of financial savings has long been viewed as a critical dimension of the development process. In the 1950's and early 1960's increasing the savings rate was seen as essential to initiate and to accelerate economic development. McKinnon (1973) and Shaw (1973) shifted the emphasis in the discussion of saving determinants in developing countries to the role of markets, particularly credit markets, and to the importance of policy restrictions on those markets. One implication of this literature *inter alia* is that formal savings in rural areas are limited by financial repression, which leads to dynamic inefficiency because informal savings mechanisms are not sufficiently linked geographically and thus do not lead to sufficient transfer of savings over space, particularly in light of the large impact of local weather shocks in developing country agriculture. This results in inefficient geographical distribution of investible resources and the use of costly mechanisms for consumption smoothing in response to local shocks.

A number of micro studies have attempted in recent years to estimate the effects of income variation on savings decisions in low-income agricultural populations to gauge the importance of credit and insurance market failures. Such studies (Bhalla (1979, 80), Wolpin (1982), Paxson (1992), and Alderman (forthcoming)) have employed the permanent income model (or variants of it). This framework assumes the existence of perfect credit markets and thus does not explicitly consider the dynamic interdependencies of savings and income within the cycle of agricultural production when markets are imperfect nor what effect the local presence of formal sector financial institutions has on either the level or the composition of savings.

Failure to take into account the constraints on information that result from the sequential nature of agricultural production within the year can lead to misleading inferences concerning farmer behavior. Because income is relatively plentiful in the harvest period and expenditure decisions in the planting period affect subsequent-period income, savings decisions are likely to

differ between the planting and harvest production periods. As a consequence, estimates of the relationships between annual income and consumption or savings, which are prevalent in the literature, do not correspond to those characterizing any actual decision rule of farmers. In particular, if a substantial proportion of income in the harvest stage could not have been anticipated in the planting stage, savings measured in the planting stage cannot be strongly related to harvest income, although savings in the harvest period may be. Moreover, to the extent that harvest income depends on planting-stage decisions, then in an environment with incomplete markets there may exist interdependencies between stage-specific savings decisions and income that have not been taken into account in prior studies of savings.

In this paper we estimate dynamic savings decision rules for farmers within the context of a model of stochastic production with planting and harvest production stages.<sup>1</sup> We exploit panel data covering 12 periods over three years from rural Pakistan to estimate savings decision rules in the major (Rabi) agricultural season while taking into account the sequential production stages of agriculture (i.e., planting versus harvest stages), credit market imperfections, bank proximity, savings-income interdependencies within a crop-cycle and heterogeneity in preferences, credit worthiness, and other unobservables. We employ a two-stage, quasi-structural procedure. We first estimate the agricultural technology based on a specification of the conditional profit function. These estimates are used to construct measures of unanticipated harvest-stage income for the purpose of estimating the effect on the amount and composition of harvest-period savings of income shocks for farmers differentiated by their proximity to formal-sector financial institutions. We also conduct tests of whether or not the residual harvest-stage income shock measures that we estimate are anticipated.

The approximations to harvest-period savings decision rules estimated in the second stage for net savings flows to financial institutions, for informal transfers, and for debt repayment also incorporate measures of harvest-stage "full" labor income, a component of income that is in

part anticipated, and state variables such as assets, family human capital, and the local presence of formal financial institutions. These state variables are allowed to be correlated with unobservables in the estimation procedure. Finally, we estimate stage-specific savings relationships using income measured over a full crop cycle to assess the extent to which this practice in the literature importantly affects inferences about the effects of income on savings in agricultural settings characterized by incomplete intertemporal markets.

The estimates suggest that the harvest-period production shocks are not anticipated in the planting period but affect significantly the amount and composition of harvest-stage savings depending on bank proximity. In particular, the presence of local formal financial institutions causes a shift from informal consumption-smoothing mechanisms (transfers) to the use of formal savings institutions, which presumably facilitates financial intermediation in larger geographical markets and thereby the development process. We also find that transfers appear to behave like credit but that the use of income aggregated over the year or a crop cycle importantly obscures the effects of income shocks on these forms of savings behavior due in part to the dependence of agricultural income on within-year stage-specific savings decisions.

## **2. Theoretical Framework**

The theoretical framework for this paper is a stochastic dynamic multistage agricultural household model, similar in general form to that in Antle (1983) and Skoufias (1993), incorporating stage-specific savings decisions that are affected by differential access to financial institutions. There are three key features of the model that are not taken into account, at least explicitly, in most prior studies of savings behavior in rural agriculture: (i) each crop cycle is divided into two stages corresponding to income availability and to the timing of the resolution of uncertainty, (ii) decisions taken in the first stage, including savings decisions, influence second-stage agricultural income, and (iii) the rate of return on financial assets may vary over the course

of the year and across households, depending in part on the extent of financial intermediation.

The first stage of each crop cycle is the planting stage. This stage may be characterized as a stage of shortage because food prices are high, as is, in the absence of sufficient financial intermediation, the return on financial assets (i.e., the cost of borrowing<sup>2</sup>) because farmers wish to mobilize assets for purchasing agricultural production inputs as well as for financing consumption during a period in which they do not have crop revenues. The second stage of the crop cycle is the harvest stage. In this period, labor demand is high and the return on financial assets may be low.

We assume that households maximize expected discounted utility with a subjective rate of discount  $\beta$ , and that single-period utility depends on consumption,  $c_t$ :

$$E_t \sum_{s=t}^{\infty} \beta^s U(c_s) \quad (1)$$

where  $E_t$  is the expectations operator evaluated at time  $t$ . Each period is assumed to correspond to one crop-cycle-specific production stage. Consumption and savings in each period are financed from wage income and stage-specific farm profits:

$$p_{ct} c_t + s_t = F_t + \pi_t \quad (2)$$

where  $p_{ct}$  is the price of consumption goods;  $F_t$  is potential labor income,  $= w_t N_t$ , where  $w_t$  is the relevant stage-specific wage rate and  $N_t$  is the maximum time of family members that could be spent working in the period;  $\pi_t$  denotes stage-specific farm profits, which are defined as current-period farm revenues net of current-period expenditures; and  $s_t$  is net savings flows and includes net contributions to financial assets, net repayment of debt, net additions to stocks (food or other inventory), and, possibly, net transfers to other households.

We assume that each asset  $A_i$  (e.g., land owned, savings, debt, equipment) has a rate of

stage-specific return  $r_{it}=r_i(t, \mathbf{A}_t, \mathbf{B}, u_t)$  that depends on the vector of assets  $\mathbf{A}_{it}$ , the household, and village-level characteristics  $\mathbf{B}$  that affect the extent of access to financial intermediaries, and  $u_t$ , which is a stage and individual-specific factor reflecting interhousehold and intertemporal variation in credit access that is known by farmers but is unmeasured in the data. The  $u_t$  may have both permanent and an i.i.d. transitory components (for example, some farmers may be deemed more creditworthy than others or costs of credit may vary from year to year). Each asset evolves according to

$$A_{it+1} = (1 + r_{it})(A_{it} + s_{it}), \quad (3)$$

where  $s_{it}$  is asset-specific net savings and  $s_t = \sum s_{it}$ . Note that we are treating net transfers as a form of savings in that net transfers can be accumulated like any other asset stock. We test below whether transfers behave differently than other forms of saving by examining the extent to which transfer “stocks,” representing accumulated obligations or contributions, affect savings and transfer behavior.

Output in a given harvest stage is assumed to depend on prior planting and harvest-stage labor and non-labor inputs and a shock that is observed by farmers after the planting-stage decisions are made. Because output arrives in the harvest stage, planting-stage “profits” are negative, consisting of the costs of the planting-stage agricultural inputs such as fertilizer and labor. Denoting the  $t^{\text{th}}$  period as a harvesting period,  $t=h$ , and thus period  $t-1$  as its corresponding planting period,  $t-1=p$ , planting-stage profits are:

$$\pi_p = -p_{lp} I_p \quad (4)$$

where  $I_p$  denotes planting-stage inputs (e.g., land cultivated, fertilizer, seeds, labor) and  $p_{lp}$  is the corresponding price.

Harvest-stage profits have two components - the value of output and the cost of harvest-

stage inputs:

$$\Pi_h = p_{fh} f(I_h, I_p, \epsilon_h) - p_{lh} I_h \quad (5)$$

where  $p_{fh}$  is the price of the output good,  $f(\cdot)$  is the production function, and  $\epsilon_h$  is the production shock. Note that output depends on the inputs used in each of the planting and harvesting stages but that harvest-stage profits are gross of planting-stage input costs and net of harvest-stage input costs.

In the harvest stage, the farm household chooses inputs, taking as given asset stocks, planting-stage inputs chosen in the prior planting period, contemporaneous prices and wages, and the information on the now-realized production shock. Substitution of the optimal decisions into (5) yields a harvest-stage conditional profit *function* with planting-stage inputs, the production shock, and prices as arguments.

$$\Pi_h = \Pi(I_p, \epsilon_h, p_{lh}, p_{fh}, w_h) \quad (6)$$

Note that neither the returns on financial assets nor the household and village-level characteristics that determine the return on financial assets appear in (6) - although the cost of borrowing in the planting stage in general affects the choice of inputs in that stage and the profitability of the crop cycle as a whole (i.e., the discounted sum of stage-specific profits), it does not affect harvest-stage profits given planting-stage inputs.

As a consequence of the dependence of harvest-stage profits on lagged (planting-stage) inputs and of the stochastic nature of harvest-period income, the structure of input decision rules differs across stages. Because production and price uncertainty for the crop cycle is resolved, returns to harvest-stage expenditures are realized as they are incurred (in the form of harvested crop), and harvest-stage incomes are high, credit costs in that stage are irrelevant and harvest-stage input decisions are identical to those from a static profit-maximizing model with no

uncertainty. First-order conditions in the harvest stage yield savings decision rules, however, which are more complex. For each asset  $i$ :

$$s_{ih} = S_{ih}(A_h, \pi_h, W_h, F_h, \mathbf{p}_h, B, G, u_h) \quad (7)$$

where  $\mathbf{p}_h$  denotes a vector of prices and  $G$  is the farmer-known joint distribution of the stochastic variables that become known to the farmer at the beginning of the harvest stage ( $\epsilon_h$  and  $u_h$ ), the future planting stage-shocks  $u_p$  and future crop-cycle realizations of innovations in harvest-stage prices.<sup>3</sup> It is assumed that  $G$  is the same in each planting stage.

Both savings and input decisions in the planting-stage are more complex than they are in the harvest stage because they importantly influence subsequent within-crop-cycle decisions and because the production shock for that cycle is not yet observed, as is evident from equations (6) and (7). The planting-stage savings decision rules are:

$$s_{ip} = S_{ip}(A_p, F_p, \mathbf{p}_p, B, G, u_p) \quad (8)$$

Thus planting-stage decisions depend on the vector of stocks in existence at the beginning of the planting stage, input prices in that period (which are known), and the distribution of shocks in the subsequent periods but not on the realizations of the profit shock  $\epsilon_h$  or harvest prices. Planting-stage input decision rules are of the same form as equation (8).

It is almost always the case that information on assets is provided based on survey data for the beginning of the planting period and not for the beginning of the harvest stage. Thus it is useful to express the harvest-stage savings decisions in terms of planting-stage state variables and harvest-stage shocks. Substitution of the planting-stage savings, which affect harvest-stage savings through their effect on harvest-stage assets, and the analogous planting-stage input decision rules, which affect harvest-stage profits through (6), into (7) yields the harvest-stage savings decision rules as functions of the measured and unmeasured planting-stage state

variables and harvest shocks:

$$s_{ih} = S_{ih}(A_p, p_p, p_h, F_p, F_h, B, G, u_p, u_h, \epsilon_h) \quad (9)$$

As can be seen, equation (9), the set of harvest-stage savings relations, still differs from equation (8), the set of planting-stage savings decisions in that neither the harvest-stage prices nor the unanticipated component of profits appears as an argument in the latter.

Studies in the prior literature examining rural savings, while differing in the exact models used and the measurement of income, aggregate agricultural incomes over the crop-cycle (or year) and either aggregate as well savings across stages (e.g., Wolpin (1982), Paxson (1992), Alderman, forthcoming), mix together savings in different stages in the same sample of observations (Paxson (1992)), or use disaggregated income and savings, mixing together different stages of production (Chaudhuri and Paxson 1994). It is clear that estimates of the relationship between income aggregated over the two stages of production and either aggregated savings or stage-specific savings do not correspond to income effects given by either the harvest or the planting-stage decision rules. We now examine how estimates of income effects on savings, which disregard the sequential nature of agricultural production, differ from those obtained using stage-specific decision rules. In particular, we derive theoretical expressions for, and subsequently estimate, the regression coefficients that would arise if stage-specific savings were regressed on annual income and the state variables appearing in equation (9) excluding the three shock terms.

Aggregated agricultural income is

$$y = \pi_h + \pi_p + F_h + F_p = Y(A_p, p_p, p_h, w_p, F_p, F_h, B, G, u_p, \epsilon_h) \quad (10)$$

and consists of exogenous components - the  $\epsilon_h$  and stage-specific full incomes  $F_p$  and  $F_h$  - and endogenous components, reflecting the choice of inputs in the planting stage  $\pi_p$ , which are in

turn functions of the planting-stage state variables. Note that by conditioning on the asset variables and on full income, included in the state variables, the only direct exogenous source of variation in income is that due to variation in  $\epsilon_h$ .

Using first-order Taylor approximations to the functions  $S_{ip}$ ,  $S_{ih}$  as specified in equations (8) and (9) and of aggregated income in (10), and normalizing the shock term so that  $\partial Y/\partial \epsilon = 1$ , we can write the estimated effects from a linear regression of stage-specific savings for any asset  $i$  on aggregated income  $y$  net of the state variables,  $\hat{\alpha}_{iy}^t$ , as<sup>4</sup>

$$\hat{\alpha}_{iy}^p = \frac{\frac{\partial S_{ip}}{\partial u_p} \frac{\partial Y}{\partial u_p} \sigma_{u_p}^2}{\left(\frac{\partial Y}{\partial u_p}\right)^2 \sigma_{u_p}^2 + \sigma_{\epsilon_h}^2} \quad (11)$$

$$\hat{\alpha}_{iy}^h = \frac{\partial S_{ih}}{\partial \epsilon_h} + \frac{\left(\frac{\partial S_{ih}}{\partial u_p} - \frac{\partial S_{ih}}{\partial \epsilon_h} \frac{\partial Y}{\partial u_p}\right) \frac{\partial Y}{\partial u_p} \sigma_{u_p}^2}{\left(\frac{\partial Y}{\partial u_p}\right)^2 \sigma_{u_p}^2 + \sigma_{\epsilon_h}^2} \quad (12)$$

where the partial derivatives  $\partial S_{it}/\partial u_p$  represent the coefficients on  $u_p$  in the Taylor approximations to equations (8) and (9) and so forth.

As can be seen from (11) and (12), the source of the bias arising from estimation of the effects of income shocks on savings in this way is the existence of variability in the unmeasured planting-stage asset or credit shock  $u_p$ . It is evident that, in the absence of any unmeasured components to the cost of borrowing or to asset returns ( $\sigma_{u_p}^2 = 0$ ),  $\hat{\alpha}_{iy}^p$  would be zero, which is the true effect of  $\epsilon_h$  on planting-stage savings (conditional on the state variables), and  $\hat{\alpha}_{iy}^h$  would be the true effect of income on harvest savings ( $\partial S_{ih}/\partial \epsilon_h$ ). In general, however, the  $\hat{\alpha}_{iy}^t$  will not consistently estimate the  $\epsilon_h$  effects, with the sign of the biases depending on the signs and

magnitudes of  $\partial S_H/\partial u_p$  and  $\partial Y/\partial u_p$ .

Suppose those with lower  $u_p$  have greater access to credit - the cost of debt is lower. Under these circumstances an increase in  $u_p$  should result in a decrease in borrowing ( $\partial S_{ip}/\partial u_p > 0$ ) and a decrease in planting stage input use ( $\partial I_p/\partial u_p < 0$ ). As long as credit is constrained, this should result in a decrease in income as

$$\frac{\partial Y}{\partial u_p} = \left( p_{th} \frac{\partial f}{\partial I_p} - p_{lp} \right) \frac{\partial I_p}{\partial u_p} \quad (13)$$

More generally, the term in parentheses is positive whenever inputs are below profit-maximizing levels. The resulting estimated effect of income on planting-stage net repayment of debt ( $\hat{\alpha}_{iy}^p$  for  $i$ =net debt retirement) will thus be negative: an increase in income will appear to lower this form of savings. If  $u_p$  only affects credit costs then it is likely that the bias of the estimate of income on other forms of savings will be positive, as funds would be shifted out of other assets to finance input use.

As can be seen from (12), it is not generally possible to sign the bias in the estimated effect of aggregated income on harvest-stage savings. However, to the extent that shocks to credit in the planting stage affect savings in the harvest stage directly (through repayment requirements, for example) and indirectly through altering planting stage inputs and thus harvest incomes, there will be bias.

Whatever the sources of the asset-specific shocks in the planting stage, the coefficient estimates using income aggregated over the crop cycle or year will not represent the true effects of an exogenous increase in income on savings in either stage. Rather, they reflect (solely in the case of planting-stage savings behavior) the reverse causation arising from the effects variation in planting-stage input use on farm profits and annual net income, where the former is itself correlated with planting-stage savings as a result of variation in  $u_p$ . One method of avoiding the

problem of reverse causation, from savings to income within the crop-cycle, is to use instruments. Paxson (1982) uses deviations from average rainfall, which is a component of  $\epsilon_h$ . Her estimate of the savings effects of that part of income variation due to rainfall “shocks” thus would have been correct, if the savings measure corresponded to particular stages rather than aggregates of stages and if rainfall shocks do not affect planting-stage credit terms (and if state variables had been included in the specifications). Measures of agricultural “permanent” income that are instrumented using average rainfall variables as in Wolpin (1982) and Paxson, however, yield biased estimates, and would even if the dependent savings measures used were stage-specific, to the extent that there are persistent components to credit worthiness or other components of the  $u_p$ . Finally, fixed effects methods (as in Alderman, forthcoming) do not eliminate the bias to the extent that the credit or asset shocks are time-varying.

### **3. Specification and Estimation Procedure**

In our theoretical framework, there are three distinct contemporaneous “income effects” on harvest-stage decision rules (9): the effect of harvest-stage wage income on harvest-stage decisions, the effects of assets by type (or, more properly the income derived from these assets), and the effect of the unanticipated component of harvest profits (the shock) on harvest-stage decisions. Our two-step or semi-structural estimation strategy is to measure these effects by first estimating the production technology, from which we can identify the production shock, and then estimating linear approximations to the harvest-stage savings decision rules. To estimate the harvest-stage decision rules an estimate of the unanticipated part of harvest profits  $\epsilon_h$  is required. To obtain this we first need to estimate the harvest-stage conditional profit function (6). Given the assumptions of the model we therefore need information on harvest-stage profits, planting-stage inputs and harvest-stage prices to estimate this function.

We obtain estimates of the conditional profit function by first normalizing using total

cultivated area, and then estimating a generalized-Leontief profit function with an additive fixed-effect. In particular if  $\mathbf{K}$  is the vector of normalized arguments in equation (6) other than the stochastic terms then we may write the estimated per acre profit function for farmer  $j$  in the period- $t$  harvest as

$$\frac{\Pi_{j,t}}{H_{j,t}} = \sum_{k_1=1}^K \left[ \gamma_{k_1} K_{k_1,t} + \sum_{k_2=k_1}^K \gamma_{k_1 k_2} K_{k_1,t} K_{k_2,t} \right] + v_{j,t} + \epsilon_{j,t} \quad (14)$$

where  $H_{j,t}$  is total cultivated area<sup>5</sup>, and  $v_{j,t}$  represents time-invariant characteristics of the household, such as its land quality, farming ability, and preferences, that are not measured in the data.

The principal problem in estimating the conditional harvest-stage profit function (10) is that all of the planting-stage production inputs are likely to be correlated with the permanent component of the error term and thus are endogenous. However, they cannot, given the information assumptions, be correlated with the post-planting harvest shock. First-differencing (10) across adjacent crop-cycles eliminates the permanent component of the error term, yielding:

$$\Delta \frac{\Pi_{j,t}}{H_{j,t}} = \sum_{k_1=1}^K \left[ \gamma_{k_1} \Delta K_{k_1,t} + \sum_{k_2=k_1}^K \gamma_{k_1 k_2} \Delta (K_{k_1,t} K_{k_2,t}) \right] + \Delta \epsilon_{j,t} \quad (15)$$

where  $\Delta$  denotes a stage-specific first difference across crop-cycles. Differencing eliminates the (linear) influence of the unmeasured time-invariant land and farmer quality inputs. However, differencing also potentially introduces a new estimation problem because the harvest production shock in the first crop-cycle affects harvest-stage savings in that first crop-cycle (equation (9)) and thus the next-cycle planting-stage stocks that may influence the input and consumption decisions in the second-cycle planting stage (equation (8)). We use instrumental variables to correct this problem, employing as instruments lagged values of assets (including inherited

assets), prices, and wages. Note that because the fixed effect is eliminated by differencing, any variables not appearing in the crop-cycle normalized conditional profit function and occurring prior to the realization of the first crop-cycle-specific shock  $\epsilon_{ijt-1}$  are valid instruments, and effective if they are correlated with the difference in input values across crop cycles.

The estimates of the profit-function parameters enable, by subtracting the predicted harvest-stage profits from actual harvest-stage profits, the computation of two compound residual terms for each household containing the household profit fixed effect  $v_{ij}$  and the stage- and crop-cycle-specific post-planting shock  $\epsilon_{ijt}$ .<sup>6</sup> These are used to estimate a linearized approximation to the savings decision rules for the harvest stage corresponding to (9), containing in addition to the harvest output shock the planting-stage stocks and unobservable time-invariant and time-varying preference and wealth factors (e.g., land quality, credit-worthiness, distributional characteristics of area-specific weather) as determinants.

We employ a similar estimation strategy as for the estimation of the conditional harvest-stage profit function, except that to take into account the possible effects of financial intermediation on savings behavior we estimate the linear approximations to the savings functions separately for villages with and without a nearby ( $\leq 5\text{km}$ ) bank. As for the estimation of the normalized generalized Leontief profit function, we difference across crop-cycles for the same production stage and employ as instruments lagged values of stocks and prices, including inherited assets. First-differencing in this case eliminates the fixed effect in savings, which include the profit fixed-effect  $v_{ij}$ , unmeasured individual-specific time-invariant credit and asset return variables  $u_p$  and  $u_h$ , and the parameters of the distribution of production shocks. Note that this procedure eliminates as well bias due to the non-random (with respect to the fixed effect) placement of banking institutions, a significant problem in identifying the influence of private or governmental institutions (Rosenzweig and Wolpin 1986, Pitt et al. 1993). While we cannot estimate the level effect of bank presence on savings, we can assess if the effects of income

shocks and of wage income on the composition and level of savings are affected by the proximity of banks. Instruments are also needed, not only because crop-cycle-specific shocks influence future stocks, so that the difference in planting-stage stocks across crop-cycles is correlated with differences in planting and harvest-stage savings shocks ( $u_p$  and  $u_h$ ), but also because the computed harvest-stage production shock  $\epsilon_{ijt}$  contains measurement error. We discuss below the additional assumptions and variables we employ as instruments to eliminate the problem due to measurement error.

#### 4. Data

To estimate the relationships between assets, income and savings, differentiated by type, within the context of the dynamic-stochastic model, while taking into account heterogeneity among households, poses considerable demands on data: information is needed on stage and season-specific prices and wages, and on household-specific variables such as consumption, assets, production inputs and outputs for at least two complete and comparable crop-cycles. The longitudinal data set that we use meets these requirements more closely than any other among those of which we are aware. The data are from a recent survey carried out by the International Food Policy Research Institute (IFPRI), the Pakistan Food Security Survey. It is not only comprehensive in detail on production, earnings, and financial transactions but was collected in many rounds sufficiently closely-spaced to identify specific crop-stages within each of the two annual crop-cycles (Rabi and Kharif). The data were collected in twelve rounds and cover a sample of 926 households residing in 52 villages in three major wheat-growing provinces of Pakistan - Punjab, Sind and the Northwest Frontier Province - followed over the period July 1986 through September 1989. In addition, the survey elicited information, in the first and last rounds, on the proximity of each village to a bank.<sup>7</sup>

Because information in the survey refers to the interval between rounds, with the

exception of consumption information and some other variables, only four of the twelve rounds permit a reasonably precise identification of variables in planting stages and their corresponding harvest stages for the same crop cycle, the Rabi, which is the major crop cycle. In the three provinces, Rabi planting takes place in the months of November and December, while Rabi harvesting occurs in March and April. Information from rounds seven and ten, which recorded information in the interval between the months of July and January for 1987-88 and 1988-89, thus are used for Rabi planting-stage variables and rounds eight and eleven, which recorded information in the interval between January and March/April for the corresponding years provide the variables for the Rabi harvest stages. Because, for the most part, inputs and assets are identified as belonging to a stage cum season by the interval in which they appeared and/or by the type of input (e.g., fertilizer versus thresher) and crop outputs are identified in the data as belonging specifically to either the Rabi season or Kharif season, information for computing profits and estimating profit functions could be obtained for each of the three Rabi seasons.

Rabi harvest profits were computed by subtracting from the value of harvested Rabi crops grown on the household's self-cultivated land the value of family and hired labor used in harvesting and thresher costs. Harvest labor costs were computed by dividing up both hired and family labor into adult males and females and children, summing within categories across hired and family labor, and multiplying each category of labor by the year/season and stage-specific daily wages for that category of labor. The aggregation of harvest labor across family and hired labor conforms to the assumption of the model and to information from other data that harvest labor is paid by piece rates so that the usual advantages of family over hired labor associated with incentives problems are minimized.

A small fraction of households leased in or out land on a share basis. As a consequence, because households sharing out their land share in the (risky) output of that land and thus contribute to risky harvest income, we added to household profits from self-cultivated land the

landlord's (household's) share (provided in the data) of the value of output harvested on the shared-out land. Any (planting-stage) inputs provided by the household to the share tenant were then included, as a separate input, among the planting-stage inputs, which also included fertilizer value (Rs), bullock days, and male and female labor days in planting activities along with owned land, by irrigated or dry, under cultivation. The household's inputs provided to its tenants included the amount (acres) of shared out irrigated and non-irrigated land and the value of all other inputs provided to the tenant. Similarly, the landlord's share of the value of the output harvested on land shared in by the sample household was subtracted from the harvest profits on shared-in land, and shared-in land, by irrigation type, and landlord provided non-land inputs are included among the planting-stage inputs.<sup>8</sup>

We examine financial savings, the form of savings that, with appropriate intermediation, can finance investment that can contribute to development and that facilitates consumption-smoothing across space. The data permit construction of three forms of financial savings - net changes in financial assets, including bank deposits and other financial instruments, net borrowing, and net contributions of monies and food to friends and relatives (transfers) - for each of the rounds. The survey was less comprehensive in the collection of stock and asset data. Although information on land owned and food stocks is available for the relevant Rabi planting-stage rounds as well as stocks of inherited land, irrigation assets, and animals, the amounts of financial assets, debt and inventory of items for sale are not. However, the unavailability of the information on these stocks is not a constraint on our ability to obtain estimates of the effects of differentiated stocks on financial savings. This is because in our fixed-effects estimation procedure we employ differences of variables across crop-cycles to obtain estimates of the savings decision rules.<sup>9</sup> Thus, the available information on the gross flows from and to stocks spanning the round intervals can be used to obtain estimates of stocks on savings flows (differences across years in the change in stocks). A shortcoming of the data is that the stock of

animals or the flow of animals differentiated between those used for animal traction and those used for food cannot be computed. Thus, we are able to estimate the effects of planting-stage food stocks, debt, financial savings, and inventory on the three types of financial savings (and their sum) in the harvest stage. In addition, we use the round-specific data on net transfers to friends and relatives to construct a measure of net informal indebtedness ("transfer debt") - the difference between the cumulative stock of all transfers out and transfers in.<sup>10</sup> This enables a test of whether the accumulation of transfers in or out affects savings behavior, as it would if transfers are a form of savings rather than a substitute for income insurance. Finally, we computed the value of family potential labor income in the planting and harvesting stages by multiplying the number of adult family males, adult females and children (ages 6 through 15) by the relevant stage and season-specific median of daily wages for the relevant sex/age groups.<sup>11</sup>

Table 1 provides means and standard deviations for a number of the computed stage-specific Rabi-season variables for the sample of 371 cultivating households for whom we could compute all of the relevant variables. The descriptive statistics are reported for households stratified by the proximity of their village to a rural bank - those less than or equal to five kilometers from a bank (166) and those more than five kilometers (205). As can be seen, on average those households closest to a rural bank deposit considerably more money at harvest time in a financial institution compared with other households, despite the fact that such households' mean harvest-stage profits are only 4% higher and per-day potential labor income is slightly lower in the harvest stage. Moreover, the lack of access to financial institutions is reflected in the larger food stocks - by 21% - held by the households located farther from the banks. The higher harvest-stage financial institution savings rates of and lower planting-stage food stocks held by the households closer to rural banks suggest that food stocks are substitutes for financial assets, although, as noted, we cannot compute stocks of financial assets from the survey data. The households farther from rural banks also exhibit higher net transfers out, which

may suggest that such households rely more heavily on informal transfer mechanisms rates than do household closer to banks, to the extent that remittances create obligations. Of course, the more rigorous method of assessing whether rural bank access affects savings behavior is to estimate the savings decision rules and to assess the differential effects of income changes on the different types of savings by bank proximity, as reported below.

## 5. Estimates

Table 2 reports the first-stage computed sample-mean derivatives, and their associated Huber t-ratios, based on IV fixed-effects estimates of the parameters of the conditional normalized generalized Leontief harvest-stage profit function obtained from a sample of 400 cultivating households. Because the four variables describing the proportion of land area shared out or in, classified by irrigation status, did not change very much over the two years, these variables were included only as linear terms and their coefficients and t-ratios are reported directly. The specification also includes interactions between village dummy variables and the crop-year to capture area-specific differences over time in all input and output prices.<sup>12</sup> Hausman tests indicate that, as expected, the error terms in the differenced specification are significantly correlated with the set of included regressors. In addition, the set of 46 squared and interaction terms associated with the generalized Leontief form are statistically significant ( $F(46, 446) = 4.24$ ), thus rejecting a linear profit-function specification.

The estimates of conventional inputs effects are generally reasonable. For example, the estimates indicate that self-cultivated and own irrigated acres are substantially more profitable than self-cultivated and owned non-irrigated acres - transforming an owned acre from dry to irrigated increases its profitability at the sample means by a statistically significant 4300 rupees - and the share return from an irrigated acre that is shared out is substantially higher than that of a shared out dry acre by a similar amount. The estimates also indicate that male family labor in the

planting stage is significantly more profitable than male hired labor, by 75 rupees per day per acre. The estimates also suggest, however, that fertilizer and female labor on average contribute insignificantly to profits.

As noted, the principal reason for estimating the profit function is to obtain an estimate of the unanticipated component of harvest-stage income, one of the components of income that affects savings behavior. The dynamic model suggests that this form of income has a different effect on savings behavior compared with that of income that is mostly anticipated, such as wage income. For example, an unexpected favorable harvest may have a larger positive effect on harvest-stage savings, given that the shock is i.i.d., than would an increase in harvest-stage potential labor income, which in part depends on family composition which is known in advance, if wages are autocorrelated across crop stages. It is important therefore that our measure of the production shock neither be anticipated nor be measured with error. To the extent that the shock variable that we have constructed from the profit-function estimates (i) contains classical measurement error and (ii) partially reflects anticipated harvest profits, the residually-measured harvest shock variable coefficient will be biased downward and may appear to have an effect similar to that due to variation in labor incomes in the harvest stage. In estimating the harvest-stage savings equations we therefore included among the instruments interactions between inherited land and village dummies to eliminate measurement error in the shock variable. These variables reflect the differential effects of village-level weather and price shocks on households with different holdings of (inherited) land wealth.<sup>13</sup>

To test the hypothesis that the measured shock is partially known in the planting stage, we first jointly estimated, using three-stage least squares, linear approximations to four planting-stage input decision rules - for total bullock days, fertilizer, male labor days and female labor days in the planting stage - and planting-stage calorie consumption (based on a 24-hour recall in the planting-stage period), including in the specification the harvest-stage shock as a state-variable

along with planting-stage state variables food stocks, debt, financial savings, inventory, and transfer debt and the interaction variables with village and crop-year dummies. Table 3 reports the shock variable coefficients and their associated asymptotic t-ratios for each of the five planting-stage decision variables. As can be seen, all but one of the coefficients is not significantly different from zero by conventional standards. Moreover, we could not reject the hypothesis that the set of coefficients associated with the harvest-stage shock was zero ( $F(5,1020)=1.11$ ). Thus there is no evidence that the estimated shock contains an anticipated component.

Table 4 reports the IV-FE estimates, and their associated Huber t-ratios, of the effects of the harvest income shocks and harvest labor income on net flows to financial institutions, net transfers sent out, and net debt repayment in the harvest stage of cultivation. The sample consists of cultivator households with all the requisite information, stratified by whether the village in which the household resided was less than or more than 5 kilometers from a rural bank. The specifications also include the planting-stage state variables - planting-stage labor income, food stocks, debt, total financial savings, farm equipment, inventory, and transfer debt, as defined above.

The last row of Table 4 reports the F-statistics for the tests of whether the set of coefficients for each dependent variable differs across the households distinguished by bank proximity. These statistics indicate that the savings decision rules differ by bank accessibility for all measures of financial flows at at least the .05 level. The point estimates indicate that an exogenous increase in unexpected profits of 1000 rupees, a 14% increase with respect to total profits, results in a statistically significant 90 rupee (6%) increase in net flows to financial institutions for households within five kilometers of a bank, but only a 39 rupee flow increase for households more than 5 kilometers from a banking institution. However, unexpected increases in profits appear to increase transfers out for households not near a bank at a rate that is 60%

higher than that for households residing close to a bank. The finding that transfers are substantially more sensitive to unexpected income fluctuations for households located away from banks, and the finding that cumulated transfer debt - a recent history of receiving transfers from friends and relatives - positively affects the size of remittances paid out, suggest that the receipt of transfers creates obligations similar to those for conventional credit. Indeed, for households not proximate to banks, transfer mechanisms may be substituting for rural bank services. The point estimate on transfer debt indicate that for every 1000 rupees that households had received up to the beginning of the current crop-cycle, they (re)pay out, for given crop-cycle income, approximately 300 rupees in the harvest stage whether near a bank or not.

While the unanticipated component of harvest-stage income has a statistically significant effect on bank deposits for households located close to a bank and transfers for households not close to a bank, labor income in the period does not have a statistically significant effect on any financial flows for any household regardless of its bank proximity. This is consistent with the notion that harvest-stage labor income is mostly anticipated. Of the estimated planting-stage stock effects on financial savings in the harvest-stage, most coefficients except for that for transfers are not measured precisely. However, the estimates indicate that households with larger amounts of (credit) debt in the planting stage are significantly more likely to add to their net financial balance at the harvest stage, principally by reducing their debt through repayment. Interestingly, not only are households with a greater amount of transfer debt in the planting stage more likely to remit to others in the harvest stage, but such households located in areas more than five kilometers from banks are also less likely to repay their loans and make smaller deposits in banks, suggesting that transfer debt creates an obligation with a higher priority than does conventionally measured debt.

## **6. Estimates of the Relationships Between Aggregated Profits and Financial Flows**

In this section we report estimates of  $\hat{\alpha}_{iy}^t$  from stage-specific savings equations. That is, we estimate linear approximations to equations (8) and (9) except that aggregated crop-cycle income (for the entire Rabi season in this case) is used instead of  $\epsilon_h$  and we do not employ instruments to predict aggregated income. The estimation procedure is otherwise the same as that employed to obtain the estimates reported in Table 4. In addition, we estimate a variant in which savings flows are also aggregated across crop stages.

As we have shown above, if time-varying shocks to asset returns in the planting stage are negligible or such shocks do not influence planting-stage input behavior and thus agricultural profits, the estimate of  $\hat{\alpha}_{iy}^t$  for  $t=p$  should be zero, given our finding that  $\epsilon_h$  is wholly unanticipated, and the  $\hat{\alpha}_{iy}^t$  for harvest-stage financial flows should be approximately the same as the estimates of the effects of  $\epsilon_h$  in Table 4. On the other hand, if time-varying planting-stage asset or credit shocks affect input decisions in the planting stage, then the  $\hat{\alpha}_{iy}^t$  will reflect not just income-shock effects on savings, if any, but also the reverse influence of stage-specific savings behavior on incomes within the crop cycle.

Table 5 presents the  $\hat{\alpha}_{iy}^t$  estimates, by bank proximity, for net debt repayment, net transfers out, and net financial savings for the total Rabi season and for the planting and harvest stages of the season. We also present the estimates for the gross flows for each of the savings categories.

Although the estimates of effects of total Rabi-season profits on all three total season net financial flow variables are not different from zero, these aggregated net estimates evidently mask relationships which suggest the importance of both differences in stage-specific savings behavior and the dependence of agricultural income on savings behavior within the crop cycle. This is most apparent for debt repayment. For households proximate to a bank, there is a negative relationship between net debt repayment in the planting stage and aggregated crop-cycle income and a positive relationship between harvest-stage net debt repayment and

aggregated income; thus, it matters from which stage savings are measured.

Moreover, as noted, the true effect of agricultural profits on planting-stage savings is zero and the estimate of the effect of  $\epsilon_h$  on harvest-stage net debt repayment, from Table 4, is also essentially zero. The Table 5 estimates for debt repayment thus reflect the role of credit in facilitating agricultural production rather than the influence of income on this form of savings - borrowing more in the planting stage results in higher income (the coefficient in row two, column two) as does a higher level of repayment in the harvest stage (row three, column three). The estimates that do not take into account the dependence of crop income on within-season savings behavior thus merely reflect the fact that within a crop cycle farmers who are able or willing to borrow more in the planting stage, and thus exhibit greater repayments in the harvest stage, obtain higher profits. These same sign patterns are repeated for households located away from banks, but the individual estimates are less precise.

The estimated crop-cycle income effects for transfers and financial savings do not show the clear patterns of the debt variables, but the use of the aggregated income measure and the lack of attention to the dependence of income on savings within a crop cycle evidently mask completely the positive effects of income shocks on both transfers out and on financial savings reported in Table 4. One interesting estimate is the negative and statistically significant association between gross transfers out in the planting stage and crop-cycle income (for households located near a bank), which suggests that factors (obligations?) leading to transfers in the planting stage lower incomes, presumably due to reductions in the household's ability to finance optimal input levels.

## **7. Conclusion**

In recent years there has been increased recognition of the important role played by the stochastic nature of agricultural production as a determinant of savings behavior in rural areas of

developing countries. In view of this fact it seems surprising that so little attention has been given to another significant features of the agricultural process, the fact that agricultural decisions must be made sequentially within the production cycle without complete access to information about eventual outcomes. This inattention to the dynamic aspects of agricultural production is particularly problematic in the context of the savings literature for two reasons. First, agricultural income tends to vary substantially over the course of the year, which has significant implications for patterns of saving over time. Second, the agricultural production process involves transfers of resources within the year (from the planting to the harvesting stage). This implies that agricultural production is, in effect, a type of savings and thus interacts importantly with other forms of savings and credit activity.

In this paper we have developed a methodology for examining savings behavior in rural areas of developing countries that explicitly incorporates the sequential decision making process in agricultural. We use this methodology to examine the relative importance of alternative forms of savings and credit activity in the presence and absence of formal financial intermediaries. In particular, we estimate a profit function that is conditional on planting stage inputs and use the resulting coefficient estimates to construct a measure of the stochastic component of agricultural production. After establishing that this measure is not anticipated by farming households during the planting stage we then incorporate this measure into harvest-stage decision rules for three forms of savings: net financial savings in formal institutions, net transfers to other households, and net repayment of debt. Separate decision rules are estimated for households with and without a nearby bank.

Our results provide clear evidence that the presence of financial intermediaries importantly influences the composition of savings behavior. While households with a nearby bank respond to the agricultural shock by increasing their savings in financial institutions, those without ready access to formal institutions tend to increase their net transfers to other households. We

find little evidence in either setting that net debt repayment responds importantly to the presence of a shock, suggesting that credit terms and therefore repayment of loans are settled before the shock term becomes known (i.e., during the planting stage). We also find evidence that transfers play an important role as a form of savings.

In order to evaluate the extent to which inattention to the structure of the agricultural production process may have adversely affected previous work on savings behavior in rural areas of developing countries we also estimate a series of savings functions by production stage that incorporate income for the entire production cycle, as is common in the literature. The evidence indicates that the bias associated with evaluations of the savings-income relationship that are inattentive to the dynamics of agricultural production within the year can be significant. Particularly striking results emerge with respect to net debt repayment: although our results provide little evidence that debt repayment responds importantly to the agricultural shock, planting stage savings in the misspecified equations appears to be decreasing in income aggregated over the production cycle, while harvest-stage savings appears to be positively affected by this measure of income. A comparison of these results with analytic expressions for the bias derived from our model show clearly why these results emerge: because credit evidently plays an important role as a source of financing for planting stage inputs, adverse credit shocks to a household in the planting stage result in both lower borrowing (i.e., more net debt repayment) and lower input use in that stage. As the latter results in lower income, a spurious negative effect of aggregated income on net debt repayment is observed.

Attention to the dynamic stochastic nature of agricultural production process is likely to provide significant dividends in terms of the analysis of household behavior in developing countries. Not only does careful attention to the details of this process provide a useful alternative to other approaches for identifying the shock component of agricultural income, but it also makes it possible to appropriately interpret coefficient estimates in a setting which does not

conform to the economic ideal of perfect credit and insurance markets. Examinations of behaviors such as savings that play an important role in the intertemporal allocation of resources that do not pay attention to the underlying dynamic process, it appears, can yield quite misleading conclusions.

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## Notes

1. Other studies (e.g., Antle 1983, Rose 1992, Skoufias 1993 and Behrman, Foster, Rosenzweig 1994), have considered the dynamic stages of agricultural production, but without explicit incorporation of financial savings decision rules.
2. Interest data from the study population indicate that the annualized interest rate from money lenders varied from 12% in the harvest period to 40% in the planting period.
3. Note that the interest rate does not appear in equation (7). The reason for this is that savings decisions made in the harvest stage, in general, incorporate what is known about future prospects for borrowing not just current conditions. For example, a household that anticipates a high cost of borrowing in the subsequent planting stage in general chooses to save more in the harvest stage. By conditioning on assets and the village-level variables we condition on the information used by the household to predict future interest rates.
4. These expressions assume for simplicity that the  $u_p$  and  $\epsilon_h$  are uncorrelated with the state variables. Clearly, planting-stage assets would be affected by  $u_p$  to the extent that  $u_p$  has a permanent component, and harvest-stage full income and prices may be affected by aggregate planting-stage shocks. Allowing for this possible source of correlation complicates, but does not substantially change equations (12) and (13). In the section below in which we attempt to quantify the bias from income aggregation our estimation procedure takes into account these potential correlations.
5. Because, as discussed below, profits include revenues from shared out and shared in land, which may both be importantly affected by weather and other shocks, the measure of cultivated area used for normalization is the sum of own, shared-in, and shared-out cultivated area.
6. It is possible that the shock contains both an anticipated and an unanticipated component. For example, an early intraseasonal drought period may influence planting-stage decisions. We test below whether the shock is purely unanticipated.
7. There were no changes in bank locations across the survey rounds.
8. We exclude fixed-rent land from the profit function because these payments (in or out) do not influence the unanticipated component of profits, assuming that there is no default; in any case, the data do not provide sufficient information on the timing of the payment of rents to assign with precision this component of revenues to the planting and harvesting stages. Note that this exclusion does not present a problem from the perspective of the estimation of harvest savings decision rules because land payments reflect only decisions that are made in the planting stage.
9. Another consequence of using the fixed effects procedure, however, is that we cannot estimate the effect owned land on savings decisions because land owned does not vary across the two consecutive Rabi seasons from which we obtain our savings estimates.
10. Of course, we do not have every household's complete history of transfers. Because we use a first difference estimation procedure, however, it is only necessary to have information on transfers in two periods.
11. Changes in family composition across the two Rabi seasons used for estimation were negligible. Thus variations over time in potential household income only reflect wage variations,

and family-composition variables do not appear as regressors in the fixed-effects specifications.

12. The estimates of the full set of 60 input parameters and 79 time-village dummy coefficients are available from the authors upon request.

13. While there is no covariation between  $\epsilon_h$  and inherited wealth, where the expectation is taken over time, in any given time period there will be a covariation across households. For example, if rainfall is favorable in a particular season households with little land would have lower values of  $\epsilon_h$  compared to large landowning households. Note that information on rainfall would be useful as an alternative instrument, as in Paxson (1992) (see also Wolpin (1982)), but is not available in this data set. Because only two periods (crop-cycles) are used in the estimation of the savings equations, village dummy variables capture all of the variation across villages and over time in the sample. Note also that the use of the village-land interactions as instruments for  $\epsilon_h$  assumes that individual variations in  $u_p$  over time are not systematically related to land ownership.

Table 1  
Means and Standard Deviations by Bank Proximity

	Bank≤ 5 Km	Bank>5 Km
Rabi Harvest-Stage Net Financial Savings (Rs)	1634 (8339)	-534.6 (7797)
Rabi Harvest-Stage Net Lending (Rs)	335.4 (16233)	1041 (7533)
Rabi Harvest-Stage Net Transfers Out (Rs)	2920 (10318)	3409 (13234)
Total Land Owned (acres)	6.83 (9.73)	9.75 (18.7)
Rabi Harvest-Stage Potential Labor Income Per Day (Rs)	151.3 (70.08)	165.4 (74.4)
Rabi Harvest-Stage Profits (Rs)	6944 (18574)	6688 (11971)
Rabi Planting-Stage Food Stocks (Rs)	745.3 (1039)	898.3 (1084)
Household Size		
Total	8.45 (4.46)	9.22 (4.49)
Men >=15	3.05 (1.74)	2.96 (1.64)
Women >=15	2.54 (1.33)	2.57 (1.43)

<sup>a</sup>Standard deviations in parentheses



Table 4  
IV Fixed-Effects Estimates of Financial Asset  
Accumulation Decision Rules in Post-Harvest Rabi Stage, by Bank Proximity<sup>a,b,c</sup>

	Net Financial Savings		Net Transfers Out		Net Debt Repayment	
	Bank <sub>≤</sub> 5k	Bank <sub>&gt;</sub> 5k	Bank <sub>≤</sub> 5k	Bank <sub>&gt;</sub> 5k	Bank <sub>≤</sub> 5k	Bank <sub>&gt;</sub> 5k
Harvest-stage						
Production Shock (Rs)	.090 (2.30) <sup>d</sup>	.029 (1.58)	.023 (1.06)	.037 (2.17)	-.032 (0.85)	-.008 (0.15)
Potential Labor Income (Rs/day)	3.48 (0.03)	55.1 (0.39)	-339 (1.90)	63.5 (0.44)	109.6 (0.34)	-108 (0.48)
Planting-stage						
Potential Labor Income	-20.6 (0.21)	-88.2 (0.81)	195 (2.07)	-149 (1.45)	18.3 (0.10)	-67.8 (0.45)
Savings (Rs)	-.574 (2.85)	-.023 (0.38)	.063 (0.56)	-.028 (0.42)	.035 (0.26)	.366 (2.05)
Transfer Debt (Rs)	.218 (1.93)	-.088 (1.21)	.307 (1.37)	.328 (4.34)	.042 (0.41)	-.648 (3.50)
Debt (Rs)	-.0239 (0.59)	.192 (2.03)	.099 (2.08)	.161 (1.57)	.213 (1.84)	.486 (4.05)
Food Stocks (Rs)	.0251 (0.03)	-.786 (1.47)	1.45 (1.93)	-.824 (3.19)	.659 (0.74)	.504 (0.59)
Equipment (Rs)	.608 (1.77)	-.200 (1.83)	.095 (2.04)	-.123 (1.61)	-.341 (2.50)	-.517 (1.25)
Inventory (Rs)	-.004 (0.05)	.014 (0.27)	.111 (0.88)	.099 (1.10)	-.105 (0.95)	.361 (2.28)
F(9,311)	2.05		3.43		8.62	
P-value	.034		.000		.000	

<sup>a</sup>Analysis based on 371 households, 166 with a proximate bank, with two observations per household.

<sup>b</sup>All specifications include village x time dummies (not shown). These control for contemporaneous variation in wages and prices.

<sup>c</sup>All right-side variables other than village x time dummies are treated as endogenous. Instruments include initial crop-cycle state variables (other than the production shock), inherited assets, household composition, land ownership and village x time x land inheritance interactions.

<sup>d</sup>Absolute t-ratios derived from Huber standard errors in parentheses.

Table 2  
 IV Fixed-effects Estimates: Normalized Generalized  
 Leontief Harvest-Stage Profit Function for Rabi  
 Crops<sup>a,b,c</sup>

	t
Derivatives at Sample Means	
Own Irrigated cultivated area	4304 (2.93) <sup>d</sup>
Bullocks (days)	114 (1.54)
Fertilizer (Rs)	-2.79 (0.94)
Inputs Provided to Tenant (Rs)	12.8 (1.30)
Inputs from Landlord (Rs)	14.7 (2.57)
Total Male labor (days)	1939 (1.14)
Family Male labor (days)	74.5 (1.92)
Total Female labor (days)	-312 (1.40)
Family Female labor (days)	-149 (1.19)
Coefficients	
Irrigated Land shared out	3891 (2.48)
Dry Land shared out	293 (0.36)
Irrigated Land shared in	-2245 (0.66)
Dry Land shared in	-2130 (1.26)
	P-value
Exogeneity Test (df)	.005 (42)

<sup>a</sup>Estimates based on 400 households contributing 1018 observations.

<sup>b</sup>All specifications include village x time dummies (not shown). These control for contemporaneous variation in wages and prices.

<sup>c</sup>All right-side variables other than village x time dummies are treated as endogenous. Instruments include planting-stage variables from initial crop-cycle, inherited assets, household composition, land ownership and village-land inheritance interactions.

<sup>d</sup>Absolute t-ratios derived from Huber standard errors in parentheses.

Table 3  
 Three-Stage Least Squares Estimates: Effects of Harvest-Stage Production Shocks on Planting-Stage Decisions<sup>a</sup>

Kilocalories per day	Fertilizer	Bullock days	Male worker-days	Female worker-days
.000369 (.450) <sup>b</sup>	-.00105 (.928)	-.0000327 (1.76)	-.0000059 (.137)	.0000377 (1.22)

<sup>a</sup>Specification includes planting-stage labor income and state-variables: food stocks, debt, farm equipment, inventory stock, financial savings, and transfer debt.

<sup>b</sup>Absolute values of asymptotic t-ratios in parentheses.

Table 5  
IV Fixed-Effects Estimates of the Relationships Between  
Total Rabi-Season Profits and Financial Flows by Production Stage<sup>a b</sup>

Period	Total Rabi Season		Rabi Planting Stage		Rabi Harvest Stage	
	Bank <= 5	Bank >5	Bank <= 5	Bank >5	Bank <= 5	Bank >5
Net Flows from Household						
Financial Savings	.007 (0.91)	-.094 (0.98)	-.010 (0.61)	.015 (0.37)	.017 (0.91)	-.108 (1.69)
Transfers	.011 (0.39)	-.012 (0.57)	.002 (0.14)	-.028 (0.93)	.009 (0.47)	.015 (0.37)
Debt Repayment	-.009 (0.14) <sup>c</sup>	.016 (0.14)	-.090 (1.70)	-.055 (0.89)	.081 (2.37)	.066 (1.45)
Flows to Household						
Financial Savings	.108 (1.81)	-.011 (0.79)	.008 (0.28)	.018 (1.01)	.100 (2.09)	-.029 (0.99)
Transfers	.021 (1.08)	-.014 (0.42)	.019 (0.63)	-.001 (0.08)	.002 (0.04)	-.013 (0.53)
Borrowing	.131 (2.06)	.098 (3.25)	.085 (1.52)	.091 (1.64)	.034 (1.22)	.007 (0.15)
Flows from Household						
Financial Savings	.029 (0.56)	-.008 (0.49)	.032 (1.24)	.004 (0.63)	-.003 (0.10)	-.012 (0.93)
Transfers	-.001 (1.00)	-.008 (1.42)	-.002 (2.16)	-.001 (0.81)	.001 (2.74)	-.008 (1.33)
Repayment	.131 (2.97)	.089 (1.92)	.030 (1.01)	.001 (0.21)	.100 (2.81)	.088 (1.71)

<sup>a</sup>Analysis based on 371 households, 166 with a proximate bank, with two observations per household.

<sup>b</sup>All specifications include the same variables as in Table 4 with total Rabi-season profits substituted for the shock and treated as exogenous.

<sup>c</sup>Absolute t-ratios derived from Huber standard errors in parentheses.