People who live in the rural areas of poor countries often must cope not only with severe poverty but with extremely variable incomes. This is most apparent for the majority who are directly dependant upon agricultural income. Weather variation, the incidence of disease, pests and fire, and a host of other less obvious factors cause farming yields to fluctuate unpredictably. Variations in the price of marketed output can also cause farm profits to vary. Fluctuations in income can present an acute threat to people's livelihoods even if, on average, incomes are high enough to maintain a minimal standard of living. Occasional famines provide the most egregious examples of the consequences of risk in poor societies, but risk also generates more commonplace worries such as the consequences of a bad harvest for a family's ability to afford school fees for children, or the implications of a wage earner's illness for the ability to provide a healthy diet for the household.¹

We have three main goals in this chapter. First, we will describe the Pareto efficient allocation of risk within a community. Risk-pooling within a community could be achieved through formal insurance markets, or through a variety of informal transfer mechanisms. It will be seen that Pareto efficiency has very strong implications for consumption patterns in a risky environment. There are a number of reasons to expect that fully efficient risk pooling rarely, if

¹See Ryan and Walker (1990), Bliss and Stern (1982) and Watts (1983) for rich descriptions of the risk faced by peopled living in different rural environments.
ever, is achieved. The second purpose of this chapter, therefore, is to examine the use of intertemporal consumption smoothing through saving and credit markets as a substitute for full risk-pooling. Finally, if a risk-averse household is not able to achieve an entirely smooth consumption path through *ex post* mechanisms like insurance, saving and credit transactions, it has an incentive to devote resources in an effort to secure a more stable income stream. In an agricultural economy, households might farm a diversified portfolio of land, adopt technologies (such as intercropping or drought-resistant crops) and contractual arrangements (such as sharecropping) which reduce the variance of income, or diversify their activities (through migration or local non-agricultural employment). Any of these *ex ante* actions might be costly, so that the household sacrifices income, on average, in order to assure a less risky stream of income.

II

There is a possibility that in some communities, mechanisms exist to allocate risk efficiently. Households within a village, kinship group or other social network may share each other's risk through institutional arrangements which approximate the Pareto efficient allocation of risk. The information flow within a cohesive community may be sufficiently rich that the incidence of random shocks to households' incomes is common knowledge, perhaps permitting community-level institutions to insure members against fluctuations in their incomes without the problems of moral hazard and adverse selection which would plague an outside insurer. Suppose that the community is a village. What are the implications of the existence of a smoothly

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2This possibility is explored informally in the large literature on the moral economy of peasant societies, most famously by Scott (1976). For reviews of the literature, see Platteau (1991) and Fafchamps (1992)
operating set of institutions which achieves a Pareto efficient allocation of risk?

To make the contrast with intertemporal smoothing most dramatic, we will first examine a village economy in which the Pareto efficient allocation of risk is achieved, but in which there is no access to credit markets or even to storage. Let i= 1,...,N index the households which live in the village. There are T periods indexed by t. s indexes the S states of nature each with objective and commonly-known probability of occurrence \( \pi_s \). In state s each household i receives an income of \( y_{is} > 0 \). Let \( c_{ist} \) represent the consumption of household i if state s occurs in period t. Suppose that each household has a separable utility function of the form:

1. \[ U_i = \sum_{t=1}^{T} \sum_{s=1}^{S} \beta^t \pi_s u(c_{ist}), \]

where \( u() \) is twice continuously differentiable with \( u' > 0, u'' < 0 \) and \( \lim_{x \to 0} u'(x) = +\infty \). A Pareto efficient allocation of risk within the village can be found by maximizing the weighted sum of the utilities of each of the N households, where the weight of household i in the Pareto program is \( \lambda_i \), \( 0 < \lambda_i < 1 \), \( \sum \lambda_i = 1 \):

2. \[ \text{Max} \sum_{i=1}^{N} \lambda_i U_i \]

\(^3\)For the moment, we assume that income is exogenous. This is relaxed in sections IV and V.

\(^4\)We should denote consumption by \( c_{ist}(h_{t-1}) \), where \( h_{t-1} \) summarizes the history of states realized through period t-1 to reflect the possibility that consumption might depend not only on the current state, but also on the entire history of states. However, we assume that the utility function is time-separable and that storage and borrowing across periods is not possible. The problem, therefore, separates by period and current consumption depends only on the current state. To simplify notation, we delete \( h_{t-1} \).

\(^5\)The assumption that households maximize expected utility is for expositional convenience. The development which follows only on the assumption that the utility function is additively separable over time.

May 29, 1998
subject to the resources available in the village at each point in time in each state of nature:

3. \[ \sum_{i=1}^{N} c_{ist} = \sum_{i=1}^{N} y_{ist} \quad \forall \ s, t. \]

4. \[ c_{ist} \geq 0 \quad \forall \ i, s, t. \]

Equation 3 is the set of village resource constraints. Equation 4 contains the non-negativity constraints, which will not bind if the village has any resources in each period along each possible history.

The first order conditions corresponding to \( c_{ist} \) and \( c_{jst} \) imply

5. \[ \frac{u_i'(c_{ist})}{u_j'(c_{jst})} = \frac{\lambda_i}{\lambda_j} \quad \forall \ i, j, s, t. \]

This equality extends across all \( N \) households in the village in any state at any point in time. The marginal utilities and therefore consumption levels of all households in the village move together. Therefore, the marginal utility of any household is a monotonically increasing function of the average marginal utility of households in the village in any state. This implies that the consumption of any household is a monotonically increasing function of average village consumption. In a Pareto efficient allocation, then, transient changes in income are fully pooled at the community level. There is no incentive for risk diversification at the household level, because after controlling for aggregate consumption, household consumption is not affected by shocks to a household's income. The only risk faced by the household is that faced by the community as a whole.

To see this result in its most stark form, suppose that everyone in the village has an identical constant absolute risk aversion utility function, so that \( u_i(x) = \frac{1}{\sigma} e^{-\sigma x} \). Applying this
utility function to the first order condition (5) and taking logs, we find

6. \( c_{ist} = c_{jst} + 1/\sigma (\ln(\lambda_i) - \ln(\lambda_j)). \)

As before, this equality holds across all N households in the village at any point in time. If we sum across these N equalities:

7. \( c_{ist} = \bar{c}_{st} + 1/\sigma \left[ \ln(\lambda_i) - \frac{1}{N} \sum_{j=1}^{N} \ln(\lambda_j) \right], \)

where \( \bar{c}_{st} = \frac{1}{N} \sum_{j=1}^{N} c_{jst}. \) So household consumption is equal to the average level of consumption in the village plus a time-invariant household fixed effect which depends upon the relative weight of the household in the Pareto program. (7) implies that the change in a household's consumption between any two periods is equal to the change in average community consumption between the two periods. This result depends on our choice of utility functions; in general the change in a household's consumption is a monotonically increasing function of the change in average community consumption. In addition, notice that household income \( y_u \) does not appear in (7). After controlling for average consumption, a household's consumption is unaffected by its own income.

In a Pareto efficient allocation of risk within a community, households face only aggregate risk. Idiosyncratic income shocks are completely insured within the community. The power of this conclusion obviously depends upon the relative importance of aggregate and idiosyncratic income risk within the relevant community. Within small regions, the incomes of households engaged in rainfed agriculture are likely to have a high covariance, reducing the effectiveness of local risk sharing arrangements (Ruttenberg 1971; Binswanger and Rosenzweig 1986).
Nevertheless, even in these regions there appears to be ample scope for risk pooling. For example, Carter (1997) estimates that less than half the variance of rainfed farm yields in semi-arid Burkina Faso can be accounted for by common village-level variation: the majority of the yield variance is idiosyncratic to the household.

From the second welfare theorem, we know that the Pareto efficient allocation of risk can be supported by a competitive equilibrium with complete contingent markets. However, the notion that such a rich set of competitive markets exists is incredible. Any risk pooling mechanism must overcome the information and enforcement problems associated with insurance contracts. The insurer might be subject to either (or both) moral hazard or adverse selection. In addition, it is likely to be impractical to write contracts in enough detail to specify each particular state which might occur or to verify to third parties that particular states have occurred in order to enforce a contract. In the presence of these information and enforcement obstacles, a complete set of markets will not exist and the competitive equilibrium will not be Pareto efficient. However, efficient (or nearly efficient) risk pooling could be supported by a variety of other mechanisms. For example, in chapter 9 we discuss the hypothesis that interlinked, repeated, personalized transactions between households provide an essential framework for economic activity in small communities. It may be the case that such personalized transactions enable transfers between agents which serve to pool risk at the community level. Sahlins (1972) provides a discussion of systems of "generalized reciprocity" in which those whose income temporarily is relatively large provide gifts to those whose income temporarily is relatively small. It is not necessarily true that gifts between specific individuals are reciprocated, but the giver can expect that if she is ever in the position of having a temporary income shortfall, gifts will be
forthcoming from someone in the community who simultaneously is enjoying a temporary windfall. Sahlins argues that systems of generalized reciprocity usually are found within kinship groups, but other communities can support similar risk-pooling arrangements. Here are two examples from the large literature on these risk-pooling systems.

Cashdan (1985) describes a system of gift exchange among Basarwa farmer-herders in northern Botswana. Most of the Basarwa studied by Cashdan subsist by providing livestock herding services to richer non-Basarwa cattle owners. In exchange for their labor they receive milk from the cattle, perhaps some of the offspring, and the opportunity to use the draft power of the animals to cultivate their own fields. As the herd sizes (and therefore labor demands) of the wealthy cattle owners fluctuate, the Basarwa workers find themselves forced to move to the cattle posts of new employers. Land is abundant and freely available for cultivation, but it takes time (two to three years) to clear and fence an optimally-sized farm in the new location. These unpredictable employment changes, therefore, generate random variations in the income of these Basarwa households. Moreover, "the probability of moving to a new location in a given year ... is largely independent for the different households" (Cashdan, p. 471). Therefore, a substantial portion of the income risk faced by these households is idiosyncratic and can be addressed by local risk-sharing mechanisms. Cashdan reports that within a given locality, households which have been resident for longer (because they have not recently been forced to change employers) have relatively high incomes, and these households provide gifts of food to newer residents with smaller farms and incomes. The important idiosyncratic risk which is insured by this mechanism is certainly observable to all members of the community, and Cashdan implies that the probability of being forced to move is relatively exogenous to the behavior of the households. The problems of
information asymmetries within the Basarwa community, therefore, seem relatively unimportant with respect to this source of risk. Whether the insurance extends to other sources of risk cannot be inferred from Cashdan’s paper. Ethnic identity and the social costs of disengaging from the system of generalized reciprocity seem to play a crucial role in enforcing the obligation of temporarily wealthy households to transfer food to newer residents of a cattle post.

Platteau and Abraham (1987) discuss the importance of "reciprocal credit" in a risk-pooling system of fishermen in a South Indian village. These fishermen live close to the margin of subsistence, and are engaged in a very risky activity (the coefficient of variation of their daily catches exceeds unity). There is little covariation in these incomes across households in the village, so there is ample scope for insurance within the village. Insurance is effected through frequent, very small "credit" transactions within the village. The acceptance of a loan by a fisherman implicitly recognizes that he will be concerned with the future economic fortune of his creditor. Such a commitment implies that in the case that the creditor falls into distress, the borrower will not only have to return his debt immediately, but also that he must be ready to come to the help of his benefactor even if he has already succeeded in paying back his initial loan. Conversely, if the debtor again finds himself on the brink of a subsistence crisis, the creditor is expected to come to his rescue irrespective of whether or not he has cleared his first debt (Platteau, 1991, p. 151).

These credit transactions, therefore, serve to pool risk between borrowers and lenders within a small community. A similar arrangement is documented by Udry (1990), who finds that households in villages in northern Nigeria often simultaneously participate on both sides of an active credit market. The credit transactions pool risk between the borrowers and lenders through the use of contracts in which the repayment owed by the borrower depends upon the realization of random production shocks by both the borrower and the lender. A key feature of both the
south Indian and northern Nigerian examples is that the risk pooling arrangements occur within the confines of small communities within which information concerning the outcomes of, respectively, fishing and farming activities flows very freely. Moreover, in each instance the local community has access to enforcement mechanisms (primarily social pressure) with which to bring pressure on recalcitrant participants (Platteau 152; Udry 259).

The documented existence of *ex post* risk pooling mechanisms within a variety of communities in less developed countries raises the possibility that some communities may have developed insurance systems which permit the allocation of risk to approach Pareto efficiency. This line of reasoning has motivated a number of quantitative studies of risk sharing. For example, Townsend (1994) and Ravallion and Chaudhuri (1997) examine consumption outcomes rather than specific risk-pooling mechanisms in the ICRISAT Indian study villages. There is a high degree of co-movement in consumption across households within this set of Indian, despite the fact that there is a substantial amount of idiosyncratic income variation. Nevertheless, a fully Pareto efficient allocation of risk is not achieved in these villages. Deaton (1992) and Grimard (1997) examine patterns of consumption to test the hypothesis of efficient risk pooling within villages and ethnic groups, respectively, within Cote d'Ivoire. There is little evidence of any risk pooling within villages, and somewhat stronger evidence of partial risk pooling within ethnic groups. In neither case is full risk pooling achieved. Udry (1992) rejects the hypothesis that Pareto efficient risk pooling is achieved in northern Nigerian villages using the specific mechanism of reciprocal credit transactions. In every case so far examined in the literature, therefore, the hypothesis of Pareto efficient risk pooling within rural communities in poor countries has been rejected.
A fully Pareto efficient allocation of risk within local communities is rarely, if ever, achieved. Some idiosyncratic income variation generally remains uninsured. Moreover, cross-sectional risk pooling cannot contribute to households' efforts to cope with the effects of aggregate community-level shocks to income. The complementary ex post mechanism for insulating consumption from the effects of income fluctuations is consumption smoothing over time using saving and credit transactions. Consider a household with no opportunity for cross-sectional risk-pooling, but with unlimited access to a credit market. The household utility function is the same as that of equation (1), but it will be useful to rewrite (1) as (dropping the i subscripts)

\[ U_t = \mathbb{E}_t \sum_{s=t}^{T} \beta^{s-t} u(c_s) \]

to emphasize the decision problem that the household faces over time. \( U_t \) is the expected utility of the household over the remainder of its lifetime. Suppose that in any period the household can borrow or lend on a credit market with a certain interest rate \( r_t \). Let the household's asset stock at the start of period \( t \) be \( A_t \) (which is positive when the household is a lender, and negative when it is a borrower). The household receives a random income \( y_t \) and decides how to allocate its resources between consumption and net saving for the next period:

\[ A_{t+1} = (1 + r_t)(A_t + y_t - c_t). \]

The household chooses consumption to maximize \( 1' \) subject to (8), non-negativity constraints on \( c \) and the transversality condition \( A_{T+1} \geq 0 \). Note that the household can be a debtor in any but

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\[ \text{This section relies on Deaton (1992).} \]
the final period.

The period t value function for the household's problem satisfies

\[
V_t(A_t + y_t) = \max_{c_t} \left\{ u(c_t) + \beta E_t V_{t+1}((1 + r_t)(A_t + y_t - c_t) + y_{t+1}) \right\}
\]

The value of current resources (assets plus current income) is equal to the maximized value of current consumption plus the discounted expected value of resources next period. Optimization and the envelope condition imply

\[
u'(c_t) = \beta (1 + r_t) E_t u'(c_{t+1}).
\]

Saving or lending decisions are made so that the marginal utility of current consumption is set equal to the discounted expected marginal utility of next period's consumption. If the yield on assets just offsets the subjective discount rate ($\beta(1+r_t) = 1$) $\forall t$, (10) simplifies to $u'(c_t) = E_t u'(c_{t+1})$.

If we make the assumption that $u$ is quadratic, than (10) becomes

11. $c_t = E_t c_{t+1}$.

In this special case, therefore, households make consumption plans such that expected consumption is constant.\(^7\) Since $A_{T+1} = 0$, the budget constraint (3') (with $r_t$ constant at $r$) implies that the discounted value of consumption from any time $t$ to $T$ equals the value of the household’s assets at $t$ plus the discounted value of its income stream from $t$ to $T$. If we combine this result with (11) and let $T$ go to infinity we arrive at the permanent income hypothesis:

12. $c_t = \frac{r}{1+r} \left( A_t + E_t \sum_{\tau=t}^{\infty} (1+r)^{-\tau-t} y_{\tau} \right)$.

Current consumption, therefore, is the annuity value of current assets plus the present value of the

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\(^7\)In the language of stochastic processes, consumption follows a martingale.
expected stream of future income.

If the permanent income hypothesis is valid, then, how will household consumption respond to random variations in household income? The answer depends on the information associated with the income shock. The change in consumption will be equal to the annuity value of the present value of the change in the expected stream of future income. If the income shock is transitory, and there is little or no change in the household's expectations concerning its future income stream then consumption will change little in response to the income shock. If the income shock causes a large change in the household's expectations concerning its future income stream then the income shock will be seen as permanent and consumption will change dramatically in response to the income shock.

There is good evidence from a variety of studies that households engage in a substantial degree of consumption smoothing. A particularly interesting study is Paxson (1992), which uses deviations of rainfall from its average level to identify transitory income shocks affecting Thai rice farmers. She uses these estimates to calculate the marginal propensity to save transitory income, and finds that these farmers save three-quarters to four-fifths of transitory income changes. This is less than the marginal propensity to save of one which is predicted by the permanent income hypothesis, but it is strong evidence of significant intertemporal consumption smoothing. Despite evidence of consumption smoothing using saving and credit transactions, the permanent income model can generally be rejected for households in all parts of the world. Microeconomic data

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8 It should be noted that Paxson does not reject the null hypothesis that the marginal propensity to save does equal one. However, she does reject the implication of the permanent income hypothesis that the marginal propensity to save out of changes in permanent income should be zero - she finds that this marginal propensity is positive.
from the U.S. and Japan indicates that even in these countries consumers are often liquidity constrained (Hayashi 1987). As we have seen in chapter 7, there are strong reasons to believe that rural households in developing countries do not have access to perfect credit markets. Morduch (1992) finds evidence of borrowing constraints strongly affecting the behavior of relatively poor households in a set villages in semi-arid India. Moreover, he finds that the households which seem to be liquidity constrained engage in less risky production activities than unconstrained households. Using data from a broader set of Indian villages and different econometric techniques, Rosenzweig and Binswanger (1993) also find evidence of limitations on households' *ex post* smoothing capabilities. They show that wealthier households, less constrained in their ability to absorb income variability, invest in significantly more risky production activities and earn significantly higher mean returns from these activities than poorer households. The inability of poorer households to completely insulate their consumption from income risk, therefore has adverse consequences for both the distribution of income and productive efficiency.

Deaton (1991) shows that even if households have no access to a credit market at all, they may still be able to achieve a high degree of intertemporal consumption smoothing through the use of assets as buffer stocks. As long as the household has positive saving, temporary income shortfalls can be smoothed through dissaving and short-term windfalls can be saved. However, once the household's wealth falls to near zero, the possibility of further smoothing shrinks and consumption can become quite volatile. This pattern has been noted in the extensive literature on famines, in which it is observed that famines often occur only after a succession of weather failures, or after people's savings are wiped out through other means (Watts, 1983; Ravallion,
1997). If the assets which are used to buffer consumption from income fluctuations are themselves used in the production process, then there can be important effects on future income from even temporary shocks to current income. This is one of the bases of Polly Hill's (1977) observation that farming households can be "too poor to be efficient" and is explored more formally by Rosenzweig and Wolpin (1991). They observe that bullocks are often purchased and sold to smooth consumption when income fluctuates in a sample of rural households in India. However, bullocks play an important role in the production process of these farm households. In order to mitigate the effects on consumption of a transitory decline income, a household might sell off a bullock. However, the household's farm profit in the next year would be lower as a consequence of the loss of this productive asset. Udry (1995) shows that as long as a household has stocks of an asset which is not used in production, this asset will be used to smooth consumption. However, once this asset is drawn down near zero, as for instance after a succession of bad harvests, then assets used in production may be sold in order to smooth consumption. Rosenzweig and Wolpin (1985), for example, show that households subject to two consecutive years of drought are 150% more likely to sell land.

IV

How does the consumption pattern of households which smooth consumption over time through credit markets compare with that discussed in section A, when the household has access to complete risk pooling? When there is complete risk pooling, the household's consumption

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9 This may be a reason that households in Burkina Faso resisted selling their inventories of livestock to smooth the dramatic loss of income during the Sahelian drought of the 1980s. See Fafchamps, Udry, Czukas (1998).
responds only to average community consumption. Holding community consumption constant, a
shock to a household's own income, whether transitory or permanent, has no affect on household
consumption. We made the additional assumption that the community had no access to credit
markets, and also that no goods were stored. With this assumption, community income equals
community consumption in each period. Therefore, even a transitory shock to community income
causes the household to change its consumption. In contrast, where there is no risk pooling but
the household has access to a perfect credit market, community income is irrelevant to the
household's consumption decision, but consumption will vary with changes in the household's
permanent income.

It can be seen, therefore, that consumption smoothing through insurance and consumption
smoothing through transferring resources over time are conceptually very distinct. However, it
may be difficult to distinguish the two models by examining the relationship between household
consumption and household and village income. Both the permanent income model and the full
insurance model imply that changes in household income may have only a small correlation with
changes in household consumption. This result would occur if the household has access to full
insurance and its income is not highly correlated with village income, and it would occur if the
household is smoothing consumption intertemporally if the variations in its income are
predominantly due to transitory shocks. Furthermore, both the permanent income model and the
full insurance model would imply that household consumption might be highly correlated with
village consumption and uncorrelated with transitory shocks to household income if these
transitory shocks are largely uncorrelated across households in the village, while permanent

\[10\] The following argument is drawn from Paxson and Alderman (1992).
shocks to households' incomes are largely common to the whole village.

Deaton and Paxson (1994) provide a simple method for distinguishing economies well-characterized by intertemporal consumption-smoothing from those characterized by an approximately Pareto-efficient allocation of risk. The idea is to examine the distribution of consumption of a cohort of people over time. In a Pareto-efficient allocation characterized by equation (7), this distribution will remain stable over time: all idiosyncratic risk has been insured. If the permanent income hypothesis is approximately true, the distribution of consumption will broaden (see equation 12) as different individuals over time receive different news concerning their future income prospects.

We have presented the insurance and intertemporal smoothing mechanisms as though they are mutually exclusive. Of course, this is not true. If both borrowing and lending in a perfect capital market and insurance within the village are possible, then household consumption will still depend only on average consumption within the village, but village consumption can deviate from village income. The village-level analogue to the permanent income hypothesis will imply that village consumption as a whole (and therefore household consumption) will have little responsiveness to transitory shocks to village income. Household consumption will change only in response to variations in the permanent income of the village.

If consumption smoothing is possible through either or both of these two *ex post* avenues, then risk averse households will act in some other respects as if they were risk-neutral. In particular, variants of the neoclassical separation theorem will hold. For example, consider again the situation of a Pareto efficient allocation of risk within a community. Suppose that production is possible. Labor is inelastically supplied, but current output must be invested in order to
produce next year. Consumption and income now depend on the history of past realized states, because investment creates a link across periods. The notation must be enriched to permit this dependence (see footnote 4), so household i’s income in state s of period t after a history of states through period t-1 (h_{i,t-1}) is

13. \( y_{ist}(h_{t-1}) = g_i(s, k_{i,t-1}(h_{t-1})). \)

g_i() is a production function with \( \frac{\partial g_i}{\partial k_i} > 0 \) and \( \frac{\partial^2 g_i}{\partial k_i^2} < 0 \). The capital invested on i’s farm in period t-1 (in order to produce output in period t) depends on the history of states realized up to and including period t-1. Naturally, the resource constraints (3) must be modified to reflect the commitment of current resources for future production:

3’. \[ \sum_{i=1}^{N} \kappa_i(h_{t-1}) = \sum_{i=1}^{N} [y_{ist}(h_{t-1}) - c_{ist}(h_{t-1})]. \]

The first order conditions for the Pareto program now imply that the investments made in period t-1 for production in period t satisfy

14. \[ \sum_{s} \lambda_s(h_{t-1}) \frac{\partial g_i(s,k)}{\partial k_{i,t-1}(h_{t-1})} = \sum_{s} \lambda_s(h_{t-1}) \frac{\partial g_i(s,k)}{\partial k_{i,t-1}(h_{t-1})} \]

where \( \lambda_s(h_{t-1}) \) is the Lagrange multiplier corresponding to the resource constraint (3’) in state s of period t after history t-1. \( \lambda_s(h_{t-1}) \) is the increment in the value of the Pareto program resulting from an increase in resources in state s of period t, so (14) implies that the marginal value of investment in period t-1 (weighted over the S states which might occur in period t) is equated
across households. Investment, therefore, is determined entirely by considerations of productive efficiency and the separation theorem holds. In particular, differences in risk aversion or wealth levels across households have no effect on the allocation of investment in a Pareto efficient allocation. This result can be put into even more stark form if we assume that \( y_n(h_{t-1}) = \theta g_t(k_{t-1}(h_{t-1})) \) so that production risk is characterized by a simple multiplicative factor. In this case, (14) becomes

\[
14'. \quad \frac{\partial g_t(k)}{\partial k_{t-1}^j(h_{t-1})} = \frac{\partial g_t(k)}{\partial k_{t-1}^j(h_{t-1})}
\]

and the marginal product of investment is equated across all households.

The same result is obtained if the PI hypothesis is true and all production risk is transitory. Therefore, if either cross sectional or time series \textit{ex post} smoothing mechanisms exist and are effective, the neoclassical separation theorem holds and production decisions do not depend on the preferences of individual households. It is clear, therefore, that a successful \textit{ex post} smoothing strategy has a dramatic effect on household behavior. We have seen that there is evidence from a wide variety of studies that households in poor, risky agrarian environments engage in both cross-sectional risk pooling and consumption-smoothing over time. However, there is equally good evidence that these strategies are not wholly successful. The information and enforcement difficulties associated with both insurance and credit transactions frustrate households' efforts to insulate their consumption from income shocks. Given the lack of access to complete and smoothly-operating insurance and credit markets, households devote substantial resources to stabilizing the incoming stream of income in order to protect themselves from the dire consequences of substantial income fluctuations.

May 29, 1998 18
V

When the *ex-post* mechanisms for mitigating the adverse consequences of income fluctuations fail, risk averse households invest in *ex-ante* means of reducing income fluctuations. Much of the rest of this book is concerned with some of the strategies used by households to ensure that their incomes do not fluctuate too severely. The effects of this imperative are felt throughout the economies of poor countries. For example, new technologies which have positive (but uncertain) expected profits might not be adopted, or might be adopted more slowly (see, for example, the discussion of the adoption of the spread of new technologies for grain production in Semi-Arid Africa in Sanders, Shapiro and Ramaswamy, 1996). Farmers might use conservative agronomic practices which lower risk and expected return, such as by planting low-yielding but rapidly maturing varieties of crops to minimize the probability that rainfall shortages will cause crop failure, or by planting multiple crops on widely dispersed fields. Households might work in a diverse range of activities rather than specialize in a single profit-maximizing business in order to diversify some of the income risk. Households might spread their members across space through migration or marriage in order to reduce the variance of aggregate household income. Or households might agree to the use of contracts (such as sharecropping) which provide poor incentives for producing profit-maximizing levels of output but which reduce the variance of income.\(^\text{11}\) All of these measures reduce expected profits, but also reduce the variance of income.

The effect of imperfect ex-post consumption smoothing on production decisions can be seen with a simple modification of the model presented in section B. Suppose that households

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\(^{11}\)Dasgupta (1993, chapters 8 and 9) provides a review of much of the relevant literature on these and similar mechanisms.
face a liquidity constraint such that in any period $A_t + y_t - c_t \geq 0$. In addition, suppose that farmers 
face a portfolio choice (think of it as a choice about how much acreage to allocate to each of two 
different crops) between two activities, one of which is more risky than the other. In particular, 
let period $t$ income be determined by the realization of a zero mean i.i.d. shock $\epsilon_t$ and the 
previous-period portfolio choice $x_{t-1}$, so that $y_t = y(x_{t-1}, \epsilon_t)$. $\partial y_t / \partial \epsilon_t > 0$, and the portfolio choice is 
such that $\partial y_t / \partial x_{t-1} > 0$ if $\epsilon_t > 0$ and $\partial y_t / \partial x_{t-1} < 0$ if $\epsilon_t < 0$. In good times, choosing more of the risky 
activity increases output, while in bad times choosing more of the risky activity reduces output. $x$ 
is costless, so if the household is maximizing expected income it will choose $x_{t-1}$ such that 
$E_{t-1} \partial y_t / \partial x_{t-1} = 0$.\textsuperscript{12}

The period $t$ value function for the household now satisfies (compare with equation (9)):

$$
V_t(A_t + y_t) = \max_{c_t, x_t} \left[ u(c_t) + \beta E_t V_{t+1}((1+r_t)(A_t + y_t - c_t) + y(x_t, \epsilon_{t+1})) + \lambda_t(A_t + y_t - c_t) \right],
$$

where $\lambda_t$ is the Lagrange multiplier corresponding to the liquidity constraint in period $t$.

Consumption in period $t$ will be chosen to satisfy

$$
\ u'(c_t) = E_t \beta (1+r_t) V_{t+1}((1+r_t)(A_t + y_t - c_t) + y(x_t, \epsilon_{t+1})) + \lambda_t'
$$

with complementary slackness holding between $\lambda_t$ and $(A_t + y_t - c_t)$. By the envelope property, $x_{t-1}$ 
will satisfy:

$$
E_{t-1} \frac{dV_t(\cdot)}{dx_{t-1}} = E_{t-1} u'(c_t) \frac{\partial y}{\partial x_{t-1}} = 0.
$$

\textsuperscript{12}This is the specification used by Morduch (1992).
Substituting (16) for $u'(c)$, we have

\begin{equation}
E_{t-1} \left[ \beta (1 + r) V'_{t-1}(c) + \lambda_t \right] \frac{\partial y}{\partial x_{t-1}} = 0.
\end{equation}

So if $\lambda_t = 0$ in all states of period $t$, so that the individual knows that the liquidity constraint will not bind in period $t$, then $x_{t-1}$ is chosen so that

\begin{equation}
E_{t-1} V'_{t-1}(c) \frac{\partial y}{\partial x_{t-1}} = 0.
\end{equation}

On the other hand, if $\lambda_t > 0$ for some states of period $t$, then $x_{t-1}$ is chosen so that

\begin{equation}
\beta (1 + r) E_{t-1} V'_{t-1}(c) \frac{\partial y}{\partial x_{t-1}} = -E_{t-1} \lambda_t \frac{\partial y}{\partial x_{t-1}} > 0,
\end{equation}

where the latter inequality holds because the liquidity constraints bind ($\lambda_t > 0$) in low income states of period $t$ ($\epsilon_t < 0$), and in those states $\partial y/\partial x_{t-1} < 0$. Therefore, the expected marginal utility of undertaking the risky activity must be larger - and thus the level of risk taking must be lower - when the liquidity constraint might bind than when it is known that it will not bind.

It is to be expected that poorer households are more likely to be subject to binding liquidity constraints. These households, therefore, will chose a more conservative portfolio of activities than richer households. Poorer households will chose activities which reduce the variance of their incomes, but which also have lower expected incomes than the activities chosen by wealthier households.
References


Sanders, John; Shapiro, Barry; Ramaswamy, Sunder (1996): The Economics of Agricultural Technology in Semiarid Sub-Saharan Africa. Johns Hopkins University, Baltimore.


