Measurement of Chronic and Transient Poverty: Theory and Application to Pakistan *

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Abstract

This paper investigates how to characterize each person's poverty status when his/her welfare level fluctuates and how to aggregate the status into chronic and transient poverty measures. The contribution of the paper is to clarify the sensitivity of relative magnitudes of chronic versus transient poverty to the choice of a poverty measure. We show this by theoretically re-examining Ravallion's (1988) decomposition of the expected value of a poverty measure into chronic and transient components. The examination covers major poverty measures including those developed by Foster et al. (1985), which are used extensively in the existing studies. Our analysis shows that the chronic-transient decomposition using the squared poverty gap index might be too sensitive to the poverty line and that the index is justified only if we accept that the welfare cost of consumption fluctuation is independent of the depth of chronic poverty. If we instead believe that the decomposition should not be too sensitive to the poverty line and that the welfare cost of risk is more severe when an individual's chronic poverty is deeper, other poverty measures such as suggested by Clark et al. (1981) are useful. We also investigate how empirically different are the relative magnitudes of chronic versus transient poverty, depending on the choice of a poverty measure. Based on a two-period household panel dataset collected in Pakistan, we show that the difference is substantial even when the poorest experienced only a small fluctuation in their consumption.

Keywords: chronic poverty, transient poverty, risk, poverty measurement.
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1 Introduction

Suppose that a person's poverty status is defined by its consumption level relative to a poverty line z, which is given exogenously to this person. We start with an example. Person A's consumption is always below z with the deviation of, say, 25% of z. Then this person is always poor. This person's *chronic poverty* status is characterized by 25% deprivation relative to z. In contrast, person B's consumption fluctuates, taking the value of z and $0.5z$ with equal probability. Then this person is not always poor. How can we characterize person B's chronic and *transient poverty* status? Given various types of individuals including persons A and B, how can we aggregate each person's poverty status into measures of chronic and transient poverty? These are the topics of this paper.

Investigating poverty from a dynamic perspective is expected to show useful insights for poverty eradication policies. *World Development Report* emphasized the importance of distinguishing transient poverty from chronic poverty in its 1990 edition (World Bank, 1990), although it is not as explicit as in its 2000/2001 edition where "security against risk" is listed as one of the three core concepts of poverty eradication policies (World Bank, 2000). Nevertheless, the measurement of chronic and transient poverty is relatively a less explored area of research.

If we are interested only in head count measures, a cross section of individuals could be divided into four categories: always poor, transiently poor with its mean consumption below z, transiently poor with its mean consumption above z, and always non-poor. As discussed by Hulme and Shepherd (2003), we can add another category in the middle, the "churning poor," with a mean poverty score around the poverty line and who are poor in some periods but not in others. They propose the aggregation of the always poor and the usually poor into the "chronic poor" and that of the churning poor and the occasionally poor into the "transient poor." Given panel information, these categories can be analyzed using poverty transition matrices (Sen, 1981; Walker and Ryan, 1990; Baulch and Hoddinott, 2000). Although useful, this analysis is not satisfactory since the welfare cost of consumption variability that occurs to the always poor is completely ignored. This criticism is a dynamic extension of the criticism against the (static) head count index that it completely ignores the depth of poverty below the poverty line (Sen, 1981).

Ravallion (1988) proposed a powerful alternative to the categorical analysis. He examined the response of the expected value of a poverty measure to changes in the variability in welfare indicator. If there is no fluctuation in the welfare indicator due to risk, the expected value of a poverty measure becomes equivalent to the value of a poverty measure corresponding to the expected level of the welfare indicator. Because of this reason, we call in this paper the expected value *total poverty*, the value of a poverty measure corresponding to the expected value *chronic poverty*, and the residual *transient poverty*, though these terms were not used by Ravallion (1988). Since this decomposition method is both practically manageable and theoretically related with the expected utility theory, it has been applied to a number of household datasets from developing countries to analyze the dynamics of poverty (Ravallion, 1988; Jalan and Ravallion, 1998; Ravallion et al., 1995; Gibson, 2001; Baulch and Hoddinott, 2000). These studies have shown that transient poverty is as important as chronic poverty and its relative importance differs across study regions and across social strata.

This paper contributes to this literature by clarifying the sensitivity of relative magnitudes of chronic versus transient poverty to the choice of a poverty measure. We show this by theoretically re-examining Ravallion's (1988) poverty decomposition. The examination is based on our view of poverty as a continuous phenomenon where the welfare cost of poverty is increasing with the size of deprivation under the poverty line. We cover major poverty measures including so called FGT poverty measures developed by Foster et al. (1985), which are used in the empirical studies mentioned above. Our analysis shows that the chronic-transient decomposition using the squared poverty gap index might be too sensitive to the choice of poverty line and that the index is justified only if we accept that the welfare cost of consumption fluctuation is independent of the depth of chronic poverty. If we instead believe that the relative magnitudes of chronic versus transient poverty should not be too sensitive to the poverty line and that the welfare cost of risk is more severe when an individual's chronic poverty is deeper, other poverty measures such as suggested by Clark et al. (1981) are useful. We also investigate how empirically different are the relative magnitudes of chronic versus transient poverty, depending on the choice of a poverty measure. This investigation employs micro household data collected in Pakistan.

The paper is organized as follows. Section 2 discusses the characteristics of chronic and transient poverty measures theoretically, focusing on their response to risk, poverty line, and income growth. Section 3 applies the chronic-transient decomposition to the case of Pakistan. After describing the two-period household panel dataset used for the analysis, the section discusses identification of permanent, transient, and error components of observed consumption, followed by empirical results. Section 4 concludes the paper.

2 Theoretical Framework

2.1 Decomposing Total Poverty into Chronic and Transient Components

We view poverty as a continuous phenomenon where the welfare cost of poverty is increasing with the size of deprivation under the poverty line. For convenience, we measure welfare by consumption. A consumer theory consistent with this view is the expected utility theory defined over a concave von Neumann-Morgenstein utility function. In other words, our focus is on poverty measures that predict the increase of overall poverty if consumption variability increases for those individuals below the poverty line.

Let P be the aggregate measure of poverty for a population of N and p_i be its individual score for person i, which is a function of his/her consumption c_i and an exogenously-given poverty line z. We restrict our attention to the class of Atkinson's (1987) poverty measures, which are additively separable, symmetric, taking the value of zero for the consumption level exactly at z, and increasing with the depth of poverty. Then,

$$P = \frac{1}{N}\sum_{i=1}^{N} p_i = \frac{1}{N}\sum_{i=1}^{N} p(c_i, z), \tag{1}$$

where $p(c_i, z) = 0$ when $c_i \geq z$, $p(c_i, z) > 0$ when $c_i < z$, and $\partial p/\partial c_i < 0$ when $c_i < z$.

Assuming c_i is stochastic, the expected value of P can be decomposed into chronic and transient components, *a la* Ravallion (1988):

$$P^P = E\left[\frac{1}{N}\sum_{i=1}^{N} p_i\right] = \frac{1}{N}\sum_{i=1}^{N} E[p(c_i, z)], \tag{2}$$

$$P^C = \frac{1}{N}\sum_{i=1}^{N} p(E[c_i], z)], \tag{3}$$

$$P^T = P^P - P^C = \frac{1}{N}\sum_{i=1}^{N} \left\{E[p(c_i, z)] - p(E[c_i], z)\right\}, \tag{4}$$

where $E[.]$ is an expectation operator. Following the later literature, the expected poverty P^P is called *total poverty*, its component corresponding to the expected consumption P^C is called *chronic poverty*, and the residual P^T reflecting the transient component of consumption is called *transient poverty* in this paper. If there is no risk in consumption, the total poverty becomes equivalent to the chronic poverty so that the transient poverty becomes zero. As shown by Ravallion (1988, Proposition 2), an increase in risk will increase P^T if function $p(c_i, z)$ belongs to the Atkinson class and is strictly convex in c_i below z.

For instance, among FGT poverty measures with $p(c_i, z) = \left(\frac{z-c_i}{z}\right)^\alpha$, $\alpha > 1$ is sufficient for P^T to be increasing in consumption variability. For this reason, all the existing studies on the chronic and transient poverty decomposition employed an FGT measure with $\alpha = 2$, i.e., the squared poverty gap index (a measure of poverty severity) (Ravallion, 1988; Jalan and Ravallion, 1998; Ravallion et al., 1995; Gibson, 2001; Baulch and Hoddinott, 2000). However, the existing studies did not discuss the sensitivity of this decomposition with respect to the poverty line and the expected level of consumption. This paper explores this so that we can infer the sensitivity of chronic poverty relative to transient poverty with respect to the choice of poverty measures, when income growth occurs (the expected level of c_i increases for everybody), or consumption risk rises (the variability of c_i increases for everybody), or there is a change in the relative poverty concept (the poverty line z changes).

2.2 Individual and Distributional Effects

Let us be more specific about the stochastic nature of consumption: $c_i = \bar{c}_i + \epsilon_i$, where ϵ_i is a zero mean disturbance with its density function $f_i(\epsilon_i)$. We assume that the distribution of ϵ_i has the following properties: $E[\epsilon_i^2] = \sigma_i^2$, $\epsilon_i \in [\underline{\epsilon}_i, \bar{\epsilon}_i]$, and $\bar{c}_i + \underline{\epsilon}_i > 0$. For simplicity, we further assume that $E[\epsilon_i \epsilon_j]/(\sigma_i \sigma_j) = \rho$ for $i \neq j$ and the shape of $f_i(.)$ is the same across i except for $\bar{c}_i$ and σ_i^2. Then the distribution of individual poverty scores can be characterized by the shape of $f_i(.)$ and two density functions across i — $g(.)$ for $\bar{c}_i$ and $h(.)$ for σ_i^2.

Dependent on the combination of $(\bar{c}_i, \sigma_i^2)$, each individual is classified into either of the four poverty statuses of *Always poor*, *Usually poor*, *Occasionally poor*, and *Always non-poor* (the terminology is borrowed from Hulme and Shepherd, 2003). Their definition is summarized in Table 1. It should be noted that the chronic poverty of a *usually poor* individual is not necessarily smaller than that of an *always poor* individual. An individual with very stable (but slightly less than z) consumption may be classified as *always poor*, such as a low-paid government clerk with many dependents, whereas a farmer cultivating a small unirrigated land under erratic rainfall may be classified as *usually poor*, not as *always poor*, although the farmer's average consumption level might be lower than the clerk's.

Let S_k be the set of individuals belonging to status k and let N_k be the number of individuals belonging to S_k, where $k = 1$ for the always poor, $k = 2$ for the usually poor, $k = 3$ for the occasionally poor, and $k = 4$ for the always non-poor ($N = N_1 + N_2 + N_3 + N_4$).

Then, equations (3) and (4) can be rewritten as

$$
\begin{aligned}
P^C &= \frac{1}{N}\sum_{i=1}^{N} p([\bar{c}_i], z)] = \frac{1}{N}\sum_{i=1}^{N} p^C(c_i, z), \\
&= \frac{N_1}{N}\left(\frac{1}{N_1}\sum_{i\in S_1} p^C(c_i, z)\right) + \frac{N_2}{N}\left(\frac{1}{N_2}\sum_{i\in S_2} p^C(c_i, z)\right), \qquad (5) \\
P^T &= \frac{1}{N}\sum_{i=1}^{N} \{E[p(c_i, z)] - p(\bar{c}_i, z)\} = \frac{1}{N}\sum_{i=1}^{N} p^T(c_i, z), \\
&= \frac{N_1}{N}\left(\frac{1}{N_1}\sum_{i\in S_1} p^T(c_i, z)\right) + \frac{N_2}{N}\left(\frac{1}{N_2}\sum_{i\in S_2} p^T(c_i, z)\right) + \frac{N_3}{N}\left(\frac{1}{N_3}\sum_{i\in S_3} p^T(c_i, z)\right), (6)
\end{aligned}
$$

where newly defined $p^C(c_i, z)$ and $p^T(c_i, z)$ are functions for chronic and transient poverty scores at the individual level. The term in the first parenthesis of equation (5) shows the chronic poverty for the always poor group and the term in the second parenthesis shows that for the usually poor group. Similarly, the term in the first parenthesis of equation (6) shows the transient poverty for the always poor group, the term in the second parenthesis shows that for the usually poor group, and the term in the third parenthesis shows that for the occasionally poor group.

Under the assumption that N is finite, the marginal impact of an *infinitely small change* in $\bar{c}_i$, σ_i^2, or z on P^C and P^T can be investigated by comparative statics of $p^C(c_i, z)$ and $p^T(c_i, z)$ with respect to $\bar{c}_i$, σ_i^2, and z, differentiated by individual's poverty status k. We call them "individual effects" and discuss further in the following subsections.

In practice, what matters is the total impact of a *finite change* in $\bar{c}_i$, σ_i^2, or z on P^C and P^T. The total impact can be approximated by the sum of the comparative statics weighted by N_k and the change in N_k weighted by the initial level of $p^C(c_i, z)$ and $p^T(c_i, z)$. The latter is called "distributional effects" in this paper because they correspond to changes in the distribution of individuals belonging to each poverty status.

The sign and magnitude of the change in N_k depend on the size of the change in $\bar{c}_i$, σ_i^2, or z, and on the exact shape of the density functions $f_i(.)$, $g(.)$, and $h(.)$. The signs we expect to observe are shown in Table 2, derived from Appendix 1.

2.3 Expected Signs of the Comparative Statics for Individual Effects

When an infinitely small change in $\bar{c}_i$, σ_i^2, or z occurs, how do P^C and P^T and therefore the relative magnitude of P^T to P^C respond? This is investigated for popular poverty measures in the next subsection through a comparative statics analysis for individual effects.

Before this exercise, let us discuss which sign we should expect for the comparative statics of chronic and transient poverty measures from a theoretical viewpoint. By definition, $\partial p^C(c_i, z)/\partial \sigma_i^2 = 0$. If $p(c_i, z)$ belongs to a class of Atkinson's poverty measures, $\partial p^C(c_i, z)/\partial \bar{c}_i < 0$ and $\partial p^C(c_i, z)/\partial z > 0$ for all individuals with $p^C(c_i, z) > 0$ (i.e., chronic poverty increases when the expected deprivation from the poverty line increases). If $p(c_i, z)$ belongs to a narrower class of strictly convex functions of Atkinson's poverty measures, $\partial p^T(c_i, z)/\partial \sigma_i^2 > 0$ for all individuals with $p^T(c_i, z) > 0$ (i.e., transient poverty increases when risk increases). Therefore, all we need to investigate is the signs of $\partial p^T(c_i, z)/\partial \bar{c}_i$ and $\partial p^T(c_i, z)/\partial z$ for individuals with $p^T(c_i, z) > 0$ (Table 3).

If we believe that the welfare cost of consumption fluctuation is more severe when an individual's permanent consumption level is lower and that this should be reflected in the magnitude of a transient poverty measure, we should require the measure to show $\partial p^T(c_i, z)/\partial \bar{c}_i < 0$ and $\partial p^T(c_i, z)/\partial z > 0$ (i.e., transient poverty increases when the expected deprivation from the poverty line increases). If we believe instead that the additional welfare burden due to deeper poverty should only be reflected in chronic poverty measures, the transient poverty measure should show $\partial p^T(c_i, z)/\partial \bar{c}_i = \partial p^T(c_i, z)/\partial z = 0$. We find no theoretical reason to support $\partial p^T(c_i, z)/\partial \bar{c}_i > 0$ and $\partial p^T(c_i, z)/\partial z < 0$ because the same risk should not be evaluated lighter for the poorer. This is an axiomatic argument (Sen, 1981).

From a practical perspective, there could be another reason to oppose a transient poverty measure with the property $\partial p^T(c_i, z)/\partial z < 0$, because this case implies that $p^C(c_i, z)$ and $p^T(c_i, z)$ move in the opposite directions when z is changed marginally. Since the choice of z is *ad hoc* in nature, the literature emphasizes the importance of investigating the sensitivity of poverty measures with respect to the poverty line. When static poverty measures are used, the stochastic dominance approach is the most popular one (Atkinson, 1987). When the dynamics of poverty is analyzed using the chronic-transient poverty decomposition, the relative magnitudes of chronic versus transient poverty may be too sensitive to the poverty line if their partials move in the opposite directions. Therefore, poverty measures associated with $\partial p^T(c_i, z)/\partial z \geq 0$ are appealing from a practical reason as well.

2.4 Investigating Popular Poverty Measures

Two groups of popular poverty measures are investigated. The first was proposed by Foster et al. (1985), in a general functional form

$$p(c_i, z) = \left(1 - \frac{c_i}{z}\right)^{\alpha}, \tag{7}$$

when $c_i < z$ and $p(c_i, z) = 0$ when $c_i \geq z$, where α is a non-negative parameter. This group is called FGT poverty measures, which include the head count index ($\alpha = 0$), the poverty gap index ($\alpha = 1$), and the squared poverty gap index ($\alpha = 2$) as special cases. When $\alpha > 1$, the function becomes strictly convex so that it has a property of $\partial p^T(c_i, z)/\partial \sigma_i^2 > 0$ (i.e., risk always increases transient poverty).

Another group we investigate was proposed by Clark et al. (1981) in a general form

$$p(c_i, z) = \frac{1}{\beta}\left[1 - \left(\frac{c_i}{z}\right)^{\beta}\right], \tag{8}$$

when $c_i < z$ and $p(c_i, z) = 0$ when $c_i \geq z$, where $\beta \leq 1$. This group is called Clark-Watts poverty measures, which include the poverty gap index ($\beta = 1$) and Watts' measure ($\beta = 0$) as special cases.[1] When $\beta < 1$, the function becomes strictly convex so that it has a property that risk always increases transient poverty.

Results are summarized in Table 4 whose derivation is given in Appendix 2. First, we find less frequently the theoretically appealing combination of $\partial p^T(c_i, z)/\partial \bar{c}_i \leq 0$ and $\partial p^T(c_i, z)/\partial z \geq 0$ for FGT measures. The range $\alpha > 2z/\bar{c}_i$ requires a very high α, which is not usually employed in the applied literature. The squared poverty index ($\alpha = 2$), which is popular in the empirical studies, has a non-appealing property that $\partial p^T(c_i, z)/\partial \bar{c}_i = 0$ and $\partial p^T(c_i, z)/\partial z < 0$ for the always poor. In other words, the second order FGT measure for severity is justified only if we accept that the welfare cost of consumption fluctuation is independent of the depth of chronic poverty captured by $\bar{c}_i$. The insensitivity of the transient poverty defined over the squared poverty gap index to $\bar{c}_i$ is as expected, because the index corresponds to a quadratic utility function. It is well known that the expected utility from a quadratic von-Neumann-Morgenstein utility function implies that the welfare loss to risk is dependent only on the variance, not affected by the mean of consumption.

In sharp contrast, the theoretically appealing combination of $\partial p^T(c_i, z)/\partial \bar{c}_i \leq 0$ and $\partial p^T(c_i, z)/\partial z \geq 0$ is found in a wider range of parameter β for the case of Clark-Watts

[1] When $\beta = 0$, Watts' measure is given as $p(c_i, z) = \ln z - \ln c_i$.

measures. A sufficient condition for the appealing combination when $i \in S_1$ is $\beta < 0$. Noting that Clark-Watts poverty measures are associated with the expected utility theory characterized by risk preferences of *constant relative risk aversion*, we can translate the condition $\beta < 0$ as a relative risk aversion coefficient larger than one. This is not off the mark of the ranges found in the empirical literature on developing economies (Kurosaki and Fafchamps, 2002).

From analytical results in Table 4, it is not possible to predict the response of transient-chronic decomposition to a finite change in the poverty line because it also depends on the shape of the three density functions. Another reason for the indeterminacy is the ambiguity of signs of the comparative statics when individuals belong to the usually poor. Therefore, the total response is investigated empirically in the next section.

3 Application to Rural Pakistan

3.1 Data

In this section, we apply the theoretical decomposition to a panel dataset compiled from sample household surveys implemented in 1996 and 1999 in three villages in Peshawar District, the North-West Frontier Province (NWFP), Pakistan. NWFP is one of the four provinces of Pakistan where the incidence of income poverty is estimated at around 40 to 50% throughout the 1990s, which is the highest among the four provinces (World Bank, 2002).

Details of the 1996 household survey are given in Kurosaki and Hussain (1999) and those of the 1999 household survey are given in Kurosaki and Khan (2001). The reference period for each survey is fiscal years 1995/96 and 1998/99 respectively.[2] In choosing sample villages in 1996, we controlled village size, socio-historical background, and tenancy structure. At the same time, to ensure that the cross section data thus generated would provide dynamic implications, we carefully chose villages with different levels of economic development. The first criterion was agricultural technology — one of the three sample villages was rainfed, another semi-irrigated, and the other fully-irrigated. Another criterion was that the selected villages be located along the rural-urban continuum so that it would be possible to decipher the subsistence versus market orientation of farming communities in the study area.

Table 5 summarizes characteristics of the sample villages and households. Village A is rainfed and is located some distance far from main roads. This village serves as an example

[2]Pakistan's fiscal year as well as her agricultural year is a period from July 1 to June 30.

of the least developed villages with high risk in farming. Village C is fully irrigated and is located close to a national highway, and serves as an example of the most developed villages with low risk in farming. Village B is in between.

Out of 355 households surveyed in 1996, we were able to resurvey 304 households in 1999. Among the resurveyed, three have been divided into multiple households[3] and two have incomplete information on consumption. Therefore, a balanced panel of 299 households with two periods is employed in this section. See Kurosaki (2002) for the analysis of attrition in this dataset.

Average household sizes are larger in Village A than in Villages B and C, reflecting the stronger prevalence of extended family system in the village. Average landholding sizes are also larger in Village A than in Villages B and C. Since the productivity of purely rainfed land is substantially lower than that of irrigated land, effective landholding sizes are comparable among the three villages.

In the analyses below, the welfare of individuals in household i in year t is measured by real consumption per capita (c_{it}). In the survey, information on the household expenditure on non-food items, quantity of food items consumed, their prices, the share met by domestic production was collected. The sum of annual expenditures on those items was converted into real consumption per capita, by dividing the household total consumption by the household size and by the consumer price index.[4] Average consumption per capita are the lowest in Village A and the highest in Village C (Table 5), confirming our survey design that different levels of economic development were represented in village selection. During the three years since the first survey, Pakistan's economy suffered from macro-economic stagnation and an increase in poverty (World Bank, 2002). Reflecting these macroeconomic shocks, the general living standard stagnated in the study villages during the study period.

In any household survey where self-employment agriculture is important, estimating household income and consumption is subject to measurement errors, although we did our

[3]In the survey, a household is defined as a unit of coresidence and sharing consumption. A typical joint family in the region, where married sons live together with the household head who owns their family land along with their wives and children, is treated as one household, as long as they share kitchen. When the household head dies or becomes older, the land may be distributed among sons, who start to live separately on that occasion. In our survey when we encounter such cases, each family of each son is counted as one household.

[4]The actual number of household members was used in this paper as a measure of household size. Alternatively, we can estimate the household size in terms of equivalence scale that reflects difference in sex/age structure and corrects for scale economy. This is left for further study. Non-adjustment for scale economy could lead to an overestimate of poverty for large households, on which see Lanjouw and Ravallion (1995) for the case of Pakistan.

best to minimize them (Grosh and Glewwe, 2000). In our survey, a series of questions on households' adjustment to risk were also asked to the household head in the 1999 survey, such as (i) any good/bad economic year(s) in the past three years due to unanticipated shocks, (ii) associated reasons/factors thereof, and (iii) possible adjustments they had to or could make to cope with the risk, such as consumption adjustments, food storage, accumulation/decumulation of productive assets (land and livestock), gold and jewelry management, mutual help, adjustment of children's schooling, etc. This part of the questionnaire provides us with qualitative information on households' subjective assessment on risk, which can be used as an independent check for changes in income and consumption. Although the information is in the form of zero-one dummies, we found that the subjective assessment on income shock corresponds well to the direction of observed income changes and that on adjustment corresponds well to the direction of observed consumption and asset changes. We use them as instrumental variables to control measurement errors below.

3.2 Identifying Permanent, Transient, and Measurement Error Components of Observed Consumption

To apply the theoretical decomposition to the dataset thus described, we need to have a proxy for permanent and transient components of consumption. The dataset has information on c_{it} for t =1996 and 1999, and for $i = 1, ..., 299$, with associated household size as a weight. The level of c_{it} for the same i fluctuates substantially. Figure 1 plots observed values of $c_{i,1999}$ against $c_{i,1996}$. The vertical and horizontal lines inside the diagram show the poverty line used in this section, which corresponds to the official poverty line of the Government of Pakistan at 673.54 Rs. per capita per month in 1998/99 (CRPRID, 2002). For convenience, 50%, 75%, 125%, and 150% of the poverty line are also drawn in dotted lines. Based on the official poverty line, 55.0% of individuals are classified as *always poor*, who are in the southwest quadrant divided by the poverty line, and 15.5% are classified as *always non-poor* in the northeast quadrant. The northwest and southeast quadrants are divided by the minus 45 degree line with *usually poor* on the southwest halves (13.1% of individuals) and *occasionally poor* on the northeast halves (16.4%).

Some of these observed changes are actual ones that happened to households due to transient shocks such as weather, diseases/injuries, macroeconomic fluctuations, etc. The observed consumption levels are also subject to measurement errors. Since we have a two-period panel dataset, household-fixed effects can control the measurement errors that are time-invariant and specific to each household. Nevertheless, idiosyncratic measurement errors could also be substantial.

Considering this problem, we try two models to obtain a proxy for permanent and transient components of consumption. The first model employs observed mean and observed changes as they are. The chronic poverty according to equation (3) is calculated based on the two-period mean consumption. The total poverty according to equation (2) is defined as the average of poverty measures calculated for each period using the observed consumption plotted in Figure 1. By subtracting the chronic poverty measure from the total poverty measure, we obtain the measure for transient poverty. In other words, the two-period mean is adopted as the proxy for permanent consumption and the observed change as the proxy for the transient consumption. Since the observed changes may include measurement errors, the results based on the first model can be interpreted as the upper limit of the transient poverty effects.

In the second model, we try to control measurement errors using instruments. First, we regress the two-period mean of the log of consumption on household characteristics that contribute to generating permanent income. Then we treat its fitted values as the proxy for permanent consumption in equation (3). Second, we regress the log of observed consumption growth on various variables that proxy transient shocks: village dummies (representing weather shocks), reported positive and negative shocks such an experience in human injuries or crop losses, and reported adjustments to those shocks. Then we treat its fitted values as the proxy for transient component of consumption.

Figure 2 plots the fitted values of $c_{i,1999}$ against $c_{i,1996}$. Regression results are given in Appendix Table. Since the figure is drawn on the same scale as in Figure 1, the contraction to the 45 degree line is clear. We assume that the difference between the two figures are due to measurement errors. From these fitted consumption data, 58.3% of individuals are classified as *always poor*, 12.5% as *usually poor*, 7.7% as *occasionally poor*, and 21.6% as *always non-poor*. Since we exclude some of the observed consumption changes, the numbers in the stable statuses (always poor and always non-poor) increase at the cost of the unstable statuses.

The first model is regarded as the benchcase with the least structure on the consumption generating process. The second model is a case with some structure imposed on the consumption generating process. Several alternatives to these two could also be defined, whose investigation is left for further study.

3.3 Empirical Results

Table 6 shows the decomposition results when observed consumption data were used. Column (1) reports the values of transient poverty (P^T), chronic poverty (P^C), and its ratio (P^T/P^C) for several choices of popular poverty measures when the official poverty line of the government of Pakistan was used. As indicated from Figure 1, the transient poverty is quite large – it is estimated at 24.2% of the chronic poverty when squared poverty gap is used and 16.7% when Watts' poverty measure is used. As expected from the definition of these poverty measures, the relative magnitude of transient to chronic poverty increases when α increases and β decreases.

What is of interest here is the sensitivity of the impact of a change in the poverty line to the choice of a poverty measure. Therefore, similar values when official poverty line was reduced by 10% are reported in Column (2). Changes in the distribution of each status (always poor, usually poor, occasionally poor, or always non-poor) are shown in the bottom rows of the table, which are quite large. All the figures for chronic poverty (P^C) in Table 6 decrease regardless of the choice of a poverty measure. When a lower poverty line is used, the estimated chronic poverty should decline by definition (Table 3). In contrast, the direction of change in transient poverty (P^T) is indeterminate theoretically (Tables 2-4). In Section 2.4, we pointed out the possibility that P^T may respond to a change in z with a sign opposite to that of the change of P^C and this is more likely to occur for FGT measures than for Clark-Watts measures. Fortunately, figures in Table 6 show that this did not occur for the case of NWFP, Pakistan. All the figures for P^T decrease regardless of the choice of a poverty measure. However, when we examine a wider range of the poverty line, the direction of change can take both signs when the poverty gap or squared poverty gap indices are used (see the top panel of Figure 3).

To investigate the sensitivity of relative magnitudes of chronic versus transient poverty to the choice of a poverty measure, Column (3) in Table 6 reports the ratio of changes due to decrease in z. As discussed in Section 2.3, we prefer a poverty measure of the chronic-transient decomposition, which is not too sensitive to the poverty line. The transient/chronic poverty ratio increases by 33.2% when the squared poverty gap is used and by 25.5% when Watts' poverty measure is used. Under this criteria, a Clark-Watts measure with $\beta = -2$ performs the best among those shown in Table 6. It predicts only an increase of 16.5% when the poverty line is decreased by 10%. An FGT measure with $\alpha = 3$ does not improve the situation much.

The contrast according to the choice of a poverty measure is shown graphically in the bottom panel of Figure 3. The response of the transient/chronic poverty ratio to a decline in the poverty line is much smaller when a Clark-Watts measure with $\beta = -2$ is used than those when poverty gap or squared poverty gap measures are used. The response of the chronic and transient poverty indices to the poverty line is also smoother for the Clark-Watts measure than for the others. A Clark-Watts measure with $\beta = -2$ corresponds to a coefficient of relative risk aversion at 3, which seems high but consistent with empirical studies based on farmers' behavior in South Asia (Kurosaki and Fafchamps, 2002).

Table 7 is a counterpart to Table 6 when fitted values of consumption were used. As before, both P^T and P^C decrease when the poverty line is reduced, and their ratios (P^T/P^C) increase because the response of the chronic poverty is larger than that of the transient poverty. Although the data are different substantially (compare Figures 1 and 2), qualitative predictions from Table 7 are similar to those from Table 6 — Clark-Watts measures perform better than FGT measures in terms of the response of the transient/chronic poverty ratios to a change in the poverty line and a Clark-Watts measure with $\beta = -2$ performs the best (Figure 4). This is observed despite the fact that the direction of changes in the distribution shares for each status is different — N_2 decreases in Table 7 when z is decreased while it increases in Table 6.

4 Conclusion

In this paper, we investigated how to characterize each person's poverty status when his/her welfare level fluctuates and how to aggregate the status into chronic and transient poverty measures. We first investigated theoretically the sensitivity of the transient and chronic poverty decomposition *a la* Ravallion (1988) to the choice of a poverty measure when the growth occurs or the poverty line changes. The examination covered major poverty measures, namely, FGT poverty measures developed by Foster et al. (1985), which are used widely in the existing empirical studies, and Clark-Watts measures developed by Clark et al. (1981).

The theoretical analysis based on comparative statics has shown that the chronic-transient relative magnitude using the second order FGT measure for severity might be too sensitive to the choice of the poverty line and that the poverty measure is justified only if we accept that the welfare cost of consumption fluctuation is independent of the depth of chronic poverty.

If we instead believe that the relative magnitudes of chronic versus transient poverty should not be too sensitive to the poverty line and that the welfare cost of risk is more severe when an individual's chronic poverty is deeper, Clark-Watts measures could be superior. However, analytical results cannot predict completely the response of the chronic-transient decomposition to a finite change in the poverty line because it also depends on the changes in the population shares of the always poor, the usually poor, the occasionally poor, and the always non-poor.

We therefore investigated the sensitivity empirically using a two-period household panel dataset collected in Pakistan. Decomposition results have shown that a Clark-Watts measure with moderate to high risk aversion performs better than FGT measures in terms of the sensitivity of transient/chronic poverty measures with respect to the poverty line. The difference is large when we used the observed consumption data, which have wider dispersion, possibly due to measurement errors. The difference becomes smaller but still remains substantial when we used the fitted consumption data, where the poorest experienced only a small fluctuation in their consumption.

The analysis in this paper can be extended to several directions. Theoretically, the marginal response of the population shares of different poverty statuses could be investigated further. Empirically, similar exercises using panel datasets with a longer time horizon, with more households, or for countries with higher income could be interesting. They will complement our case using a small household dataset with a short time horizon where the incidence of income poverty is very high. These are left for further research.

Appendix 1: Likely Changes in the Distribution of Poverty Status across Individuals

Here, we give only a rough sketch for the case $N_k > 0$ for all k.[5]

First, it is obvious that the number of the poor decreases with $\bar{c}/z$, which is the real consumption relative to the poverty line. Because of this, we have

$$\frac{\Delta N_1}{\Delta \bar{c}} < 0, \tag{9}$$
$$\frac{\Delta (N_1 + N_2)}{\Delta \bar{c}} < 0, \tag{10}$$
$$\frac{\Delta (N_1 + N_2 + N_3)}{\Delta \bar{c}} < 0, \tag{11}$$
$$\frac{\Delta N_1}{\Delta z} > 0, \tag{12}$$
$$\frac{\Delta (N_1 + N_2)}{\Delta z} > 0, \tag{13}$$
$$\frac{\Delta (N_1 + N_2 + N_3)}{\Delta z} > 0. \tag{14}$$

This is not sufficient to sign the changes of N_2 and N_3 separately. It depends on the relative magnitudes of those churning between two poverty statuses of the always poor and the usually poor, between the usually poor and the occasionally poor, and between the occasionally poor and the always non-poor. If we further assume that $g(.)$ is approximately smooth and unimodal, the combination $(\Delta N_2/\Delta \bar{c} > 0, \Delta N_3/\Delta \bar{c} < 0)$ cannot happen. When $g(.)$ is unimodal with its mode bigger than z, it is likely that $\Delta N_2/\Delta \bar{c} < 0$. Likely signs of the comparative statics with respect to z is the opposite of the above. Considering the range of head count indices reported from developing countries, especially South Asia (World Bank, 2000; 2002), around 20 to 50%, the further assumption may not be satisfied in the real data.

Second, regarding the effects of a small increase of risk, we can show without further assumptions on the shape of $g(.)$ or $h(.)$ that

$$\frac{\Delta (N_1 + N_2)}{\Delta \sigma^2} = 0, \tag{15}$$
$$\frac{\Delta N_1}{\Delta \sigma^2} < 0, \tag{16}$$
$$\frac{\Delta N_3}{\Delta \sigma^2} > 0. \tag{17}$$

The first equation holds because the set for individuals whose permanent consumption level $\bar{c}$ is below z is not affected by the change in risk by definition. The second inequality holds because, when the risk increases, those individuals who were initially in S_1 may escape into S_2, whereas those individuals who were initially in S_2 cannot enter into S_1, for the increase in risk increases the probability of better welfare status, which is above the poverty line by definition. The third inequality holds for a similar reason — when the risk increases, those individuals who were initially in S_4 may fall into S_3, whereas those individuals who were

[5] A formal proof treating N infinite so that both density functions of $g(.)$ and $h(.)$ are continuous is left for further study.

initially in S_3 cannot enter into S_4, for the increase in risk increases the probability of worse welfare status, which is below the poverty line by definition. Combining equations (15) to (17), we obtain

$$\frac{\Delta N_2}{\Delta\sigma^2} > 0, \qquad \frac{\Delta N_4}{\Delta\sigma^2} < 0. \tag{18}$$

Appendix 2: Comparative Statics for Individual Effects

(1) FGT Poverty Measures

From equations (4) and (7), we can derive

$$\frac{\partial p^T(c_i,z)}{\partial \bar{c}_i} = -\frac{\alpha}{z}\left[E\left(1-\frac{\bar{c}_i+\epsilon_i}{z}\right)^{\alpha-1} - (1-\bar{c}_i/z)^{\alpha-1}\right], \qquad i \in S_1, \tag{19}$$

$$\frac{\partial p^T(c_i,z)}{\partial \bar{c}_i} = -\frac{\alpha}{z}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} f_i(e_i)de_i - (1-\bar{c}_i/z)^{\alpha-1}\right], \quad i \in S_2, \tag{20}$$

$$\frac{\partial p^T(c_i,z)}{\partial \bar{c}_i} = -\frac{\alpha}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} f_i(e_i)de_i \;<\; 0, \qquad i \in S_3. \tag{21}$$

The sign of expression (19) can be evaluated by investigating the curvature of $(1-c_i/z)^{\alpha-1}$ with respect to c_i. When $\alpha > 2$, the function becomes strictly convex so that the whole expression within the bracket of expression (19) becomes positive, resulting in $\partial p^T(c_i,z)/\partial\bar{c}_i < 0$. When $1 < \alpha < 2$, the opposite occurs so that the comparative statics becomes positive.

The sign of expression (20) is indeterminate in general because its second term in the bracket, which is positive, is subtracted from its first term, which is also positive. Equation (20) can be transformed further as

$$\begin{aligned}\frac{\partial p^T(c_i,z)}{\partial \bar{c}_i} &= -\frac{\alpha}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} - (1-\bar{c}_i/z)^{\alpha-1}\right) f_i(e_i)de_i \\ &\quad +\frac{\alpha}{z}(1-\bar{c}_i/z)^{\alpha-1}(1-F_i(z-\bar{c}_i)),\end{aligned} \tag{22}$$

where $F_i(.)$ is a cumulative distribution function determined by the density function $f_i(.)$. Since the last term in equation (22) is positive, the sign of the whole is also positive if the first term is non-negative, which occurs when $\alpha \le 2$. If $\alpha > 2$, the sign of the whole is indeterminate, although it is likely to be negative when α is sufficiently large.

Similarly, the comparative statics with respect to z can be derived as

$$\frac{\partial p^T(c_i,z)}{\partial z} = \frac{\alpha}{z^2}\left[E\left((\bar{c}_i+\epsilon_i)\left(1-\frac{\bar{c}_i+\epsilon_i}{z}\right)^{\alpha-1}\right) - \bar{c}_i(1-\bar{c}_i/z)^{\alpha-1}\right], \qquad i \in S_1, \tag{23}$$

$$\begin{aligned}\frac{\partial p^T(c_i,z)}{\partial z} &= \frac{\alpha}{z^2}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left((\bar{c}_i+e_i)\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1}\right) f_i(e_i)de_i - \bar{c}_i(1-\bar{c}_i/z)^{\alpha-1}\right] \\ &= \frac{\alpha}{z^2}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left((\bar{c}_i+e_i)\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} - \bar{c}_i(1-\bar{c}_i/z)^{\alpha-1}\right) f_i(e_i)de_i \\ &\quad -\frac{\alpha}{z^2}\bar{c}_i(1-\bar{c}_i/z)^{\alpha-1}(1-F_i(z-\bar{c}_i)), \qquad i \in S_2,\end{aligned} \tag{24}$$

$$\frac{\partial p^T(c_i,z)}{\partial z} = \frac{\alpha}{z^2}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}(\bar{c}_i+e_i)\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} f_i(e_i)de_i \;>\; 0, \qquad i \in S_3. \tag{25}$$

The sign of expression (23) can be evaluated by investigating the curvature of $c_i(1-c_i/z)^{\alpha-1}$ with respect to c_i. When $\alpha > 2z/\bar{c}_i$, the function becomes strictly convex so that the whole expression within the bracket of expression (23) becomes positive, resulting in $\partial p^T(c_i,z)/\partial z > 0$. When $1 < \alpha < 2z/\bar{c}_i$, the opposite occurs so that the comparative statics becomes negative.

The sign of equation (24) is indeterminate in general because its second term in the bracket in the right hand side of the first expression, which is positive, is subtracted from its first term, which is also positive. The second expression of equation (24) shows that the sign of the whole is also negative when $\alpha \leq 2z/\bar{c}_i$. If $\alpha > 2z/\bar{c}_i$, the sign of the whole is indeterminate, although it is likely to be positive when α is sufficiently large.

(2) Clark-Watts Poverty Measures

From equation (8), we can derive

$$\frac{\partial p^T(c_i,z)}{\partial \bar{c}_i} = -\frac{1}{z}\left[E\left(\frac{\bar{c}_i+\epsilon_i}{z}\right)^{\beta-1} - (\bar{c}_i/z)^{\beta-1}\right], \qquad i \in S_1, \tag{26}$$

$$\begin{aligned}\frac{\partial p^T(c_i,z)}{\partial \bar{c}_i} &= -\frac{1}{z}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta-1} f_i(e_i)de_i - (\bar{c}_i/z)^{\beta-1}\right] \\ &= -\frac{1}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta-1} - (\bar{c}_i/z)^{\beta-1}\right) f_i(e_i)de_i \\ &\quad +\frac{1}{z}(\bar{c}_i/z)^{\beta-1}(1-F_i(z-\bar{c}_i)), \qquad i \in S_2,\end{aligned} \tag{27}$$

$$\frac{\partial p^T(c_i,z)}{\partial \bar{c}_i} = -\frac{1}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta-1} f_i(e_i)de_i \ < \ 0, \qquad i \in S_3. \tag{28}$$

The sign of expression (26) can be evaluated by investigating the curvature of $(c_i/z)^{\beta-1}$ with respect to c_i. Because $\beta \leq 1$, the function is always convex so that the whole expression within the bracket of expression (26) is positive, resulting in $\partial p^T(c_i,z)/\partial \bar{c}_i < 0$. This implies that expression (27) is the sum of a negative term as in expression (26) and a positive term. Therefore, its sign is indeterminate although it is likely to be negative when β is sufficiently negative.

Similarly, the comparative statics with respect to z can be derived as

$$\frac{\partial p^T(c_i,z)}{\partial z} = \frac{1}{z}\left[E\left(\frac{\bar{c}_i+\epsilon_i}{z}\right)^{\beta} - (\bar{c}_i/z)^{\beta}\right], \qquad i \in S_1, \tag{29}$$

$$\begin{aligned}\frac{\partial p^T(c_i,z)}{\partial z} &= \frac{1}{z}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta} f_i(e_i)de_i - (\bar{c}_i/z)^{\beta}\right] \\ &= \frac{1}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta} - (\bar{c}_i/z)^{\beta}\right) f_i(e_i)de_i \\ &\quad -\frac{1}{z}(\bar{c}_i/z)^{\beta}(1-F_i(z-\bar{c}_i)), \qquad i \in S_2,\end{aligned} \tag{30}$$

$$\frac{\partial p^T(c_i,z)}{\partial z} = \frac{1}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta} f_i(e_i)de_i \ > \ 0, \qquad i \in S_3. \tag{31}$$

The sign of expression (29) can be evaluated by investigating the curvature of $(c_i/z)^\beta$ with respect to c_i. When $\beta < 0$, the function becomes strictly convex so that the whole expression within the bracket of expression (29) becomes positive, resulting in $\partial p^T(c_i, z)/\partial z > 0$. When $0 < \beta < 1$, the opposite occurs so that the comparative statics becomes negative.

The sign of expression (30) is indeterminate in general. When $\beta \geq 0$, both the first and the second terms in the last expression become negative, implying that the whole comparative statics is negative. When $\beta < 0$, these two terms have opposite signs. Therefore, the sign of the whole comparative statistics is indeterminate although it is likely to be positive when β is sufficiently negative.

(3) Discussion

The sign of $\partial p^T(c_i, z)/\partial \bar{c}_i$ when i belongs to the always poor group (i.e., $i \in S_1$) is closely associated with the concept of *prudence* discussed in the consumer theory under risk (Kimball, 1990; 1993). When a consumer maximizes expected utility defined over a strictly concave von-Neumann Morgenstein utility function, he/she is said to be *prudent* when the marginal utility is decreasing and convex in the average wealth level. If this is satisfied, $\partial p^T(c_i, z)/\partial \bar{c}_i < 0$ holds. FGT measures with $\alpha > 2$ and Clark-Watts Measures with $\beta < 1$ are associated with $\partial p^T(c_i, z)/\partial \bar{c}_i < 0$ because these parametric restrictions are necessary for prudence.

In contrast, the sign of $\partial p^T(c_i, z)/\partial z$ when $i \in S_1$ is associated with the level of risk aversion. $\partial p^T(c_i, z)/\partial z > 0$ holds when the poor is sufficiently risk averse. For example, $\alpha > 2z/\bar{c}_i$ is sufficient for FGT measures and $\beta < 0$ is sufficient for Clark-Watts measures.

The sign of the comparative statics when $i \in S_2$ (usually poor) is indeterminate in many cases and it contradicts with the theoretically appealing pattern discussed in Section 2.3 in cases where the sign is determinate. This occurs because $p^T(c_i, z) \equiv E[p(c_i, z)] - p^C(c_i, z)$ and the second term dominates the first one in the determinate cases. The effect of a change in $\bar{c}_i$ or z through the first term is truncated above the poverty line whereas the effect through the second term is not truncated by definition of the usually poor. Although this characteristic of the usually poor is not appealing theoretically, whether it is sufficiently strong to affect the direction of the total change of P^T and P^C when a finite change occurs in $\bar{c}_i$ or z is left for empirical exercises. The case of Pakistan reported in this paper shows that it is not.

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Table 1. Definition of Poverty Status of Individuals

Status	Definition
Always poor	$\bar{c}_i + \bar{\epsilon}_i < z$
Usually poor	$\bar{c}_i + \bar{\epsilon}_i \geq z$ and $\bar{c}_i < z$
Occasionally poor	$\bar{c}_i + \underline{\epsilon}_i < z$ and $\bar{c}_i \geq z$
Always non-poor	$\bar{c}_i + \underline{\epsilon}_i \geq z$

Table 2. Likely Signs of the Distributional Effects

	Poverty Status			
	Always poor (N_1)	Usually poor (N_2)	Occasionally poor (N_3)	Always non-poor (N_4)
Sign of the expected change in N_k due to a change in:				
$\bar{c}$	–	(–, –)*, (–, +)*, (+, +)*		+
σ^2	–	+	+	–
z	+	(+, +)*, (+, –)*, (–, –)*		–
Sign of the initial value of individual poverty scores:				
p^C	+	+	0	0
p^T	+	+	+	0

Note: '*' indicates that these combinations are more likely. See Appendix 1 for details.

Table 3. Signs of the Comparative Statics of the Individual Effects

	Expected poverty attributable to:	
	Chronic poverty $p^C(c_i, z)$	Transient poverty $p^T(c_i, z)$
$\bar{c}_i$	$-$	This paper
σ_i^2	0	$+$
z	$+$	This paper

Notes: (1) 'This paper' indicates that the sign is investigated in this paper. (2) Atkinson-class poverty measures with strictly convex functional forms are assumed.

Table 4. Summary of the Comparative Statics of the Individual Effects

Parameter range		Poverty Status		
		Always poor	Usually poor	Occasionally poor
Poverty Gap ($\alpha = 1$ for FGT and $\beta = 1$ for Clark-Watts measures)				
$\bar{c}_i$	$\alpha = 1$, $\beta = 1$	0	$+$	$-$
z	$\alpha = 1$, $\beta = 1$	0	$-$	$+$
FGT measures with $\alpha > 1$				
$\bar{c}_i$	$1 < \alpha < 2$	$+$	$+$	$-$
	$\alpha = 2$	0	$+$	$-$
	$\alpha > 2$	$-$	?	$-$
z	$1 < \alpha < 2z/\bar{c}_i$	$-$	$-$	$+$
	$\alpha = 2z/\bar{c}_i$	0	$-$	$+$
	$\alpha > 2z/\bar{c}_i$	$+$	?	$+$
Clark-Watts measures with $\beta < 1$				
$\bar{c}_i$	$\beta < 1$	$-$	?	$-$
z	$0 < \beta < 1$	$-$	$-$	$+$
	$\beta = 0$	0	$-$	$+$
	$\beta < 0$	$+$	?	$+$

Notes: (1) This table shows the comparative statics of $p^T(c_i, z)$ (individual transient poverty scores) with respect to $\bar{c}_i$ (expected consumption) or z (poverty line). (2) For each group, the parameter range is listed in the order of increasing risk aversion. (3) '?' indicates that the sign is indeterminate. (4) See Appendix 2 for details.

Table 5. Sample Villages and the Panel Data (NWFP, Pakistan)

	Village A	Village B	Village C
1. Village Characteristics			
Agriculture	Rainfed	Rain/irrig.	Irrigated
Distance to main roads (km)	10	4	1
Population (1998 Census)	2,858	3,831	7,575
Adult literacy rates (1998 Census)	25.8	19.9	37.5
2. Characteristics of Panel Households			
Number of sample households	83	111	105
Average household size			
in 1996	10.75	8.41	8.95
in 1999	11.13	7.86	9.30
Average farmland owned			
in 1996 (ha)	2.231	0.516	0.578
in 1999 (ha)	2.258	0.517	0.595
Average per capita consumption			
in 1996 (nominal US$)	134.4	157.0	200.8
in 1999 (nominal US$)	133.5	143.1	198.3

Notes: (1) "Average per capita consumption" shows household averages of individual consumption c_{it}, with household size used as weights.
(2) "Average farmland owned" is an average over all the sample households.

Table 6. Estimates for Transient and Chronic Poverty Measures
Using Observed Consumption Data (NWFP, Pakistan)

		Based on the official poverty line z (1)	Based on 90% of z (2)	% change due to decrease in z (=100*[(2)/(1)-1])
Poverty Gap ($\alpha = 1$ for FGT and $\beta = 1$ for Clark-Watts measures)				
	P^T	0.024	0.023	–4.1
	P^C	0.189	0.141	–25.5
	P^T/P^C	0.129	0.166	+28.6
FGT measures with $\alpha > 1$				
$\alpha = 2$	P^T	0.017	0.015	–10.0
	P^C	0.069	0.047	–32.4
	P^T/P^C	0.242	0.323	+33.2
$\alpha = 3$	P^T	0.011	0.009	–17.9
	P^C	0.029	0.018	–37.1
	P^T/P^C	0.371	0.483	+30.4
Clark-Watts measures with $\beta < 1$				
$\beta = 0.5$	P^T	0.031	0.029	– 6.3
	P^C	0.211	0.155	–26.4
	P^T/P^C	0.146	0.186	+27.3
$\beta = 0$	P^T	0.040	0.036	–8.82
	P^C	0.239	0.173	–27.4
	P^T/P^C	0.167	0.210	+25.5
$\beta = -1$	P^T	0.071	0.061	–14.7
	P^C	0.315	0.221	–29.7
	P^T/P^C	0.226	0.275	+21.3
$\beta = -2$	P^T	0.139	0.110	–21.3
	P^C	0.437	0.296	–32.4
	P^T/P^C	0.319	0.371	+16.5
N_1		0.550	0.437	–20.4
N_2		0.131	0.137	+4.11
N_3		0.164	0.194	+17.8
N_4		0.155	0.232	+50.1

Note: P^T and P^C indicates the transient and chronic poverty measures respectively, according to the definition in equations (3) and (4).

Table 7. Estimates for Transient and Chronic Poverty Measures
Using Fitted Consumption Values (NWFP, Pakistan)

		Based on the official poverty line z (1)	Based on 90% of z (2)	% change due to decrease in z (=100*[(2)/(1)-1])
Poverty Gap ($\alpha = 1$ for FGT and $\beta = 1$ for Clark-Watts measures)				
	P^T	0.010	0.009	–9.1
	P^C	0.139	0.087	–37.8
	P^T/P^C	0.073	0.106	+46.0
FGT measures with $\alpha > 1$				
$\alpha = 2$	P^T	0.005	0.004	–22.6
	P^C	0.037	0.020	–47.0
	P^T/P^C	0.141	0.205	+46.0
$\alpha = 3$	P^T	0.003	0.002	–30.3
	P^C	0.012	0.005	–53.9
	P^T/P^C	0.222	0.336	+51.1
Clark-Watts measures with $\beta < 1$				
$\beta = 0.5$	P^T	0.012	0.011	–11.6
	P^C	0.150	0.092	–38.6
	P^T/P^C	0.079	0.114	+43.9
$\beta = 0$	P^T	0.014	0.012	–14.2
	P^C	0.163	0.099	–39.4
	P^T/P^C	0.087	0.123	+41.6
$\beta = -1$	P^T	0.020	0.016	–19.6
	P^C	0.195	0.114	–41.3
	P^T/P^C	0.105	0.144	+36.9
$\beta = -2$	P^T	0.031	0.023	–25.3
	P^C	0.236	0.134	–43.4
	P^T/P^C	0.129	0.171	+32.0
N_1		0.583	0.443	–24.0
N_2		0.125	0.088	–29.6
N_3		0.077	0.157	+104.2
N_4		0.216	0.313	+45.0

Note: P^T and P^C indicates the transient and chronic poverty measures respectively, according to the definition in equations (3) and (4).

Appendix Table: Estimation Results for the Consumption Generating Process

Explanatory variables	Dependent variable: Two-period mean of the log of consumption			Dependent variable: Log of cons. growth from 1996 to 1999		
Village fixed effects						
Village A	8.880	(47.77)	***	0.039	(0.240)	
Village B	8.953	(47.82)	***	0.047	(0.296)	
Village C	9.097	(48.41)	***	0.058	(0.363)	
Effects of asset values[1]						
Household assets	0.092	(4.893)	***	0.024	(1.884)	*
Credit outstanding	0.021	(1.305)		0.015	(1.279)	
Debt outstanding	0.013	(1.043)		0.005	(0.687)	
Farmland	0.024	(4.048)	***	0.003	(0.330)	
Livestock	0.062	(3.986)	***	0.025	(2.119)	**
Effects of household education						
Schooling years of the head	0.009	(1.418)		-0.005	(0.888)	
Highest schooling years of adults	-0.007	(1.215)		0.007	(1.488)	
Literacy rates among adults	0.139	(1.206)		-0.040	(0.381)	
Effects of household demography						
Female dummy for the head	-0.296	(1.826)	*	-0.106	(0.773)	
Age of the head	0.000	(0.028)		0.000	(0.474)	
Dependency ratio	-0.327	(3.856)	***	0.157	(2.120)	**
Female ratio	-0.137	(1.180)		-0.040	(0.393)	
Household size	-0.030	(6.855)	***	0.004	(0.876)	
Dummy variables for reported shocks and adjustments[2]				(Jointly significant, 1%)		
Mean of dependent variable	8.581			0.003		
Standard deviation of dep. var.	0.379			0.238		
R-squared	0.504			0.234		
Adjusted R-squared	0.478			0.083		
F statistics for zero slope	19.209		***	1.551		**

Notes: (1) As explanatory variables for "Effects of asset values," the log of one plus the two-period mean asset value (1000 Rs.) is used for the first model, whereas the log of (one plus asset value in 1999)/(one plus asset value in 1996) is used for the second model. (2) Thirty six dummy variables are used for reported positive and negative shocks and reported adjustments to those shocks. See Kurosaki and Khan (2001) for the list of these shocks and adjustments. (3) Estimated by the OLS. (4) The number of observations is 299. (5) The absolute values of t statistics are reported in the parenthesis with *** significant at 1%, ** at 5%, and * at 10% (two sided test).