SIMULATING THE IMPACT OF POLICY UPON CHRONIC AND TRANSITORY POVERTY IN RURAL PAKISTAN

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SUMMARY

Anti-poverty programs often seek to improve their impact by targeting households for assistance according to one or more criteria. Since such targeting criteria are often based upon measurements of welfare in a single time period, they tend to be chosen to provide an indication of the long-run level of welfare. However a growing literature shows the importance to poor households of fluctuations in their welfare from month to month and year to year. This paper measures the extent to which poverty is caused by fluctuations in welfare as well as the long-run level of welfare, using the IFPRI household food security panel which tracked 686 households from rural Pakistan between 1986/76 to 1990/91. The article compares the poverty impact of policies designed to increase mean incomes ('growth' policies) and those designed to even out fluctuations of income over time ('smoothing policies') after making an explicit adjustment for measurement error. Since the majority of poverty in our sample is transitory, large reductions in poverty can be achieved by interventions designed to 'smooth' incomes, but reducing chronic poverty in the long-term will require large and sustained growth in household incomes. The income generation process is then modelled as a function of household characteristics and the resulting model is used to estimate the poverty impact of a range of interventions including transfer policies and measures designed to build human and physical capital.

I INTRODUCTION

Anti-poverty programs often seek to improve their impact by targeting households for assistance according to one or more criteria. Such targeting criteria are often based upon measurements of key welfare indicators, such as income, in a single time period. This can result in the inclusion within the target group of transitorily poor households who are suffering from temporary misfortunes but who would not be considered poor when judged according to their permanent income. Similarly, chronically poor households, whose long-run income falls below the poverty line, may be excluded from the target group due to temporary good fortune.

A growing literature shows the importance to poor households of such fluctuations in their welfare from month to month and year to year.[1] Where consistent measures of household welfare are available for more than one period, it is possible to quantify the extent to which poverty is caused by *fluctuations* in welfare (transitory poverty) as well as low *levels* of welfare in the long-term (chronic poverty) [Jalan and Ravallion, 1998]. The relative size of chronic and transitory poverty is clearly of importance to policymakers since the interventions appropriate for reducing transitory poverty may be quite different from those needed to combat chronic poverty.

This paper uses a five-year panel of 686 households to investigate the magnitude of chronic and transitory income poverty in rural Pakistan. Income fluctuations at the household level are shown to remain an important part of overall poverty even after potential measurement error in the income variable is, at least partially, accounted for. The impact of two types of stylised policy simulations (those designed to smooth incomes over time, and those designed to promote income growth) on the severity of chronic and transitory poverty is then examined together with the effect of certain transfer policies and measures designed to build human and physical capital. These simulations show that interventions which enable households to smooth their incomes over time might achieve large reductions in transitory poverty, while certain transfer and investment policies could substantially reduce both chronic and transitory poverty. However, the redistribution of physical assets (land and livestock) would have relatively small impacts on either chronic or transitory poverty in the study area.

The next section describes the methodology we use to estimate the chronic and transitory poverty paying special attention to the extent to which these estimates are inflated by measurement error in the welfare variable (equivalised income). It also details the impact of different levels of smoothing of incomes on aggregate chronic and transitory poverty. The following section describes the study area, data and the derivation of our poverty line. This is followed by presentation of our policy simulations and the assessment of the efficacy of transfer and investment policies in reducing poverty. A final section concludes.

II METHODOLOGY

When defining aggregate chronic and transitory poverty we have adopted the decomposition proposed by Jalan and Ravallion [Jalan and Ravallion, 1998]. They define household poverty as:

$$P_i = P(y_{i1}, y_{i2}, \ldots, y_{iT}) \qquad (1)$$

where y_{it} is a measure of household i's welfare (which it may be useful to think of as income) at time t, and there are T periods in which it is measured. P is some well defined poverty measure, such as those in the Foster-Greer-Thorbecke class of poverty measures [Foster, *et al.*, 1984]. Thus using the squared poverty gap measure, they define household total poverty P_i as the expectation over time of the poverty measure at each point in time p_{it}.

$$P_i = \frac{1}{T}\sum_{t=1}^{T} p_{it} \qquad (2)$$

where p_{it} is

$$p_{it} = \begin{cases} \left(\frac{z - y_{it}}{z}\right)^{\alpha} & \text{if} \quad y_{it} < z \\ 0 & \text{if} \quad y_{it} \geq z \end{cases} \qquad (3)$$

z is the poverty line, and the value of α is a measure of inequality aversion.[2]

A household's chronic poverty is then defined to be:

$$C_i = P(E_t(y_{it})) \qquad (4)$$

that is the poverty associated with the household's mean income over the T periods. This can be written as the expectation over time of the household's chronic poverty at each point in time c_{it}, but since the household's chronic poverty does not change over time, $C_i = c_{it}$ where:

$$c_{it} = \begin{cases} \left(\frac{z - E_t[y_{it}]}{z}\right)^{\alpha} & \text{if} \quad E_t[y_{it}] < z \\ 0 & \text{if} \quad E_t[y_{it}] \geq z \end{cases} \qquad (5)$$

and $E_t[y_{it}]$ is the expected value over time of the income of household i. The transitory poverty of household i, T_i is then defined to be the residual $P_i - C_i$.

The Jalan and Ravallion measures of chronic and transitory poverty can be used with any continuous monotonic welfare variable with consumption expenditure or income being the most commonly used variables. There has been considerable debate over whether consumption expenditure or income represent the better measure of welfare (see [Ravallion, 1992] for some of the arguments). In determining the balance between policies designed to increase the level of welfare and those designed to cushion welfare shocks, practical policy will obviously want to take into account the extent to which households already have access to means of consumption smoothing – consequently whenever this information is available it makes more sense to use consumption expenditure in such circumstances. Unfortunately, in the Pakistan panel we use for these calculations, consistent and reliable information on households' expenditures were only collected for three out of five years. In contrast information on incomes were collected for all five years of the panel, so we restrict our attention to estimates of chronic and transitory poverty using equivalised incomes as the welfare measure.

The calculation of transitory poverty using income as the welfare measure tends to result in higher levels of poverty being found than the same calculation using consumption.[3] The reason for this is that income tends to be considerably more volatile than consumption and the expected value of poverty rises with the riskiness of the welfare indicator (see [Ravallion, 1988] for a comprehensive analysis of expected poverty under risk-induced welfare variability).

However, income also tends to be more variable than consumption because of measurement error. While consumption expenditures are also susceptible to

measurement error, the manner in which many surveys in developing countries are undertaken tend to mean that consumption is more accurately measured than income.[4] In developed country datasets, measurement error in income typically arises due to a tendency for respondents to under-report their true income because of concerns about use of the data for taxation assessment purposes. In developing countries taxation systems tend to be less well developed and so measurement error more often results from the difficulties of accounting for the imputed value of own-account production. Consequently we should be concerned that some of the additional poverty measured using income as the welfare variable may simply be the result of contamination of the welfare measure with measurement error.

To illustrate, consider a 'true' income variable y^* to which a measurement error m has been added to yield to observed income variable y. i.e. $y = y^* + m$.[5] Let y^* have mean μ_{y^*} and variance $\sigma^2_{y^*}$ and let the measurement error have a zero mean, variance σ^2_m and be uncorrelated with the 'true' income. The variance of the observed income variable, σ^2_y, is then simply the sum of the true income variance and the variance of the measurement error.

In surveys in which both consumption and income data have been collected it is possible to construct an estimate of the extent of measurement error by exploiting the fact that consumption and income tend to be well correlated and therefore can be used as instruments for each other in econometric models.[6] We therefore construct a simple model in which the 'true' real adult equivalent income of household i in year t (i.e., uncorrupted by measurement error), y^*_{it}, is a function only of its value in the previous year – that is:

$$y^{*}_{it} = \rho y^{*}_{i,t-1} + \varepsilon_{it} \qquad (6)$$

where ε_{it} is an error term which is assumed to be uncorrelated with past income. If income is measured with error, then estimating this model using measured income will yield an estimate of ρ that is biased towards zero by $\left(1-\frac{\sigma^2_m}{\sigma^2_y}\right)$ where σ^2_m is the variance of the measurement error and σ^2_y is the variance of observed income. However, an unbiased estimate of ρ can be obtained by estimating the model using consumption in year t-1 as an instrument for measured income; $\left(\frac{\rho_{IV}-\rho_{OLS}}{\rho_{IV}}\right)$ then provides an estimate of the 'noise-to-signal' ratio σ^2_m/σ^2_y. We estimate this ratio using both consumption and lagged income as instruments in order to obtain an indication of the magnitude of measurement error.

Once an estimate of the extent to which measured income is contaminated with measurement error has been obtained, it is necessary to estimate how it affects our calculations of chronic and transitory poverty. Since the measurement error is, by its nature unknown, it is not possible merely to 'undo' its affects. However, it is possible to construct an adjusted income variable which shares the same estimated mean as the true income variable but has the estimated variance of the true income variable rather than that of the observed income. The adjusted income variable is:

$$a_{it} = \bar{y}_i + \left(y_{it} - \bar{y}_i\right)\left(\frac{\sigma_{y^*}}{\sigma_y}\right) \qquad (7)$$

where $\bar{y}_i$ is the inter-temporal mean of the observed income of household i and σ_{y^*} is the standard deviation of "true" income. Under the assumption above that the measurement error has a zero mean, the expected value of $\bar{y}_i$ is equal to the expected value of true income; deviations from this expected value are scaled by the estimated ratio of the standard deviation of true income to the standard deviation of observed income. Calculating chronic and transitory poverty measures using adjusted income can therefore give an indication of the extent to which our estimates of poverty are inflated by the presence of measurement error.

The Impact of Policy upon Chronic and Transitory Poverty

After taking into account the influence of measurement error, it is possible to simulate the impact of different policies upon chronic and transient poverty using Jalan and Ravallion's measure of aggregate intertemporal poverty. Initially, we focus on two broad categories of policies, those designed to raise the mean incomes of households ('growth promoting policies') and those designed to even out their fluctuation over time ('smoothing policies'). Growth policies may be thought of as policies which aim to reduce poverty by producing distributionally neutral growth in household incomes.[7] They would include sectoral investments in human and physical capital not targeted at specific sections of the population. Smoothing policies would include measures such as safety nets, micro-credit and insurance schemes that are designed to 'smooth' the incomes of the poor.[8]

For growth promoting policies the simulation can be done simply by considering the impact of increasing the real adult equivalent income of all households. We therefore

look at the impact upon chronic and transitory poverty of applying arbitrary increments of 10 per cent to adjusted income ranging from zero to 50 per cent as follows:

$$a_{it}^{new} = (1+g).a_{it}^{old} \qquad (8)$$

where *g* is the percentage shift in household i's adjusted income.[9]

For smoothing policies, a set of simple moving average filters is applied to the intertemporal adjusted income of each household. These allow us to assess the possibility of households being able to smooth their incomes (with no change in their overall mean) over different numbers of years. It may be helpful to explain the moving average filters used in our simulations sequentially. First consider the introduction of a policy which allows households to smooth their incomes such that their new set of incomes over time is the average of their current income and the income of the previous year. This means that we replace our T period series of income measures for each household with a set of T-1 two-period averages of income. Next consider an intervention which allows households to smooth over three periods, creating a set of T-2 three-period averages of income. This can be continued until we have complete smoothing with a single value for each household equal to the inter-temporal average of income for the duration of the panel. That is

$$a_{it}^{s} = \frac{1}{s}\sum_{j=0}^{s-1} a_{i,t-j} \qquad (9)$$

where a_{it}^{s} is the smoothed income series and s is the number of periods over which income is smoothed.

Clearly such smoothing will reduce transitory poverty by reducing the size of income fluctuations as well as preventing incomes falling below the poverty line for some households. Jalan and Ravallion's aggregate measures of total, chronic and transitory poverty can also be redefined to incorporate such smoothing as follows:

$$P_i = \frac{1}{T-s+1}\sum_{t=s}^{T} p_{it}^{s} \qquad (10)$$

which is the same as equation (2) except that the expectation over time is of p^{s}_{it}, the total poverty of household i in period t after income has been smoothed for s periods.[10] The total poverty of household i in period t after income has been smoothed for s periods can then be written as:

$$p_{it}^{s} = \begin{cases} \left(\frac{z - a_{it}^{s}}{z}\right)^{\alpha} & \text{if} \quad a_{it}^{s} < z \\ 0 & \text{if} \quad a_{it}^{s} \geq z \end{cases} \qquad (11)$$

where a^{s}_{it} is defined in equation (9) above.

The chronic poverty of household i after s periods of income smoothing is exactly as described by equation (5) above except that the expectation over time is of a^s_{it} instead of y_{it}. That is:

$$C_i = c_{it} = \begin{cases} \left(\frac{z - E_t\left[a^s_{it}\right]}{z} \right)^{\alpha} & \text{if} \quad E\left[a^s_{it}\right] < z \\ 0 & \text{if} \quad E\left[a^s_{it}\right] \geq z \end{cases} \tag{12}$$

and the expectation over time of smoothed income is taken over the reduced length income series

$$E_t[a^s_{it}] = \frac{1}{T - s + 1} \sum_{t=s}^{T} a^s_{it} \tag{13}$$

Transitory poverty may then again be calculated as the residual $T_i = P_i - C_i$. In the simulations reported below, we calculate the reduction in total, chronic and transitory poverty for different lengths of smoothing period s.

Smoothing incomes using even a two-year moving average filter constitutes a very high level of intertemporal transfers. It would therefore be useful to design a filter which could capture different degrees of income smoothing. The simplest way to do this is to amend equation (9) above by using two-period smoothing with a smoothing parameter γ. The income series, $a_{it}{}^s$, smoothed over two periods can be written as:

$$a^s_{it} = \frac{a_{i,t} + \gamma . a_{i,t-1}}{1 + \gamma} \tag{14}$$

When $\gamma=0$ there is no smoothing whereas when $\gamma=1$ we have perfect two period smoothing. Thus by varying γ between zero and one, it is possible to simulate different degrees of income smoothing.[11]

In the simulations reported below, we explore the reductions in total, chronic and transitory poverty that would result from different degrees of smoothing (i.e. different values of γ) over just two time periods. The reductions from such smoothing policies are then compared with the reductions arising from interventions intended to raise mean incomes via (distributionally neutral) growth. Strictly this comparison requires a measure of the costs of pursuing growth promoting and income smoothing policies. However, in the absence of reliable data on such costs, we assume that both growth and smoothing policies may be achieved costlessly. Clearly this is an unrealistic assumption, but the differential impact of adopting these two types of policies are so stark, that we believe this is still a useful, illustrative exercise.

The income growth and income smoothing simulations, while useful, are clearly rather stylised. It is also possible to simulate the impact of a set of transfer policies that aim to transfer productive assets (such as land, livestock or human capital) to the poor, policies such as those affecting household composition, education, and access to key productive assets. In order to do this it is necessary to model the process of income determination. Because we are interested in both chronic and transitory poverty, we estimate two related models: firstly a regression of the inter-temporal mean of each households' income against a variety of household characteristics (including geographical, demographic, educational and asset variables) is performed to understand the relative influence of different characteristics on the average level of income; secondly the inter-temporal

standard deviation of income is regressed against the same set of characteristics in order to understand their influence upon fluctuations in income. The models are described in the section on results below.

The resulting econometric models were then used to calculate the predicted mean income and its standard deviation for each household given its characteristics. These were used to modify the mean and standard deviation of adjusted income for each household in a similar manner to the way in which real income was adjusted for measurement error in equation (7). The resulting income series was then used to calculate chronic and transitory poverty. A set of interventions involving various transfer and investment policies were then simulated to examine how aggregate chronic and transitory poverty would be affected.

III THE IFPRI PAKISTAN PANEL

The data set used in this paper is taken from a panel data survey of around 800 households in 52 villages in rural Pakistan conducted by the International Food Policy Research Institute (IFPRI) between July 1986 and October 1991. Each household in the survey was interviewed a total of fourteen times between these dates, although due to the uneven spacing of visits it has only been possible to construct a panel for five annual rounds. Data collection took place in three provinces: Punjab, Sind and North-West Frontier Province (NWFP), and within each Province in one purposively sampled least developed district (Attock in Punjab, Badin in Sind and Dir in NWFP). In Punjab, a second more prosperous district, Faisalabad was also included in the panel as a control. Originally, the IFPRI team had also planned to include one least developed district

(Kalat) from Pakistan's fourth province, Baluchistan, but survey work had to be suspended in this district after one year due to 'special logistic conditions in that province' [Adams and He, 1995]. So the final sample that we have available contains households from 52 villages in four districts and three provinces. It should be stressed that this sample cannot be regarded as representative of Pakistan, but, with the exception of Faisalabad, may be representative of poor rural areas within Pakistan.

The IFPRI survey collected information on households' composition and characteristics, their land ownership and use, crop production and distribution together with asset ownership. A specific concern of the study was to document rural households' sources of income and the factors driving changes in income inequality [Adams and He, 1995]. Unfortunately, although detailed information on household expenditures were collected during the first three years of the panel, the procedures used to collect information on expenditure in the last two years of the panel are not comparable to those in the previous three years. Estimating consumption expenditures accurately for the panel is also problematic because different rounds of the survey used different recall periods even within its first three years. So our attention in this paper is restricted to poverty measures based on equivalised incomes.[12] A number of studies using the first-three years of the panel [Alderman, 1996; Gillani, 1996] have found that the study households experience difficulties in smoothing consumption (especially after repeated shocks) and very little risk-sharing occurs between individuals who are not related even within villages. So our use of income as a long-term welfare measure, while imperfect, may be less problematic than in other developing country settings. In addition, we take explicit account of measurement errors in income when estimating the extent of chronic and transitory poverty in the panel.

In contrast to consumption expenditures, we are able to 'track' the incomes, assets and household characteristics of 686 household over all five years of the sample. Together with its geographical coverage this places the IFPRI panel in between the large-scale panels constructed from national sample surveys in China, Ethiopia and India with 3,000 or more households, and smaller micro-panels constructed for specific studies such as the ICRISAT panel in southern India, Muller's [1997] work in Rwanda, [Kinsey *et al.*, 1998] in Zimbabwe, and [Scott and Litchfield, 1994] in Chile. It is also important to recognise that unlike many data sets described as panels (including the majority of the World Bank's Living Standard Measurement Studies), the IFPRI panel allows for households to be tracked between more than two points in time. This enables the comparison of policies designed to increase average incomes with those designed to smooth incomes over different lengths of time – which is done later in the next section.

The means and standard deviations of adult equivalent income and the household composition, educational and asset variables used in our subsequent analysis are shown in Appendix 2. It will be noted that equivalised incomes decline over the five-years of the panel reflecting a general increasing trend in rural poverty in Pakistan during the period [UNDP Pakistan, 1999; UNDP, 1998]. This trend is, however, likely to be accentuated due to ageing and lifecycle effects increasing household size (itself reflecting the rising proportion of children under 6 and between 6 and 15) in our panel households. While land ownership is quite stable, there is some tendency for accumulation of other assets such as jewellery and vehicle ownership.

All previous studies using the IFPRI Pakistan panel have used a relative poverty line set equal to the bottom quintile of the distribution of either incomes or consumption expenditures [Alderman and Garcia, 1993; Adams and He, 1995]. Although this differs from the way in which the Pakistan Household Income and Expenditure Survey sets its poverty line, the adoption of a relative poverty line may be justified in two ways.[13] First, there is no clear basket of goods to use within the sample districts/villages for constructing a poverty line using the cost of basic needs method. Second, when the alternative food energy intake method is used, the level of expenditure required for an individual to acquire Kcal 2,100 per day turns out to be remarkably similar to the bottom quintile of the per capita consumption distribution. Furthermore, as Alderman and Garcia argue, in the first three years of the panel the consumption and income distributions of the panel are so well correlated that the cut-offs from their distributions may be used interchangeably. Our poverty line was therefore set equal to the bottom quintile of the per adult equivalent income distribution in the first year of the panel – a figure of Rupees 2,000 per adult equivalent unit.

IV RESULTS

We present our results in three sections: first we show the relative magnitude of chronic and transitory poverty; second the relative impact upon poverty of policies to promote income growth and policies to facilitate income smoothing are explored; and, finally the poverty impact of a variety of transfer and investment policies is described.

The Magnitude Of Chronic And Transitory Poverty

It is useful to start by exploring the extent to which households experience chronic and transitory poverty. One way in which this can be done is to look at the number of

households experiencing poverty. Table 1 shows the number of years households experienced poverty during the five year period of the panel. Note that these years are not necessarily consecutive – for example, a household experiencing three years of poverty during the five year period might experience them in the first, fourth and fifth years of the survey. Table 1 shows that almost 60 per cent of the households in the panel have some experience of poverty. However, a quarter are only in poverty for one year whilst over a third are in poverty for two or more years. Only 3 per cent of the sample households had incomes below the poverty line in all five years of the panel.

Table 1: Number of Households Experiencing Different Periods of Poverty

Number of years in poverty	**Number of households**	**Percentage of households**
0 (i.e. never poor)	290	42 %
1	163	24 %
2	100	15 %
3	68	10 %
4	47	7 %
5 (i.e. always poor)	18	3 %

Note: There are 686 households in the survey. Percentages do not add up to 100 per cent due to rounding.

Table 1 suggests that income poverty is predominantly transitory. To examine this further we calculated aggregate total, chronic and transitory poverty using the Jalan and Ravallion measures described in Section II. The results are shown in Table 2.

Table 2: Total, Chronic and Transitory Poverty using Observed Income

	Total Poverty	Chronic Poverty	Transitory Poverty
α=0 (Headcount)	0.249	0.152	0.097
α=1 (Poverty Gap)	0.082	0.031	0.051
α=2 (Squared Poverty Gap)	0.051	0.009	0.042

The total poverty headcount is 25 per cent – this is the average percentage of households below the poverty line during the five years of the panel. About 15 per cent of households have average incomes below the poverty line; the remaining 9 per cent of 'headcount poverty' resulting from households with average incomes above the poverty line who temporarily fall into poverty. The proportion of the total poverty gap accounted for by transitory poverty is greater since the gap between households' average income and the poverty line is 3 per cent of the poverty line, but the average shortfall below the poverty line is 8 per cent of the poverty line – the remaining 5 per cent resulting from the variability of income.[14] Similarly with the squared poverty gap, transitory poverty constitutes over 80 per cent of total poverty. Thus if one is particularly concerned with the poorest of the poor, Table 2 appears to show that most of the squared poverty gap results from fluctuations of income rather than average income levels.

To what extent is the dominant role ascribed to transitory poverty resulting from errors in the measurement of income? To assess this the simple autoregressive model of income described in the Section II was estimated; the same model was then re-estimated using consumption as an instrument using the first three years of the panel. The parameter estimates on lagged income from the two regressions were then combined to provide an estimate of the ratio of the variance of measurement error to the variance of income of 0.43.[15] Given that the variance of observed income is equal to the sum of the variance of 'true income' and the variance of measurement error, a value of 0.43 indicates that the variance of measurement error is around three-quarters of the variance of the true income indicator. Thus measurement error is playing an important role in inflating the estimates of the transitory poverty using observed income in Table 2.

The income variable was scaled in the manner described in the Section II in order to produce an adjusted income variable with the same mean but with variance equal to the estimated variance of the true income variable. We recognise that this is an approximate adjustment, but nonetheless we believe that it is important to attempt to estimate the approximate size of the bias induced by measurement error upon our estimates of poverty. Table 3 shows our estimates of total, chronic and transitory poverty using the adjusted income variable.

Table 3: Total, Chronic and Transitory Poverty using Adjusted Income

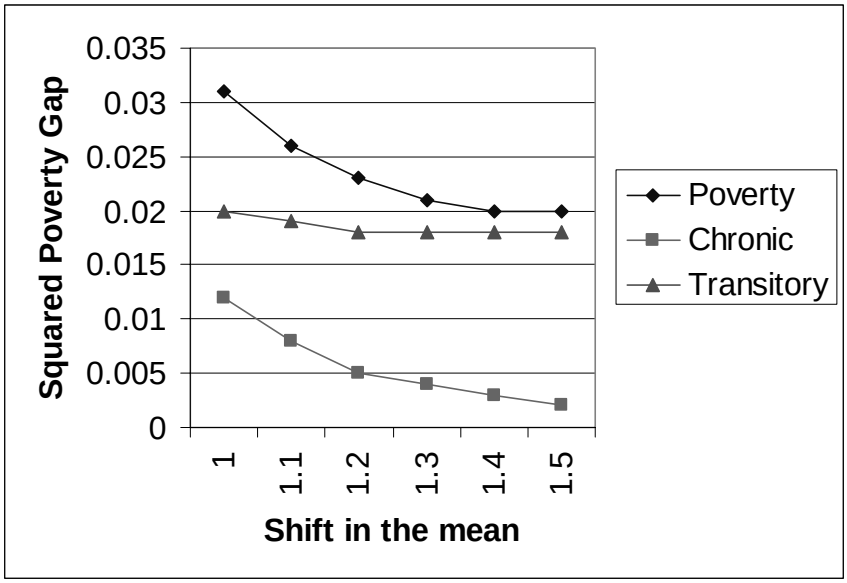
	Total Poverty	Chronic Poverty	Transitory Poverty
α=0 (Headcount)	0.212	0.153	0.059
α=1 (Poverty Gap)	0.058	0.031	0.027
α=2 (Squared Poverty Gap)	0.028	0.009	0.019

Chronic poverty remains unchanged when using adjusted income since the mean income of each household is unaltered. However, total poverty using all three measures is approximately halved due to a large reduction in transitory poverty. This is unsurprising given that the adjustment of the income variable involved a reduction in its variance, and emphasises the importance of accounting for measurement error in panel data. Nonetheless, 47 per cent of the total poverty gap and 68 per cent of the total squared poverty gap is still accounted for by transitory poverty.

The Poverty Impact Of Growth And Smoothing Policies

Poverty reduction policies often focus upon improving poor households' endowments of those elements of human and physical capital found to be most strongly associated with poverty. Such policies can be characterised as aiming to promote income growth, since the assumption is that improved endowments will enable those households to increase their productivity or earning capacity. The impact of economic growth on chronic and transitory poverty can be simulated directly by increasing household incomes. In the following empirical results, we focus on the squared poverty gap measure only, both for simplicity and because of the well known desirable properties of this poverty measure [Ravallion, 1992]. The effect on total, chronic and transitory poverty of increasing incomes by between 10 and 50 per cent are shown in Figure 1.[16]

Figure 1: The effect of income growth on chronic and transitory poverty

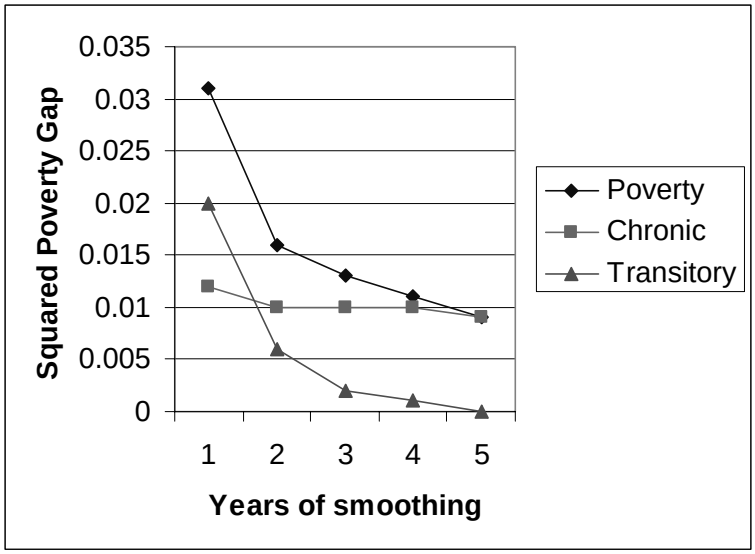


Note: Shift in the mean indicates the proportionate shift in the mean income. Thus the value 1.1 indicates a ten per cent increase in the mean.

Figure 1 shows that increases in income cause large reductions in chronic poverty but has relatively little effect upon transitory poverty.[17]

How chronic and transitory poverty changes when household incomes are smoothed may be simulated using a set of moving average filters as described above. Figure 2 shows the impact of perfect smoothing of incomes over different numbers of years on total, chronic and transitory poverty in the Pakistan panel.

Figure 2: The effect of income smoothing on chronic and transitory poverty



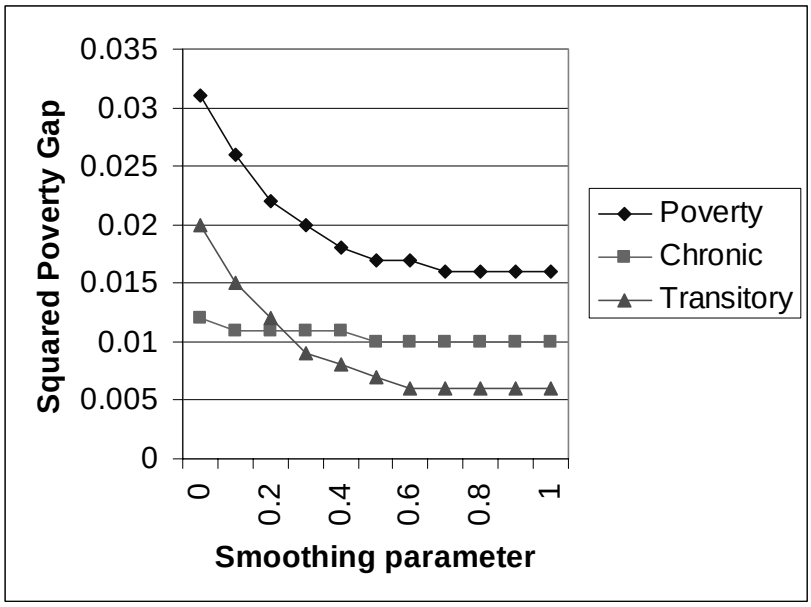
Note: Years of smoothing indicates the number of years in the moving average filter; when this has the value 1 there is no smoothing.

Figure 2 shows that smoothing gives a dramatic reduction in poverty with the squared poverty gap falling by almost half from 0.031 to 0.016, due to a 70 per cent reduction in transitory poverty by applying a two-year filter. Since there is no change in mean incomes, chronic poverty remains virtually unchanged over the period.

It is instructive to compare the reductions in poverty due to growth and those due to smoothing. Comparing Figure 1 and Figure 2 it is apparent that smoothing incomes over two years achieves a far larger reduction in overall poverty than that achieved by most plausible growth rates. A two year smoothing achieves the same reduction in overall poverty of an increase in mean real adult equivalent income of more than 50 per cent (which with current rates of economic and population growth would not be achieved for many years). However, the overall reduction in poverty is achieved almost entirely through reducing transitory poverty – chronic poverty is only significantly reduced through growth.

Given the large reduction in transitory poverty resulting from smoothing using a two-period filter, it is interesting to consider the effect of smoothing by less than this amount. This can be done by parameterising the smoothing filter as described in the methodology. Figure 3 shows the impact upon chronic and transitory poverty of smoothing for different values of the smoothing parameter from zero (no smoothing) to one (perfect two-period smoothing as above).

Figure 3: Parameterising the smoothing function



The smoothing parameter γ ranges from 0 (no smoothing) to 1 (perfect two-period smoothing). Thus the starting values of Figure 3 are the same as for Figure 1 and Figure 2 while the finishing values are the same as Figure 2 with two years of smoothing.

As Figure 3 shows transitory poverty is more than halved when the smoothing parameter $\gamma = 0.3$. Thus the major part of the poverty reduction takes place with a relatively low level of the smoothing parameter. Comparing this result with the impact of growth in Figure 1 it is clear that smoothing with a parameter value of $\gamma=0.1$ achieves approximately the same reduction in overall poverty as that achieved by a ten per cent increase in mean incomes.

The above simulations suggest that policy makers face a dilemma: the largest reductions in overall income poverty may best be secured through improving the ability of poor households to smooth incomes over time; however, chronic poverty will persist in rural Pakistan without large and sustained growth in incomes. Thus the balance between interventions to improve households' abilities to smooth incomes over time and those designed to promote growth must depend not only on the effectiveness of each type of intervention but on the relative weight which policymakers place upon the welfare of the chronically versus the transitorily poor.

The Poverty Impact Of Transfer And Investment Policies

The simulations above are highly stylised. Real policy interventions take many different forms including investments in human and physical capital, improved access to services and credit, support for particular vulnerable groups and so forth. Such interventions are likely to have an impact upon both chronic and transitory poverty. However, in order to assess the likely effectiveness of any particular intervention in reducing income poverty it is necessary to characterise the income generation process and to identify the relative importance of the factors determining income. The reduced form income equation is shown in equation (15):

$$\ln(a_{i\cdot}) = k + \mathbf{b.HC}_{i\cdot} + \mathbf{c.Educ}_{i\cdot} + \mathbf{d.Land}_{i\cdot} + \mathbf{f.Assets}_{i\cdot} + \mathbf{g.DVill}_{i} + \varepsilon_{it}^{18} \qquad (15)$$

where i indexes the household and $\cdot$ represents an average over the years of the survey; $a_{i\cdot}$ is the average per adult equivalent income of household i; k is a constant; $\mathbf{HC}_{i\cdot}$ represents a vector of household composition variables indicating the proportion of household

members in each of a set of age-sex categories; $\mathbf{Educ}_{i\cdot}$ is a vector of educational variables including the proportion of members of the household with basic and secondary education and the highest level of education achieved by the household head; $\mathbf{Land}_{i\cdot}$ is a vector of land ownership variables; $\mathbf{Assets}_{i\cdot}$ is a vector of asset variables including the value of livestock, vehicles and jewellery owned; $\mathbf{DVill}_i$ is a vector of dummy variables for each of the 52 villages in the panel and; ε_{it} is an error term which is assumed to be independent and identically distributed. Village dummies are included to take account of village specific shocks which may affect the incomes of all households in a particular village. Estimation used the panel 'between' estimator[19]; the regression results are shown in Table 4.

Table 4 shows that households which have a high proportion of members under the age of 16 tend to have substantially lower incomes than those which do not. In particular the proportion of children between the ages of 6 and 15 have a strongly negative effect upon a household's real adult equivalent income while the proportion of children under six years old has a much smaller effect. This is partially a consequence of using equivalised incomes as the welfare measure – since the addition of a young child has a much bigger impact upon per capita income than it does on per adult equivalent income. However, it also suggests that, although older children in rural Pakistan typically contribute to household income, they remain a net cost to the household (in the sense that if one were to 'add' an older child to an average household, the real adult equivalent income of the household would decline). This is particularly true for boys, which may reflect the fact that boys receive substantially more schooling than girls in rural Pakistan [Sawada, 1999].

Table 4: Regression of Log Real Adult Equivalent Mean Income on Household Variables

n = 681
F(59, 621) = 11.81
Prob > F = 0.0000
R-sq within = 0.0126
between = 0.5288
overall = 0.3744

Variable	coeff	Robust std err	t-stat	Prob > t
Proportion of household members consisting of:				
males aged 6-15	-0.7026	0.1516	-4.635	0.000
children aged less than 6	-0.1330	0.1212	-1.097	0.273
females aged 6-15	-0.5704	0.1518	-3.758	0.000
males with basic education	0.1008	0.1397	0.721	0.471
males with secondary education	0.7739	0.1948	3.973	0.000
females with basic education	0.0034	0.1551	0.022	0.982
females with secondary education	0.7912	0.6081	1.301	0.194
Household head has basic education	0.1240	0.0405	3.065	0.002
Acres of rainfed land owned	0.0021	0.0018	1.189	0.235
Acres of irrigated land owned	0.0113	0.0019	6.067	0.000
Value of livestock owned	0.0032	0.0013	2.385	0.017
Value of vehicles owned	0.0026	0.0016	1.647	0.100
Value of jewelry owned	0.0054	0.0021	2.624	0.009
Value of household assets owned	0.0006	0.0002	3.259	0.001
Household owns a tractor	0.3449	0.1024	3.370	0.001
Constant	7.8037	0.1034	75.461	0.000

Note: OLS panel estimation using the 'between estimator'. Village dummies have been omitted to clarify the presentation. Five households with particularly high leverage were omitted from the regression.

The proportion of household members who have basic or secondary education is strongly associated with higher incomes; secondary education in particular has a strong impact upon income. These results hold for both males and females, but it is notable that having a higher proportion of females with basic education has a much smaller impact upon household real adult equivalent income than the same proportion of educated males. This may reflect the marginal role women play in market oriented activities in rural Pakistan [Fafchamps and Quisumbing, 1997]. Whether the household head has (at least) basic education also has a strong positive impact upon income.

Not surprisingly, the value of physical assets owned has a strong positive influence upon income. Both rainfed and irrigated land contribute positively to income, but the influence of irrigated land is much stronger. Similarly, the value of livestock, vehicles, jewellery and other household assets contribute positively and significantly to household income and households which own a tractor are also likely to have substantially larger incomes. However, we are conscious that these variables suffer from potential endogeneity problems – it is not clear whether a household is better off because it holds a large amount of irrigated land, or whether it has a large amount of land because it is better off. If our data set contained a set of variables which could be treated as exogenous to both income and asset ownership then it would be possible to account for such problems using either instrumental variable or simultaneous equation methods. However, such variables are not readily available, so we treat the results for the asset variables with a certain degree of caution.[20]

The above income regression gives an indication of the relationship between household characteristics and the mean level of income. Given that transitory poverty is important we also estimated the relationship between household characteristics and fluctuations in income by regressing the log of the inter-temporal standard deviation of (adjusted) real income against the same household characteristics. The results are shown in Table 5.

Table 5: Regression of Log Inter-temporal Standard Deviation of Real Adult Equivalent Income on Household Variables

n = 681
F(60, 620) = 18.95
Prob > F = 0.0000
R-sq between = 0.6471

Variable	coeff	Robust std err	t-stat	Prob > t
Log mean real income	1.0689	0.0479	22.328	0.000
Proportion of household members consisting of:				
males aged 6-15	-0.1516	0.1841	-0.823	0.411
children aged less than 6	-0.3457	0.1449	-2.386	0.017
females aged 6-15	-0.3104	0.1834	-1.693	0.091
males with basic education	-0.2867	0.1668	-1.719	0.086
males with secondary education	-0.5539	0.2352	-2.355	0.019
females with basic education	0.2098	0.1850	1.134	0.257
females with secondary education	0.8313	0.7265	1.144	0.253
Household head has basic education	0.0323	0.0487	0.664	0.507
Acres of rainfed land owned	0.0014	0.0022	0.656	0.512
Acres of irrigated land owned	-0.0017	0.0023	-0.727	0.467
Value of livestock owned	-0.0001	0.0016	-0.068	0.946
Value of vehicles owned	0.0019	0.0019	1.009	0.314
Value of jewelry owned	0.0010	0.0025	0.389	0.697
Value of household assets owned	0.0001	0.0002	0.458	0.647
Household owns a tractor	-0.0477	0.1230	-0.387	0.699
Constant	-1.5554	0.3964	-3.923	0.000

Note: We have included log inter-temporal mean income as an explanatory variable to account for heteroskedasticity in real income. Village dummies have been omitted to clarify the presentation. Five households with particularly high leverage were omitted from the regression. Method of estimation is OLS.

Table 5 shows that the inter-temporal standard deviation of income rises with the inter-temporal mean of income. Furthermore, having a high proportion of children in the household reduces the variability of income – thus households with high dependency ratios are not only poorer, but also have more stable incomes perhaps indicating a greater degree of chronic poverty among this group. Having a larger proportion of males with basic or secondary education reduces income variability, but having a larger proportion of females with such education increases it. This may reflect the differing income earning

opportunities for men and women, with men having greater access to a diversity of income sources reducing total income variability.

As would be expected, an increase in the area of rainfed land owned increases the standard deviation of income while ownership of irrigated land reduces variability. Similarly, livestock and tractor ownership decreases the variation in income but owning vehicles, jewellery and other household assets increases it. However, all of these effects are small and none are statistically significant.

Transfer and Investment Policy Simulations

The above models of mean income and the standard deviation of income were used to simulate the impact of various transfer and investment policies upon poverty. First, the mean income model was used to calculate the predicted mean income of each household. Second, the inter-temporal standard deviation of income for each household was estimated using the second model. The estimated mean and standard deviation were then used to construct a new predicted income variable, q_{it} where:

$$q_{it} = \hat{\bar{a}}_i + (a_{it} - \bar{a}_i)\left(\frac{\hat{\sigma}_{a_i}}{\sigma_{a_i}}\right) \qquad (16)$$

where a_{it} is adjusted income, $\bar{a}_i$ is the inter-temporal mean of adjusted income and σ_{a_i} is the inter-temporal standard deviation for household i; $\hat{\bar{a}}_i$ is the estimate of the inter-temporal mean of income from the income regression and $\hat{\sigma}_{a_i}$ is the estimated inter-temporal standard deviation. We prefer to construct the new income variable in this way rather than simply use the estimate from the income regression since the new variable

more accurately reflects the impact of policy upon both the mean and the standard deviation of income.[21]

The mean income and standard deviation models were used to predict the impact of a number of different policies upon the mean and standard deviation of each household's income. For each policy a new income variable was constructed and used to calculate total, chronic and transitory poverty.[22] Table 6 shows the poverty impact of a range of transfer and investment policies.

Table 6: Transfer and Investment Policy Simulations

	Total Poverty	Chronic Poverty	Transitory Poverty
Base Case	0.0251	0.0023	0.0228
Policy Simulations			
- child benefit	0.0181	0.0011	0.0170
Education			
- basic male education	0.0185	0.0018	0.0167
- basic female education	0.0323	0.0023	0.0300
- education of hh head	0.0182	0.0012	0.0170
Land Redistribution			
- all get the mean	0.0316	0.0020	0.0296
- all get 2 acres	0.0245	0.0022	0.0222
Livestock Redistribution	0.0247	0.0021	0.0227

Note: The poverty figures are for the average squared poverty gap in each case.

Using the new income variable to calculate poverty gives an average squared poverty gap of 0.025, similar to the 0.028 calculated using adjusted income in Table 3.[23] As before, transitory poverty dominates. Turning to the policy simulations, Tables 4 and 5 suggest

that households with a high proportion of children in the household tend to be poorer. This might be addressed through implementing a child benefit scheme which supplies additional assistance to households with a high proportion of children. Such schemes typically involve the provision of income in-kind rather than cash and can be administered in a variety of ways including school feeding programmes, distribution to mothers as part of post-natal health care as well as distribution to households targeted by their dependency ratio.[24]

We abstract from the details of any particular scheme and simulate a generic scheme in which each child under the age of six receives an annual benefit equivalent to Rupees 100 (in 1986 prices). It is assumed that such a scheme is paid for either by government or by those whose incomes are permanently and significantly above the poverty line, so that the need to pay for the scheme does not impact upon our poverty calculations. Delivering this relatively modest benefit to each child under the age of six each year reduces the predicted squared poverty gap from 0.025 to 0.018. Most of the reduction comes from lowering transitory poverty, but chronic poverty is also more than halved. This suggests that schemes which support households with high dependency ratios can be effective in reducing poverty.

Our next policy experiment explores the consequence of investing in education. On average a quarter of the members of each household are males with no education; a third are females with no education. We therefore consider separately the impact of giving males and females basic education. The results are shown in Table 6. The results suggest that improving basic male education would reduce poverty by 26 per cent with the transitory poverty experiencing a greater proportionate reduction than chronic

poverty. However, improving female education actually increases poverty reflecting the positive coefficient on basic female education in the standard deviation model. This perverse result is likely to be due to the limited opportunities for higher income employment for educated females in rural Pakistan. It should be stressed that it is unlikely that the same result would apply to other measures of social welfare such as infant and child mortality where female education has been found to be important.

By contrast, promoting basic education among the 63 per cent of household heads with no education has a substantial impact upon poverty. As with child benefit most of the reduction comes from lowering transitory poverty, but chronic poverty experiences a much larger proportionate fall. The large poverty impact of educating the household head may be because households' income generation strategies are often principally determined by the (almost invariably male) household head. Thus their education not only impacts upon their own ability to bring income into the household, but also upon the likely success of the activities undertaken by others.

Land distribution in rural Pakistan is extremely unequal (the Gini coefficient of land ownership in our sample is 0.78). Consequently land redistribution is often suggested as a poverty reduction policy on the grounds that if all households had access to land then they would all be able earn at least a minimal income [Besley and Burgess, 1998; Putzel, 1998]. We explored the impact of such an asset transfer policy through two different simulations on the structure of land ownership. First all households were allocated the mean acreage of rainfed and canal irrigated land in the district in which they lived.[25] Second households were allocated two acres of the most prevalent type of land in their district (i.e. rainfed land in Attock and Dir, and irrigated land in Faisalabad and Badin) if

their current holding was less than this. The first redistribution is substantial since the mean holding is very much higher than the median in each district due to the presence of a small number of large holdings. Despite this, Table 6 shows that the impact upon chronic poverty is very much less than either child benefit or the educational policy simulations. Moreover, transitory poverty increases due to the positive association between holdings of rainfed land and income variability, so that the total squared poverty gap rises. The smaller but more realistic distribution of two acres of land to all households with less than this holding has virtually no effect upon income poverty. Thus, although land redistribution may have other beneficial effects (such as improving the security and status of poor households), our simulations suggest that it is not a panacea for reducing income poverty.

Finally, we simulate the impact of transfer of livestock by giving all households a value of livestock equal to the mean value within their district. Whilst a similar policy was found to be effective in reducing poverty in southern India [Singh and Hazell, 1993], we find that this has a very small impact upon both chronic and transitory income poverty in our Pakistan panel.

V CONCLUSIONS

Anti-poverty interventions are often based on static conceptions of poverty even though it is well-known that household living standards vary over time. This paper has investigated the magnitude of chronic and transitory poverty using a five-year panel survey from rural Pakistan. Applying the Jalan and Ravallion measures of chronic and transitory poverty to observed income suggests that over 80 per cent of the total squared

poverty gap is transitory. Adjusting, at least partially, for potential measurement error in the income variable reduces this figure to 68 per cent, but the poverty resulting from income fluctuations still remains a large and important part of total poverty.

Different types of anti-poverty interventions may be needed to address chronic and transitory poverty. We therefore examine the impact of two types of stylised anti-poverty interventions on the chronic and transitory poverty. Our simulations show that interventions which enable households to smooth their incomes over time achieve a large reduction in transitory poverty and therefore, given the relative importance of this type of poverty, in total poverty. This finding remains valid even when the extent of smoothing is quite small. However, simulated 'smoothing' makes little difference to chronic poverty, which is reduced only by large and sustained growth in real incomes.

We then extend these simulations by modelling both the income generation process and income variability. The resulting models are then used to simulate the impact upon chronic and transitory poverty of a series of transfer and investment policies. We show that the provision of a child benefit of Rs 100 to each child could dramatically reduce poverty, reflecting the high dependency ratios among households with low average incomes. Improving education via educational subsidies and other mechanisms also reduces poverty, particularly education of the household head. However, promoting basic education among females does not reduce income poverty, suggesting strong gender biases in the market for educated female labour in our study area. Finally land redistribution does not appear to reduce chronic poverty even when substantial amounts of land are redistributed, indeed larger holdings of rainfed land are associated with greater

transitory poverty. Similarly, redistribution of livestock has a very small impact upon poverty.

These findings have important implications for anti-poverty policy. They suggest that, while the current emphasis on sectoral (and in some countries geographical) interventions to improve the human and physical capital of the poor are likely to be successful in the long-run in reducing chronic poverty, in the short-term potentially much larger reductions in aggregate income poverty might be achieved by enhancing households' ability to smooth incomes across time. Interventions to achieve such improvements might include the provision of micro-credit, seasonal public works, crop insurance and food price stabilisation schemes. However, the most appropriate ways of smoothing incomes will clearly depend upon the nature of market failures in specific contexts. Further work is also needed to determine the extent to which such policies can smooth incomes in order to provide policymakers with realistic forecasts of the poverty reducing impact of different policy mixes.

In addition, the results suggest that the reduction of income poverty in rural Pakistan can be most effectively achieved through supporting households with high proportions of children. Promoting education, particularly of existing household heads can be critical in helping households to formulate effective strategies for income generation. More controversially, in our sample of households neither female basic education nor land redistribution appear to reduce income poverty in the short-term (although this in no way negates their value for the achievement of other social objectives). In the former case this may point to the need to tackle the social or cultural barriers which, by preventing female access to income earning opportunities, may decrease the level and increase the

variability of income in such households.

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Appendix 1: Adult Equivalence Scale

Age	Male Weight	Female Weight
0	0.33	0.33
1	0.46	0.46
2	0.54	0.54
3-4	0.62	0.62
5-6	0.74	0.70
7-9	0.84	0.72
10-11	0.88	0.78
12-13	0.96	0.84
14-15	1.06	0.86
16-17	1.14	0.86
18-29	1.04	0.80
30-59	1.00	0.82
60+	0.84	0.74

The equivalence scale is based on a World Health Organisation equivalence scale quoted in [Dercon, 1998].

Appendix 2: Descriptive Statistics for Pakistan Panel

Variable	Year 1 (1986)	Standard Deviation	Five Year Mean (1985-1991)	Standard Deviation
Real Adult Equivalent Income (Rs 000s)	4,386	4,066	4,098	4,052
Household Composition Variables (Proportion of Household members)				
Children aged less than 6	0.169	0.142	0.214	0.160
Females aged 6-15	0.113	0.123	0.107	0.115
Males aged 6-15	0.138	0.132	0.129	0.124
Member aged 65 or over	0.047	0.089	0.045	0.084
Household size (number of individuals)	8.714	4.138	9.744	4.766
Education Variables (Proportion of household members)				
Females with basic education	0.087	0.137	(see note)	
Males with basic education	0.189	0.164		
Females with secondary education	0.006	0.032		
Males with secondary education	0.066	0.114		
Dummy for basic education of household head	0.369	0.483		
Assets				
Acres of rainfed land owned	2.931	11.128	2.867	11.223
Acres irrigated land owned	4.152	10.949	4.433	11.744
Value of livestock owned	17.422	15.813	17.422	17.738
Value of vehicle owned	1.603	14.032	2.451	15.871
Value of jewelery owned	6.978	11.94	8.719	14.270
Value of household assets owned	72.28	145.5	88.466	157.544
Dummy for tractor ownership	0.962	0.191	0.897	0.304

Notes
Based on 686 households
Basic education is defined as primary or middle school education.
Secondary education is defined as secondary or college education.
Values are in Rs 1000s
Educational variables were only collected in the first year

NOTES

[1] See the surveys by [Morduch, 1995; Besley, 1995; Townsend, 1995] for reviews of the extensive literature on risk and consumption smoothing; [Chambers, 1989] provides an account of the importance of vulnerability and seasonality from a participatory perspective.
[2] If $\alpha=0$, the measure is the poverty headcount; $\alpha=1$ gives the poverty gap and $\alpha=2$ the squared poverty gap.
[3] If the calculation of poverty is made using a Foster-Greer-Thorbecke poverty measure with $\alpha > 0$.
[4] The reverse tends to be true in richer countries [Deaton, 1997].
[5] As Ravallion [1988] notes, measurement error may be more likely to be multiplicative than additive in some situations. In this case, the variables in the illustration should be considered as logs of the underlying variables.
[6] For example, [Altonji and Siow, 1987] use this technique to obtain unbiased estimates of the response of consumption to changes in income.
[7] Of course growth can also be pro-poor or anti-poor, but for simplicity here we focus on distributionally neutral growth.
[8] Note that we make a distinction here between smoothing incomes and smoothing consumption. There is a considerable literature on the ability of households to smooth consumption in developing countries [Alderman and Paxson, 1992; Deaton, 1989; Eswaran and Kotwal, 1990; Kochar, 1995; Morduch, 1994; Rosenweig and Wolpin, 1993; Townsend, 1994] including work using the first three years of the panel data we use [Alderman, 1996; Gillani, 1996; Broca, 1995].
[9] Note that the calculations are performed using income adjusted for measurement error.
[10] The length of an income series which has been smoothed over s periods is T-s+1 rather than T periods (for example two-period smoothing produces an income series of length T-1)
[11] This type of smoothing is a special case of smoothing using a set of negative exponential weights for incomes from all previous years.
[12] Equivalised incomes were obtained by applying the standard WHO caloric equivalence scale reproduced in Appendix 1.
[13] [Malik, 1993] provides a useful survey of previous studies of poverty in Pakistan. The most common approach used to define a poverty line has been in terms of the consumption expenditure required to meet a minimum per capita calorie requirement – this is the approach used by Irfan and Amjad [Irfan and Amjad, 1984], Ahmad and Allison [Ahmad and Allison, 1990] and Ercelawn [Ercelawn, 1990]. Typically a calorie requirement of Kcal 2,550 per day is used, as suggested by the Nutrition Cell of the Planning and Development Division of Pakistan, although lower figures such as Kcal 2,100 have also been used.
[14] This is possible because the total poverty gap averages only income fluctuations below the poverty line; the chronic poverty gap looks at the gap between the poverty line and a households average income across the panel; this will include any income it receives above the poverty line. If all households only received incomes below the poverty line then total poverty gap would equal the chronic poverty gap despite any fluctuations in income. For this reason Jalan and Ravallion focus on the squared poverty gap rather than the headcount and poverty gap measures, but we report all the measures here for completeness.
[15] The same estimation was also done using income lagged twice as an instrument for lagged income – this produced an estimated noise-to-signal ratio of 0.49.
[16] All simulations use adjusted income rather than observed income. The poverty measure used is the squared poverty gap. Similar results are obtained using the headcount and poverty gap poverty measures.
[17] The values shown in Figure 1 are not identical to those in Table 3 because the figure uses the last four years of the panel to facilitate comparison with smoothing policies later.
[18] We follow the standard practice of using a semi-log functional form for the income equation.
[19] Pooled OLS estimation with village and time dummies gave very similar results.
[20] It could also be argued that household composition and education are endogenous. Whilst this is clearly true in the long-term, it is unlikely to be important for the relatively short period of our panel.
[21] A set of simulations was also performed using the income model only. Predicted income was much smoother than actual income since the income model only explains 37 per cent of the variation in the dependent variable. Consequently the calculations of poverty using predicted income were substantially less than poverty calculated using actual income.
[22] [Singh and Hazell, 1993] uses a similar approach to policy simulation, but does not explicitly model variability in income.

[23] The figures are not identical because the new income variable gives all households their predicted mean and standard deviation whereas the adjusted income variable uses their actual mean and standard deviation (adjusted for measurement error).
[24] The last option is often problematic due to the difficulties in identifying which children 'belong' to a particular household.
[25] We restricted distribution to be within district since it would not be administratively realistic to redistribute land across different districts.