Savings Behaviour in Low-Income Countries

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The empirical literature on savings in low-income countries has exploited some remarkable data sets to shed new light on savings behaviour in the poor agricultural households that make up the majority of the population in such countries. A number of conclusions have emerged: (i) the degree of consumption smoothing over seasons within the year and across years, in response to very large income fluctuations, is higher than was supposed; (ii) the lack of complete insurance and credit markets, however, is manifested in asset stocks and asset compositions among farmers, especially small farmers, that are inefficient; (iii) the combination of low and volatile incomes is an important cause of inefficiency and income inequality; (iv) the proximity of formal financial institutions increases financial savings and crowds out informal insurance arrangements, thus, in principle, better facilitating financial intermediation; and (iv) simple life-cycle models of savings do not appear to explain long-term savings in low-income settings.

I. Introduction

This paper reviews the recent empirical literature on savings in low-income countries. There are a number of distinguishing features of low-income countries that make the study of savings behaviour different, as least in emphasis, from the study of savings in high-income countries. First, on average the incomes of households are sufficiently low that, given minimum standards for survival and productivity, opportunities for sustaining savings over the long term or even the short term are limited. Second, the majority of the populations in low-income countries are engaged in the agricultural sector. This has important implications for the properties of the income streams facing the households. In particular, there are strong and unpredictable inter-annual fluctuations in incomes chiefly caused by the fact that a major production input—rainfall—is unpredictable and volatile. Rosenzweig and Binswanger (1993) note that in the semi-arid tropics of India, the coefficient of variation in annual incomes computed over a 10-year period for a typical farm household is 2.5 times that of a white male aged 25–
There are also strong intra-annual fluctuations in incomes owing to the fact that production takes place in stages. Thus, there are times within the year when incomes are (predictably) low and times of the year when incomes are predictably high.

A third important characteristic of low-income environments that has important implications for savings behaviour is the absence of well-developed insurance and credit markets. In part this stems from the inherent difficulties of establishing insurance schemes and credit organizations in the agricultural sector in which the source of risk is highly spatially covariant combined with the standard problems of moral hazard and adverse selection. And in part this aspect of underdevelopment reflects the scarcity of capital to set up and maintain the large-scale institutions that are required for intermediation. Whatever the causes, the principal challenge facing populations in low-income countries is maintaining consumption when incomes are both low and highly variable. The central policy question for low-income countries is thus to what extent the welfare of rural, poor populations is hindered by inadequate financial intermediation—how well have rural households coped with fluctuating incomes in terms of their abilities to smooth both consumption and production efficiency given available production resources and technology?

Because of income variability and the absence of insurance, most of the savings observed in low-income environments are, unsurprisingly, what Angus Deaton has called ‘high-frequency’ savings or ‘precautionary’ savings designed to smooth consumption. Savings resulting from the mostly anticipated change in incomes over the life-cycle would appear to be much less important. The study of life-cycle savings, however, is made more difficult in low-income countries because of a fourth feature of low-income rural areas—many rural households contain adults of multiple generations (vertical extension), so the life-cycle of the household is not the same as the life-cycle of any individual (Deaton and Paxson, 2000).²

Low-income, rural settings have been fertile ground for the empirical study of savings in recent years. The fact that a major exogenous source of income volatility (rainfall) can be measured and the relative simplicity of the production technology in agriculture, permitting the estimation of technology parameters that describe the income-generation process, are major advantages in the study of the response of consumption to income ‘shocks’. Most importantly, the availability of panel or time-series data describing the consumption, production and incomes of rural households has permitted the exploitation of these natural advantages. Two notable data sets that have become available in recent years and have made major contributions to the study of how rural households cope with income fluctuations are from surveys carried out by the International Crop Research Institute of the Semi-Arid Tropics (ICRISAT) in India and Burkina Fasso. The former data set provides detailed information on production, incomes, and consumption at intervals of approximately 3 weeks for 40 households in each of three villages for 10 consecutive years and for 120 households in three additional villages for six consecutive years. Such data permit, in particular, the exploration of the high-frequency savings behaviour that is endemic to low-income areas with highly variable incomes and its consequences for consumption and production.

This paper focuses on the major studies that have provided empirical evidence on savings in low-income countries, and is in four parts. Section II reviews the literature that exploits information on rainfall variability to assess how well savings behaviour in agricultural populations conforms to perfect smoothing models and examines the inter-temporal patterns of consumption in the face of borrowing constraints. In the next section, studies that look at the consequences for production efficiency arising from constraints on borrowing when incomes are highly variable are examined. Section IV reviews studies that focus on agricultural households’ abilities to smooth consumption within the year and the role of formal banking institutions in facilitating consumption smoothing, in affecting informal transfer arrangements, and in augmenting intermedia-

² Rosenzweig and Wolpin (1985) report that in rural India in the 1970s over 62 per cent of farm households were vertically extended.
The fourth section briefly reviews the evidence on longer-term aspects of savings. These sections are followed by a brief conclusion.

II. HOW WELL ARE RURAL HOUSEHOLDS ABLE TO SMOOTH CONSUMPTION IN THE FACE OF INTER-ANNUAL FLUCTUATIONS IN INCOME?

(i) The Permanent Income Model

One of the most widely employed models of savings and consumption is the 'permanent income' model, a model in which households are freely able to save and borrow to smooth their consumption. A key implication is that purely transitory fluctuations in income should not significantly affect consumption compared with changes in persistent components to income. If this is found to be so among rural households in low-income countries, then that would represent evidence that such households are able to cope well with the vagaries of weather and other sources of income variability, calling into question the need for improvements in credit institutions as keys to improving the welfare of the poor.

The permanent income model is a benchmark that can be used to assess to what extent households face credit and saving constraints. The challenge in testing the permanent income model is the measurement of permanent and transitory components of income. A feature of rural low-income populations exploited by many researchers is the availability of time-series information on rainfall, a key and measurable determinant of agricultural income fluctuations. Rainfall has desirable features for the analysis of transitory income effects—rainfall cannot be affected by the behaviour of the farmers and rainfall distributions are characterized by stationarity over the periods of time relevant to the study of income effects on consumption, so that the distinctions between permanent and transitory are meaningful.

The first studies to exploit rainfall variation to assess the literal and classic permanent income model, with its assumptions of fully functioning credit markets and frictionless storage, were by Wolpin (1982) and Paxson (1992). Wolpin used differences across Indian districts in the mean of the rainfall distribution in order to estimate the permanent income effect for rural farmers and contemporaneous village-level indicators of rainfall deviations from mean rainfall as instruments to estimate the transitory income effect. Paxson used deviations in contemporaneous rainfall from regional means for each of four crop seasons based on data from rural Thailand to identify the transitory income effect, but used landholdings as an instrument for permanent income. This latter is problematical if landholdings reflect savings preferences. Both Paxson’s and Wolpin’s estimates of transitory income effects using the rainfall instruments were such that the hypothesis that consumption was unresponsive to transitory changes in income could not be rejected, a seemingly strong finding in favour of farmers’ ability to smooth consumption in less developed, rural areas.

To show how weather information can be used to test household’s ability to smooth consumption, and the pitfalls of the approach, it is useful to set out a simple two-period, canonical model in which there are no inputs to production other than weather and only consumption provides utility. Following Rosenzweig and Wolpin (2000), each farm household maximizes its expected present discounted utility flow from consumption:

\[ E_1 U(c_1) + \beta U(c_2), \]

where \( \beta = 1/(1 + \rho) \) is the subjective discount factor, subject to income constraints. In each period the farmer receives farm income from his output and an exogenous amount of ‘assured’ or permanent income \( y_0 \) that is known in advance. Farm income is stochastic and solely a function of rainfall, so that farm output \( y_t = f(\omega) \), with \( \omega \) the amount of rainfall at \( t \) and \( \omega_t = \omega + \epsilon_t \), where \( \omega \) is mean rainfall and \( \epsilon_t \) is an unforecastable rainfall shock (independent identically distributed (i.i.d.) over time).

Farmers can save and borrow, but they cannot purchase insurance and do not make bequests. With a unit output price, the budget constraints in the first and second periods are thus:

\[ c_1 + a_2 = y_1 + y_0 \]

\[ c_2 = a_2(1 + r) + y_2 + y_0 \]
where $a_2$ is savings in period 1 and $r$ is the interest rate. The first-period problem for the ‘farmer’ is to select the amount of assets to carry over to the second period that maximizes (1), given (2).

The first-order condition, assuming the Inada conditions hold, is the standard Euler equation,

$$U'(c_1) = \beta (1 + r) E \omega U'(c_2). \tag{3}$$

The effects of changes in the assured income flow and in transitory first-period income on savings are, respectively,

$$da_2/dy_0 = \left(U''(c_1) - \beta (1 + r) E \omega U''(c_2)\right) / \Psi \tag{4}$$

and

$$da_2/dy_1 = U''(c_1) / \Psi, \tag{5}$$

where $\Psi = U''(c_1) - \beta (1 + r)^2 E \omega U''(c_2)$. The key result, comparing (4) and (5), is that the effect of an increase in transitory income on savings exceeds that of an equivalent change in permanent income. Rosenzweig and Wolpin (2000) show that the instrumental-variable estimator of the transitory income effect on savings, that is, \((da_2/d\epsilon_1)/(dy_1/d\epsilon_1)\), yields (5) exactly, while the parallel estimator for the permanent-income effect only delivers (4) if rainfall shocks have a linear effect on income. The instrumental-variables estimator using permanent rainfall attributes to identify the permanent income effect has other problems, however, even in the context of the simple model. First, the spatial variation in permanent weather characteristics may be correlated with long-standing spatial differences in preferences for savings (e.g. $\beta$). Households in better weather areas may also have already paid for such conditions, as they will be reflected in property values. Transitory changes in rainfall, however, are orthogonal to culture or preferences.

(ii) Savings Behaviour and the Rural Labour Market

A major problem with the studies that have utilized weather within the context of the basic model is that, as discussed by Rosenzweig and Wolpin (2000), they carry over the savings-literature tradition of ignoring labour supply choice and the production process, which has important implications in this context for the interpretation of the findings. Recent work based on developed country data (Blundell et al., 1994; Attanasio and Browning, 1995; Attanasio and Weber, 1995) has shown that ignoring labour supply considerations leads, in at least some cases, to the false rejection of the implications of consumption-smoothing models. In the studies using weather to study savings behaviour in a farm context, however, under some assumptions inattention to labour-supply behaviour and the process generating income may have led to the inappropriate acceptance of the null hypothesis of perfect consumption smoothing.

The labour-supply problem arises in the Paxson and Wolpin tests of the permanent-income model because both studies use a measure of farm income that ignores the use of “unpaid” family labour. In particular, income is defined as gross farm output less the cost of paid or marketed inputs only. Family labour is a major input in agricultural production in many areas of the world, and in some areas (Africa) the only labour input. When family labour is employed in agricultural production, the IV estimator based on the income measure used in the Paxson and Wolpin studies yields biased estimates of income effects on consumption that will depend on labour-supply behaviour and on the completeness of labour markets. Thus, the standard assumption in the savings literature of inelastic labour supply, because of the measurement of farm income, turns out to be critical and the test of the completeness of credit markets turns out to be a joint test of credit and labour-market completeness.

To illustrate the problem, the model can be modified in two respects. First, assume that instantaneous utility is a function of both consumption and leisure $l$. Second, assume that family labour $(1 - l)$ and hired labour $h$ are used in agricultural production and, for simplicity, that family and hired labour are perfect substitutes. The income function is now

$$y_t = f(h_t + (1 - l), \omega_t). \tag{6}$$

Labour markets are competitive such that hired labour can be purchased at a fixed wage $w$. The

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3 This bias arises even if leisure and consumption are strongly separable.
farm household now chooses the amount of labour in production, the amount of leisure and savings.

If labour is hired after the realization of the rainfall shock and wages are invariant to rainfall, then the model is separable in production and consumption—the production decision always maximizes profits and the savings and labour-supply decisions take profits as given in the first period. A favourable rainfall shock that increases output will, if leisure is a normal good, reduce family labour supply and thus increase the use of hired labour relative to family labour. If only paid-out costs are subtracted out of gross farm income, then the increase in true farm labour. If only paid-out costs are subtracted out of gross farm income, then the increase in gross income less marketed input costs. If only paid-out costs are subtracted out of gross farm income, then the increase in true farm labour. If only paid-out costs are subtracted out of gross farm income, then the increase in gross income less marketed input costs. The appropriate IV estimator for the transitory income effect using $y_t$ in the first period is

$$d_{12} = (d_{21}/d_{11})(d_{12} - w(h_1 + (1 - l_1))/d_{11}). \quad (7)$$

Thus in the Wolpin (1982) and Paxson (1992) studies, which used crop revenues net of only hired inputs as the measure of income, the IV estimators of the impact on savings of a transitory income change will be overstated and the impact on consumption understated—making the findings conform more closely to the implications of the ‘perfect smoothing’ benchmark. Kochar (1999), based on the Indian ICRISAT data set, focuses explicitly on how labour supply by family members is responsive to income shocks when labour supply is a choice and, indeed, can serve as a consumption-smoothing mechanism. She employs a model in which labour supply is a choice and, in particular, pays attention to the fact that there are different cases or corner solutions; in particular, that in some households family members do not work in the wage labour market. This study, too, indicates small responses, in this case of labour supply, to transitory income shocks. However, Kochar’s measure of transitory income, instrumented by monthly rainfall levels, also does not subtract out the value of family labour so that the estimates are downward biased, as in the Paxson and Wolpin studies.

Jacob and Skoufias (1994, 1998) use the same data set as Kochar to test whether credit markets allow perfect smoothing using weather shocks. They assume that family and hired labour are perfect substitutes. But unlike in the Kochar, Paxson, and Wolpin studies, they net out the cost of both hired and family labour valued at the market wage from gross farm income, as is required to obtain consistent estimates of income effects in the model under that assumption. But what if family and hired labour are not perfect substitutes? To investigate this, Rosenzweig and Wolpin (2000) expand the basic model by including in the income-generating function a component of labour (‘supervisory’) that is not a perfect substitute for hired labour and cannot be purchased in the market. Thus, the production and consumption sectors are no longer separable and neither the marginal rate of substitution between leisure and consumption nor the marginal value product of family labour is equal to the market wage. They show that therefore dividing the transitory rainfall effect on consumption or savings by the transitory rainfall effect on revenues net of the value of labour valued at the market wage, the equivalent of the IV estimator used by Jacoby and Skoufias, will not provide a consistent estimate of the transitory income effect on consumption. Moreover, the direction of the bias in the IV estimator based on such an income measure can be of either sign. Thus, in this case, there is no measure of net income that can be used as the basis of a weather-based IV estimator of transitory income effects that would be consistent. Thus, if, for example, it is not possible for reasons of moral hazard to hire supervisory farm labour, then weather-based income effects obtained from farm populations, where this instrument has the most power, will be biased.4

Rosenzweig and Wolpin (2000) carry out a simple test of the plausibility of the labour-market assumptions used in the Wolpin, Paxson, and Jacoby and Skoufias studies using a weather instrument based on data describing rural Indian households that distinguish between supervisory and crop-labour time. The data indicate that in over 12 per cent of farms at least one family member devotes time to supervisory tasks. The basic idea of their test is that if there are hired substitutes for supervisory and manual labour, exogenous variations in permanent attributes of weather should have the same effects.

4 Fafchamps et al. (1998), described in more detail below, use a rainfall-based instrumental-variables estimator of income effects on savings based on the African ICRISAT data, in which labour markets are far from complete and almost all farm labour is family-based. Their income measure also does not net out the cost of family labour.
on the amounts of both types of family labour. Their results, based on an annual time-series of average daily rainfall from 1961 to 1980 at the district level, indicated that in favourable rainfall areas family members worked significantly fewer days per year, consistent with leisure being a normal good (and the need to net out the cost of family labour in studies that use farm income). However, family time in supervisory activities was also higher in such areas (as was the ratio of supervisory to crop-labour family days), indicating the difficulty of obtaining market substitutes for supervisory labour. This suggests that netting out total family labour time valued at the hired labour wage may not be sufficient to obtain identification of either permanent or transitory income effects using weather events as instrumental variables.

The results concerning the difficulties of identifying transitory income effects using rainfall variation as an instrument for income were derived under the assumption that the local weather events do not affect the locale-specific price of the consumption good relative to the wage. One sufficient condition is that either all inputs, including labour, or all goods are perfectly spatially mobile. Another is that leisure and consumption are strongly separable. If, for example, consumption and leisure are substitutes, then if wage rates and income both co-move positively with favourable weather shocks and the wage is excluded from the specification of the consumption equation, the estimated transitory income effect is positively biased because it also contains a substitution term. In the case in which family (supervisory) labour is not marketed, an additional omitted variable is the "shadow" wage of this labour, which is endogenously determined and varies with local weather. The tests of credit market perfection based on rainfall-based income shocks are not, therefore, conclusive, either because of the inappropriate measurement of income in the agricultural context or because imperfections in the labour market, and possibly other commodity markets, make clear tests difficult.

(iii) Precautionary Savings with a Borrowing Constraint

An alternative to carrying out tests of market perfection examines savings behaviour in an environment of fluctuating incomes when markets are incomplete. Deaton (1991) assesses savings patterns by modifying the standard model (i.e. maintaining the inelastic labour supply and otherwise perfect markets assumptions) to include the constraint, using the model set out above, that $a_2 > 0$. That is, households are unable to borrow. Deaton also assumes that the subjective rate of discount exceeds the market return on assets $r$, so that households would never save except to use assets to buffer fluctuations in income. The borrowing constraint assumption results in a modification of the standard Euler equation (3). In particular,

$$U'(c_1) = \max\{U'(y_0 + y_1), \beta (1+r)E \omega U'(c_2)\}. \quad (8)$$

Expression (8) says that the income realization in period one may be so low that, with no ability to borrow, the marginal utility of first-period consumption, if all income is consumed, exceeds discounted expected marginal utility in period two. In a model with more than two periods, expression (8) holds for any adjacent periods, and the binding constraint occurs when the marginal utility of total cash on hand, total income plus the value of any current stocks carried over from the previous period, is greater than expected marginal utility in the next period. If that occurs, the household 'stocks out'—it consumes all of its assets and income.

Deaton simulates an infinite horizon version of the model, drawing income shocks from a stationary distribution that are i.i.d. and that are autocorrelated. By assuming an infinite horizon and a stationary distribution, life-cycle considerations and growth effects are abstracted from, thus highlighting 'high-frequency' or precautionary saving. The simulations with i.i.d. shocks indicate that households do hold stocks, despite being impatient; the level of stocks is

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5 Browning and Meghir (1991), using data from a developed country, provide evidence that rejects the assumption that consumption and leisure are separable.
relatively low; holding stocks does smooth consumption; peaks in income are smoothed more than troughs; and there are repeated, but infrequent, periods in which households are stocked out. When income has a positive serial correlation, the periods in which households are stocked out are prolonged and considerably less smoothing is enabled. That stocking out is more extended in a regime of positive autocorrelation is not surprising—if incomes today are low, and lead to stocking out, incomes tomorrow will be also, with total income likely to be fully consumed again.

III. INTER-ANNUAL INCOME VARIABILITY AND PRODUCTION EFFICIENCY

(i) Saving with a Productive Asset

The models considered so far ignore the form of savings. This turns out to be important in the context of the agricultural sector because it creates a link between the consumption-smoothing problem and productive efficiency, and thus the average level of income. Low savings thus become a cause and consequence of poverty. In addition the form of saving and the source of income generation can affect the inter-temporal pattern of incomes, which Deaton’s modelling shows has important effects on savings behaviour. The model simulated by Deaton with i.i.d. shocks is, in fact, characterized by a small degree of positive autocorrelation in income. As seen in equation (2), given a positive return \( r \) to the asset, high income in a period, which permits some saving, leads on average to higher total income in the next period with i.i.d. shocks. Deaton chooses a distribution of exogenous shocks, however, in which on average the share of asset income \( a_r \) in total income is less than 0.001. Rosenzweig and Wolpin (1993) construct a model in which the store of value is a major contributor to total income. Thus, the income-generating function (6) is modified so that

\[
y_t = f(a_t, h_t + (1-l), \omega_t). \tag{9}
\]

There are two important implications that arise if the asset \( a \) is a major contributor to income and is used as a buffer stock. First, as noted, even with i.i.d. shocks, such as weather shocks, income will have a high degree of serial correlation and stocking out will be more sustained. Thus, households will be more vulnerable to income shocks. Second, the use of the productive asset to smooth consumption because of borrowing constraints for consumption purposes makes income generation inefficient and lowers average incomes.

The model incorporating (9) highlights the fact that most of the savings of farm households is in the form of productive assets. The Indian ICRISAT data indicate that approximately 85 per cent of the value of total assets held by farm households is in the form of land and buildings. However, farm households in India rarely sell or buy land; it is not used as a buffer stock. Of the remaining asset portfolio in the semi-arid tropics region covered by the ICRISAT data, a large proportion—between a half and a third—consist of bullocks, which provide the principal motive power for agricultural production in that environment. The data also indicated, however, that there was a great deal of turnover in bullocks in the 10-year period covered by the data, and regression analyses indicated that bullock sales were significantly higher when incomes were low and bullock purchases significantly higher when incomes were high—bullocks appeared to serve as a buffer stock.

Rosenzweig and Wolpin (1993) estimated a structural multi-period, finite-horizon model which incorporated the no-borrowing constraint and in which the only form of storage was in bullocks, which could be bought, sold, or bred, but not rented. Agricultural income at \( t \) depended on the stock of bullocks at the beginning of the period and shocks drawn from a (normal) distribution whose parameters were estimated. The model incorporated a constant relative risk-aversion utility function and a fixed minimum consumption level (an estimable parameter). Given the highly variable nature of agricultural incomes, and with borrowing for consumption purposes shut down, the model also incorporated a form of insurance by necessity—there were a substantial number of instances in which cash at hand, the proceeds from the sale of all bullocks, if any, plus income, fell below the minimum consumption level. It was thus assumed that in these cases the household received income equal to minimum consumption; i.e. added to the budget constraints was
assured income increased the stock of bullocks and thus raised average agricultural incomes for small and medium-sized farmers. The simulations thus illustrated the point that without insurance and the ability to borrow in a setting with highly variable incomes, those with low average incomes are too poor to be efficient.

(ii) Asset Portfolio Choice

The Rosenzweig–Wolpin model embodies the simplifying assumption that bullocks are the only asset used to smooth consumption. Fafchamps et al. (1998) set out a model in which both food stocks and animals are substitute forms of liquid wealth. They construct their model in the context of the semi-arid tropical regions of Africa, however, in which animals are not used for motive power but are bought and sold solely for consumption purposes. Crop income $y$ is variable over time and may covary with the return $\alpha$ to selling animals. Food stocks are alternative desirable stores of value since they are immune to food price shocks, but they deteriorate over time at rate $\lambda$, so have a constant negative return. The authors ask two questions of their model: (i) how much of total liquid wealth will be held in the form of animals? and (ii) will animal stocks move as total liquid wealth moves in response to income shocks? They approximate the expected value function $E[V(X)]$ by a mean-variance specification. The optimal holding of livestock at any time $t + 1$ $L_{t+1}$, for given total wealth at time $t+1$, is then given by

$$L_t = \left[ 1 + \alpha^* - (1-\lambda)P - \theta - \text{cov}(y,\alpha^*)/A\sigma^2(r) \right]$$

where $\alpha^*$ is the mean return to holding animals, $P$, is the price of animals relative to the grain price at time $t$, $\theta$ is per-animal maintenance cost, and $A$ is the coefficient of absolute risk aversion $(-[V''(E[X])]/[V'(E[X])])$. Thus a larger proportion of animals are held as a proportion of total liquid wealth the higher is the mean return to selling animals and the higher is the depreciation rate of food stocks, but the lower are maintenance costs, the covariance between crop income and the return on livestock, household risk aversion, and the variance in the return to

$$c_i = c_{\text{min}} \text{ if } y_i + a_i \leq c_{\text{min}},$$

where $c_{\text{min}}$ = minimum consumption necessary for survival. Thus, empirically precautionary savings was not sufficient for survival in a real world setting.\textsuperscript{6}

A key assumption of the Rosenzweig–Wolpin bullock model is that the price of bullock is fixed and thus independent of income shocks. The argument is that unlike land, which is immobile, bullocks can be transported even without transportation vehicles so that spatially integrated bullock markets are possible.\textsuperscript{7} Spatial arbitrage resulting from the self-propelled nature of bullocks thus immunizes bullock prices from local income shocks. In contrast, given the local spatial covariance of income shocks in agriculture, land prices would positively covary with income shocks, thus reducing substantially their value as buffer stocks. The model also assumes separability conditional on bullock stocks—thus all variable input markets were assumed to be perfectly spatially integrated and the conditional profit function solved a static problem and could be estimated separately from the dynamic consumption side. The estimates indicated that for medium-sized farmers, having two bullocks was substantially more profitable than any other quantity. Yet on average, half of the medium-sized farmers had no bullocks at any point in time—stocking out was common and the use of bullocks to smooth consumption evidently lowered incomes on average.

The structural estimates indicated that the farmers were risk averse, and thus had a motive for smoothing consumption, and yielded predictions for the time-paths of bullock stocks that were close fits to those for the sample. More interesting were the out-of-sample fit tests. The model also predicted well for the small-farmer sample but failed badly the fit tests for large farmers (defined by land size), suggesting that large farmers may have had other means of smoothing consumption. Simulations using the estimated parameters of the model also indicated the efficiency loss that arises from the combination of variable incomes, low levels of income, and borrowing constraints. In particular, increasing

\textsuperscript{6} Deaton’s simulations were based on assumed parameter values for income generation in which consumption was never forced to zero even during stock-out periods.

\textsuperscript{7} The data indicated that 60 per cent of bullock transactions were made with partners located outside of the villages.
animals. From the perspective of asset portfolio considerations, the importance of the covariance between crop income and livestock returns is the most interesting implication of the model. The authors indeed speculate that the returns to holding livestock increase in drought periods, as next-period selling prices are higher and maintenance costs (common land resources) are cheaper. However, there is no evidence presented on this interesting parameter.

Fafchamps et al. go on to show that animal stocks will covary positively with total liquid wealth holdings as long as relative risk aversion is non-increasing. Thus, animal stocks should behave like total liquid wealth, increasing when incomes are high and decreasing when low. They use the Burkina Fasso ICRISAT data to test only this proposition, implementing an empirical methodology similar to that used by Wolpin (1982), Paxson (1992), and others in which rainfall shocks are used as an instrument to predict crop-income fluctuations, inclusive of measuring crop income gross of family labour costs. They find weak evidence that livestock is sold and bought based on consumption-smoothing motivations, with small animals being more responsive than cattle and both more responsive to aggregate, community-level shocks than to idiosyncratic household-level shocks. However, cattle and small animals combined only offset at most 30 per cent of downside deviations in crop income.

In the specification that Fafchamps et al. use to predict crop income, they allow for the fact that the impact of rainfall on income depends on soil quality. Rosenzweig and Binswanger (1993) highlight the possibility that production assets differ in the extent to which they mitigate the effects of weather shocks on income and assess to what extent asset portfolio choice is affected by risk considerations. The emphasis here is not on the ability of production assets to buffer consumption against income variability ex post, but to buffer income against weather shocks ex ante. Rosenzweig and Binswanger set out a model in which farmers have preferences over the mean (µ) and standard deviation (σ) of consumption, U=V(µ, σ), with V>0 and V<0 if farmers are risk averse. A farmer k with total wealth Wk chooses a vector of asset shares ak to maximize utility, subject to the following technological relationships:

\[ \mu_{ek} = W_k F(a_k) \mu_a \] (12)

\[ \sigma_{ek} = W_k \Gamma(a_k) \sigma_a, \] (13)

where µa and σa are the mean and standard deviation of the rainfall distribution, respectively. Thus in this model the distributions of consumption and income are isomorphic—there is no ex-post smoothing—but the choice of the asset portfolio affects income profiles and thus consumption.

The first-order conditions are given by

\[ V(F_{ai} - F_{an}) = -V(\Gamma_{ai} - \Gamma_{an}) \sigma_{a}, \] (14)

where Fai and Γai are the marginal contributions of the jth capital asset to mean profits and profit variability, respectively. Expression (13) indicates that (i) as long as farmers are risk averse and assets differentially affect the variability in incomes in (12), the asset portfolio will not be efficient (the efficiency condition being that for any pair of production assets i and n, F_{ai} - F_{an} = 0) and (ii) assets that contribute more to the mitigation of income riskiness hold a larger share of the portfolio and thus have a lower mean return. Rosenzweig and Binswanger investigate under what conditions the characteristics of the asset portfolio, expressed in terms of its mean return and standard deviation, for a given weather distribution, vary by wealth level Wk. They show that sufficient conditions are that farmers exhibit non-constant absolute risk aversion and that with decreasing absolute risk aversion, farmers with higher wealth levels will have riskier and thus more profitable portfolios on average.

The authors estimated, using information on the farmers in the Indian ICRISAT data set, a generalized normalized (by total wealth) quadratic profit function with nine different assets (including irrigation equipment, land, small farm implements, ploughs, bullocks, cash) of the form

8 The mean-standard-deviation model maps straightforwardly into expected-value function models under weaker conditions on the properties of the V-function than do mean-variance representations when the distribution of shocks is fully characterized by scale and location parameters (Meyer, 1987).
\[ \pi_{ki} = \sum \alpha_{ij}a_{ij} + \sum \gamma_i a_{ij} + \gamma_i a_{ij} + \nu_j + \nu_{ij}, \quad i, j = 1 \ldots 12, \quad (15) \]

where \( \pi_{ki} \) = profits for farmer \( k \) at time \( t \) net of all purchased inputs and family labour per unit of wealth, \( \nu_j \) = farmer-specific error (ability, soil quality), \( \nu_{ij} \) is an i.i.d. time-varying profit shock, and the \( \alpha_{ij} \) and \( \gamma_i \) are coefficients. From (15), the marginal contributions of the \( i \)th asset (share) to average profits \( F_a \) and to profit variability, \( \Gamma \), are \( \Sigma \alpha_{ij}a_{ij}a_{ij} + \gamma_i a_{ij} \) (mean weather normalized to 0) and \( \gamma_i \), respectively. Moreover, a scalar value of the riskiness \( \Gamma \) of each farmer’s total portfolio can be computed, which is \( \text{sqrt}(\Sigma \gamma_i a_{ij}^2 + \gamma_i \gamma_i \Sigma \gamma_i \gamma_i \gamma_i) \). Rosenzweig and Binswanger estimated (15) using a fixed-effects procedure to take into account the existence of possible unobserved differences across farmers that might influence their portfolio choice, as captured by the \( \nu_j \) term. Based on the estimates of the \( \alpha_{ij} \) and \( \gamma_i \) parameters, they tested both that the correlation between \( F_a \) and \( \Gamma \) across the 12 assets was positive and that across farmers average profits per unit wealth and portfolio riskiness were also positively correlated.

The estimates indicated that the correlation between asset-specific marginal contributions to profits and marginal contributions to profit variance was positive, but only statistically significant at the 15 per cent level. The evident outlier was the draft animal asset—bullocks—which had a very high marginal return but only modestly contributed to profit variability relative to other assets. These estimates thus indicated that farmers were holding too few bullocks, a result that can be explained by the findings in Rosenzweig and Wolpin (1993) that bullocks were used as a buffer stock to smooth consumption ex post and thus were often stocked out. Exclusion of bullocks from the set of nine assets raised the rank correlation from 0.26 to 0.68. These results thus suggest that to understand fully farmers’ asset portfolio choices it is necessary to consider the two risk-mitigating roles of production assets—(i) buffering income from production shocks such as weather and (ii) insulating consumption from variability in income. Rosenzweig and Binswanger also found, consistent with the model, that farmers facing greater weather variability (as measured by the standard deviation in the monsoon onset date) had less risky (lower \( \Gamma \)) asset portfolios that were also less profitable. Moreover, increasing wealth levels were associated with both riskier portfolios and greater profit/wealth ratios on average. Thus, again, owing to the presence of uninsured income risk, most farmers are poorer on average, the more so the poorer the farmer.

IV. INTRA-ANNUAL INCOME VARIABILITY: CONSUMPTION SMOOTHING AND SAVINGS OVER SEASONS AND STAGES OF PRODUCTION

Agricultural incomes not only fluctuate from year to year, but also within the year owing to intra-annual cycles in rainfall and temperature and to the fact that agricultural production takes place in sequential stages. While the general phenomenon of within-year fluctuations is often referred to as ‘seasonality’, there are two distinct uses of the term ‘season’ in the literature. One use implicitly defines a season as a stage of agricultural production—the harvest or planting ‘season’ (as in Paxson, 1993). A more traditional use defines a season as a complete cropping cycle (e.g. the rabi and kharif seasons in India and Pakistan), consisting, roughly speaking, of three distinct stages—a planting stage, in which expenditures on inputs are high and incomes are low; a growing stage; and a harvest stage, when incomes are relatively high. A given time period (month) thus may be characterized by the stage of production that is taking place and by the crop season (e.g. the planting stage in the rabi season). Farmers may be able to go through two or three crop-cycles in a year.

There are two important implications of the sequential nature of agricultural production. First, even the mostly predictable fluctuation in income across agricultural production stages creates an additional challenge for farmers seeking to maintain their consumption when credit markets are incomplete. A second implication is that results from studies of savings decisions in agricultural households may be sensitive to the exact time periods by which income and consumption are reported in the data. This is because within a year or crop cycle income will in

\({}^9\) However, they did not take into account the possibility that lagged shocks to profits \( \nu_j \) might influence future asset investments.
part depend on savings decisions—the agricultural production process involves transfers of resources over time within the year. For example, farmers who are able or desire to borrow more in the planting stage to finance, say, additional fertilizer applications will have lower planting-stage savings and incomes (as the higher input expenditures are subtracted from gross income). Such farmers will also experience higher harvest-stage incomes (from the additional fertilizer) and will be observed to have greater savings in the harvest stage (owing to the higher debt repayments). The dependence of crop income on debt would thus bias upward savings–income relationships estimated over a cross-section of farmers in which, say, observations on income and savings were for a particular month, as in many household data sets.

(i) Testing for Perfect Intra-year Consumption Smoothing

The Thailand survey data set used by Paxson (1992) to test farmers’ abilities to cope with inter-annual income fluctuations provides income on an annual basis (last year’s income), food expenditure for the week prior to the survey, and non-food consumption expenditures for the last month. Paxson (1993) exploited the fact that respondents were interviewed in different months during the surveys to test the degree to which consumption was smoothed within a year. As Paxson notes, in a setting with no uncertainty and perfect smoothing there would be no relationship between monthly consumption and the anticipated deviations in monthly income from average annual income. Paxson specifies an estimating equation relating the monthly consumption of respondent $j$ in month $i$ $c_{ij}$ to his total annual income $Y_j$ and the ratio of that month’s income to annual income $R_{ij}$ in a setting in which consumption-smoothing is imperfect as the following:

$$\ln(c_{ij}) = \ln(Y_j) + (1 - \phi)\zeta_j + \phi R_{ij} + v_{ij},$$

where the $\zeta_j$ are common month-specific consumption preferences and the $v_{ij}$ is an individual time-varying error term. If there is perfect within-year smoothing, then parameter $\phi = 0$.

Paxson assumes that $v_{ij}$ is solely measurement error in consumption. Given that monthly income is constructed in the data as monthly consumption plus savings, estimation of (16) by ordinary least squares would, given measurement error, produce bias in the estimate of $\phi$. However, what is not recognized is that variability in $v_{ij}$ may reflect individual-specific differences in consumption preferences or in the ability to borrow, which could be correlated with annual income. For example, suppose that month $i$ is a planting month. Then those farmers with greater ability to borrow for production purposes might have higher consumption $c_{ij}$ and a lower $R_{ij}$ in that month and would also have higher income on average over the year to the extent that production credit is constrained. Indeed, one of the reasons that rainfall deviations are useful as instruments is that they enable estimation of consistent transitory income effects when income depends on consumption. Here, Paxson utilizes an instrumental-variables approach that is applied only to the monthly income variable, positing that whether a household is urban or rural or rural-agricultural or rural-non-agricultural affects the time paths of monthly income within a year, but not month-specific preferences for consumption. Thus,

$$R_{ij} = R_j + Z_j R_j + e_{ij},$$

where $Z_j$ is an indicator variable taking on the values of 0 or 1 depending on whether the household is in one of the two comparison groups. A necessary condition for this approach to be successful is that $Z_j R_j$ be statistically significant; that is, that there be significant differences in monthly income patterns across the groups.

Paxson finds that the patterns of incomes over the year do differ between urban and rural households and also between rural farm and rural non-farm households. She also finds that monthly consumption patterns differ across urban and rural households, thus rejecting the perfect smoothing model. However, she does not find any differences in the monthly consumption patterns of both types of rural households, consistent with perfect intra-annual consumption smoothing. Given that the month-specific dependence of annual income on monthly consumption will likely differ between farm and non-farm households because of the stage-specific dynamics of agricultural production, and this dependence is not taken into account in the estimation procedures used, it is not clear whether these results conclusively support the absence of impediments to
The major limitations on the ability to test the perfection of consumption smoothing within or across years in the studies by Paxson (1992, 1993) derive from the shortcomings of the data, which do not provide sufficient information for measuring agricultural income, do not have a time dimension appropriate for studying decisions by agricultural households, and do not follow any one farmer over time. Jacoby and Skoufias (1998) exploited the high frequency and detailed production information in the India ICRISAT data to assess the degree to which consumption smoothing takes place across production stages. They distinguish between planting and harvesting stages, taking into account the information known to the farmers at each stage, another important distinction of agricultural production stages. In particular, they decompose profits (netting out the value of family labour) into anticipated and unanticipated components, using rainfall as an instrument to deal with the simultaneity between consumption and income. Estimates of anticipated profits are based on household and farm characteristics considered to be predetermined and their interactions with rainfall characteristics that are realized prior to planting, and thus known to the farmer at the time planting decisions are made. Estimates of unanticipated profits are based on interactions of the predetermined variables with rainfall characteristics realized after planting and just prior to harvesting, which are unknown at the time of planting. Aggregate (village) level shocks are thus assumed to affect profits of individual farmers idiosyncratically. The results of the instrumental variables estimation using rainfall show that neither the effect of anticipated nor unanticipated profits on consumption expenditures within a season is statistically or economically significant. This result is thus consistent with the findings in Paxson (1993), implying that farm households are able to smooth consumption over seasons as if there were perfect credit and labour markets.

(ii) Rural Credit Institutions, Financial Savings, and Transfers

The absence or inefficiency of formal credit institutions is one of the factors alleged to result in the reliance of households on costly informal insurance mechanisms and inefficient use of productive resources to mitigate production and price shocks. However, while there is a large literature describing informal insurance mechanisms, which implicitly or explicitly motivates the existence of such mechanisms by the absence of formal insurance and banking institutions, there is little evidence on the extent to which formal and informal institutions interact. Rosenzweig (1988) shows that informal transfers, which appear to help insure households against income fluctuations, crowd out loans using the Indian ICRISAT data. This evidence is based on a regression of loans against transfers, using household structure as an instrument to predict transfer levels based on evidence showing that the number of married women in the household is an important determinant of transfers. However, household composition and structure may itself be a function of credit availability.

Behrman et al. (1997) used data from a survey of farm households in Pakistan to assess more intensively the role of banks in affecting the savings composition of rural households. Unlike the Thailand data set used by Paxson, these data provide information explicitly by agricultural stage and by crop season for multiple seasons for the same farmers, with detailed information on input allocations, investments, and financial savings and transfers. Indeed, the authors use the data to show that the time frame over which savings and income are defined matters for understanding savings behaviour in agricultural populations. In particular they show that net-indebtedness of farm households proximate to a bank in the planting stage is negatively correlated with total rabi-season income, while net-indebtedness in the harvest stage is posi-

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10 There are also significant differences in month-specific labour-force participation rates across the two types of rural households. Given that for both rural household types income is defined gross of family labour supply variation, additional assumptions are required about the marginal rate of substitution between labour supply and consumption to interpret these results.

11 Besley (1995) reviews this literature along with the literature on savings.
tively correlated with income measured over the crop season. While these results are completely understandable as indicating that production credit augments harvest income, they show that the observed relationship between savings and income depends importantly on the time-periods over which both savings and income are measured.

To assess the role of formal credit institutions in fostering financial savings when credit may augment incomes, the authors seek to identify that component of income that is exogenous and unanticipated. To do this they use information from two adjacent *rabi* seasons to estimate a harvest-stage profit function, employing a specification like (15) except that the asset variables are planting-stage inputs and harvest-stage prices. By differencing equation (15) across the 2 years for the same farmer, they eliminate fixed unobservables, and instruments are used to predict the differenced inputs. The authors then use the harvest-stage profit-function estimates to predict individual farmer profits, from which they obtain an estimate of the unanticipated harvest-stage shock.

Behrman et al. use the shock estimate to test whether the proximity of formal financial institutions affects the amount of financial savings. If bank proximity raises the net return to savings, as indicated by the Fafchamps et al. analysis of asset portfolio composition, then a higher proportion of savings should be in the form of financial savings. On the other hand, to the extent that banks loosen credit constraints, farmers have less need to hold assets to insure against future adverse shocks. Behrman et al. find that an unexpected 20 per cent increase in harvest profits increases net savings flows to financial institutions by 9 per cent for households located within 5 kilometres of a bank, while a similar increase in income for households not near a bank results in savings only 4 per cent as large, a statistically significant difference. Their results also indicate that the presence of formal banking institutions significantly reduces transfers. Thus, introducing formal financial institutions in a locality would appear to cause a shift away from informal consumption-smoothing mechanisms to the use of formal savings institutions. However, the authors do not estimate the impact of bank presence on overall asset accumulation.

### V. LONGER-TERM SAVINGS

Almost by definition, savings in low-income settings for long-term purposes such as retirement are not going to be substantial, given the difficulties of meeting subsistence consumption requirements, particularly in the face of income volatility. Two hypotheses have emerged from the theoretical savings literature that relate savings to age when individuals are forward-looking. The first, from the life-cycle savings framework, is that savings will be used to smooth consumption when income varies by age. Thus, given standard inverted-U-shaped income trajectories, it would be expected that, over the life-cycle, savings will be negative when an individual is young and ‘hump’-shaped when he or she is old. The second hypothesis concerning the relationship between age and savings views age as signifying a birth cohort. Thus in economies experiencing income growth, the young will have higher lifetime earnings compared with the old, and will as a consequence dissave relative to the old at a given point in time. For the most part, data from low-income countries do not provide support for either of these hypotheses. For example, Deaton (1992) looked at cross-sectional data sets from Thailand and Côte d’Ivoire to assess to what extent savings by age conformed to both the life-cycle and income-growth hypotheses in those settings. Despite the fact that Thailand over the relevant period had a growth rate four times that of Côte d’Ivoire, in both data sets the only determinant of consumption at any age was current income.

There are three reasons that the absence of a systematic relationship between age and savings may not reflect the constraints of low incomes, institutional underdevelopment, or lack of forward-looking behaviour, however. First, cross-sectional data are not well-suited to studying life-cycle behaviour. As is well known, at a given point in time age signifies both a place in the life-cycle and a birth cohort, and birth cohorts may differ in preferences and expectations. Data from low-income countries

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12 The authors test whether the ‘shock’ estimate is unexpected by ascertaining if planting-stage inputs were statistically significantly related to the shock. They were not.
do not as yet provide panel information that would track savings behaviour for any individual or household over a sufficient time span to assess precisely the life-cycle savings behaviour of any birth cohort.

A second reason that observed age–savings relationships might obscure forward-looking behaviour in low-income settings is that households in many low-income countries are complex, often consisting of more than two adults, and adults of different generations. It is thus not clear whose age matters for savings decisions. Deaton and Paxson (2000) explore this issue, using information on the age composition of the household rather than, arbitrarily, of the household head, as in the standard literature. However, the composition of the household over the time spans that are relevant to the theory is not itself unresponsive to the forces that shape savings decisions. Fafchamps et al. (1998) cite evidence from a number of studies that in African societies households change size and composition in response to income fluctuations. Rosenzweig and Stark (1989) present evidence from the Indian ICRISAT villages that households are more extended (have more daughters-in-law) in riskier settings because marital ties enhance ex-post protection against income shocks via cross-village transfers. And Foster and Rosenzweig (2000) show that within a span of 11 years, a third of Indian farm households split, with splits less likely in areas exposed to agricultural technical change. It is thus necessary to understand better the determinants of household configurations in order better to characterize longer-term and perhaps even short-term savings behaviour in low-income countries.

Finally, financial savings and even productive asset changes are not the only means by which forward-looking households can and do allocate resources over time. As noted, the literature concerned with short-term consumption smoothing has until recently ignored labour supply considerations and the labour market. Similarly, investigations of savings generally ignore investments in human capital. Indeed, a long-standing hypothesis for why fertility is high in low-income environments is that children provide old-age support. Clearly, if true, children are a form of long-term savings. Additionally, households facing enhanced growth prospects may find that rates of return to investment in schooling are elevated, and will shift resources to educational investments (Foster and Rosenzweig, 1996). There is as yet little evidence of how human capital investments and financial savings interact in low-income settings.13

VI. CONCLUSION

The empirical literature on savings in low-income countries has exploited some remarkable data sets to shed new light on savings behaviour in households that make up the population majority in low-income countries—the rural, agricultural poor. A number of conclusions emerge: (i) the degree of consumption smoothing over seasons within the year and across years in response to very high income fluctuations is higher than was supposed; (ii) lack of complete insurance and credit markets, however, is manifested in asset stocks and asset composition among farmers, especially small farmers, that are inefficient; (iii) the combination of low and volatile incomes, given absent inter-temporal markets, is a cause of inefficiency and income inequality which can, however, be ameliorated by enhancing income growth (it is not necessary to develop all markets); (iv) the proximity of formal financial institutions increases financial savings and crowds out informal insurance arrangements, thus in principle better facilitating financial intermediation; and (v) simple life-cycle models of savings do not appear to explain long-term savings in low-income settings.

These findings must be qualified by two considerations. First, the number of low-income settings in which savings issues have been investigated empirically is very limited, owing to constraints on the availability of the kinds of data needed to explore these issues in such contexts. The number of studies far outnumbers the number of data sets, thus creating a high correlation in findings. Second, most studies of savings, as is typical of the entire savings literature, have not allowed agents to have multiple

13 Jacoby and Skoufias (1994) look at the responsiveness of children’s school attendance to farm household income shocks, based on the Indian ICRISAT data. However, in their model schooling does not yield a return in the short run they consider. Thus, essentially, schooling is treated as labour supply (of children) and not as an investment.
choice variables or markets. This has led in some cases to ambiguity in interpreting existing findings. But an emerging literature also suggests that, in the future, major advances in the understanding of the dynamic behaviour of households in low-income countries will require integration of decisions concerning savings, labour supply, human capital, and the organization of the household.

REFERENCES


