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

Takashi Kurosaki †

November 2005 (previous versions: March 2004, March 2005)

*The author is grateful to two anonymous referees, the editor, Bob Baulch, Koji Yamazaki, and other seminar participants at the CPRC Conference (University of Manchester), Osaka City University, the Japanese Economic Association Annual Meeting, and Hitotsubashi University for useful comments on earlier versions of this paper.

†Institute of Economic Research, Hitotsubashi University, 2-1 Naka, Kunitachi, Tokyo 186-8603 Japan. Phone: 81-42-580-8363; Fax.: 81-42-580-8333. E-mail: kurosaki@ier.hit-u.ac.jp.

The Measurement of Transient Poverty:
Theory and Application to Pakistan

November 2005 (previous versions: March 2004, March 2005)

Keywords: chronic poverty, poverty measurement, prudence, risk, transient poverty.

Abstract

The present paper investigates the measurement of transient poverty when each person's welfare level fluctuates due to exogenous risk. The paper namely characterizes the sensitivity of transient/chronic poverty decomposition with respect to the poverty line and to the expected welfare level so that the decomposition analysis will be based on solid theoretical foundations and be robust empirically. Theoretical results show that poverty measures associated with prudent risk preferences perform better than other measures in assuring that the value of transient poverty increases with the depth of chronic poverty and that the decomposition is not highly sensitive to the poverty line. Poverty measures such as those associated with constant relative risk aversion are thus superior to popular Foster-Greer-Thorbecke (FGT) measures such as headcount, poverty gap, and squared poverty gap indices. These theoretical arguments are confirmed empirically by the application of the decomposition to a two-period household panel dataset from rural Pakistan. The relative magnitudes of transient versus chronic poverty are more robust to changes in the poverty line when poverty measures associated with constant relative risk aversion are used than when FGT poverty measures are used.

1 Introduction

Suppose that a person's poverty status is defined by his/her consumption level relative to a poverty line z, which is given exogenously to this person. For example, person A's consumption is always below z with the deviation of, say, 25% of z. Then this person is always poor and his/her *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 person B's chronic and *transient poverty* status be characterized? Given various types of individuals including persons A and B, how can each person's poverty status be aggregated into measures of chronic and transient poverty? These are the topics of this paper.

Investigating poverty from a dynamic perspective is expected to provide useful insights for poverty reduction policies (World Bank, 2000). Nevertheless, the measurement of transient poverty is a relatively under-explored area of research. If one is interested only in headcount measures, a cross section of individuals could be divided into four categories: the always poor, the transiently poor with their mean consumption below z, the transiently poor with their mean consumption above z, and the always non-poor.[1] 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 may not be satisfactory since the welfare cost of consumption variability for the always poor is likely to be ignored.[2] This argument is a dynamic extension of the criticism against the (static) headcount index for its tendency to ignore the depth of poverty below the poverty line (Sen, 1981).

[1] As discussed by Hulme and Shepherd (2003), another category can be added in the middle, the "churning poor," with their average consumption level close to the poverty line so that they are poor in some periods but not in other periods.

[2] One way to incorporate the poverty depth in such analyses is to adopt more detailed categories such as "always very poor," "always moderately poor," "usually moderately poor but sometimes very poor," and so on.

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 a welfare indicator (i.e., consumption in this paper). If there is no fluctuation in consumption 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 consumption. Because of this, later studies called the expected value of a poverty measure "total poverty," its component corresponding to the expected value of consumption "chronic poverty," and the residual "transient poverty." This terminology is also adopted in this paper. Since this decomposition is both practically manageable and theoretically founded on the expected utility hypothesis, 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; Baulch and Hoddinott, 2000). These studies have shown that transient poverty is as important as chronic poverty and its relative importance differs across regions and across social strata. The relative importance of transient poverty adds information not included in the total poverty measure. The additional information is valuable for a policymaker since it can be used to guide targeting and adjusting poverty reduction policies with due considerations paid to the vulnerability of consumption to risk.[3]

For this purpose, it is desirable that the decomposition analysis be based on solid theoretical foundations and be robust empirically. With this motivation, this paper reexamines Ravallion's (1988) decomposition. The main question is to search for a transient poverty measure with a property that it does not decrease with the depth of chronic deprivation and that the relative importance of transient poverty is not highly sensitive to the poverty line. In Section 2, the response of transient and chronic poverty decomposition to risk, the poverty line, and income growth is discussed theoretically, associating

[3]See Ligon and Schechter (2003), Calvo and Dercon (2005), and Kurosaki (2006) for the literature focusing on measuring vulnerability from angles different from this paper's.

the poverty measurement literature with the expected utility theory. Since the theoretical analysis cannot yield an unambiguous answer to the main question for a finite change in the poverty line, an empirical illustration is given in Section 3. The transient/chronic decomposition is applied to a two-period household panel dataset collected in Pakistan using various poverty measures and poverty lines. Section 4 concludes the paper, suggesting the direction of choices of poverty measures in empirical analyses.

2 Theoretical Framework

2.1 Decomposing Total Poverty into Chronic and Transient Components

This paper views poverty as a continuous phenomenon where the welfare cost of poverty increases with the size of deprivation under the poverty line. For convenience, welfare is measured by consumption. 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. Because of the scale invariance axiom, only x_i ($\equiv c_i/z$) matters. The analysis in this paper is limited to the class of poverty measures that are additively separable, symmetric, taking the value of zero for the consumption level exactly at z, and non-decreasing with the depth of poverty. Then,

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

where $p(x_i) = 0$ when $x_i \geq 1$, $p(x_i) > 0$ when $x_i < 1$, and $\partial p/\partial x_i \leq 0$ when $x_i < 1$.

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

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

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

$$P^T \equiv P^P - P^C = \frac{1}{N}\sum_{i=1}^{N}\{E[p(x_i)] - p(E[x_i])\}, \qquad (4)$$

where $E[.]$ is an expectation operator. The expected value P^P is *total poverty*, its component corresponding to the expected consumption P^C is *chronic poverty*, and the residual P^T reflecting the transient component of consumption is *transient poverty*. 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 the function $p(x_i)$ belongs to the class of Atkinson's (1987) poverty measures and is strictly convex in x_i when $x_i < 1$.

Poverty measurement by equation (1) can be interpreted as a social welfare function to aggregate the loss of individual welfare due to low consumption. The transient poverty component P^T can be interpreted as the welfare cost of consumption fluctuation for the poor and the chronic poverty component P^C can be interpreted as the welfare cost due to the low level of expected consumption. Then, the adoption of a particular function $p(.)$ for the decomposition analysis should imply that a particular type of preferences is assumed for the social planner. For example, the adoption of a strictly convex function for $p(.)$ is equivalent to assuming a risk-averse and inequality-averse social planner. Among FGT poverty measures with $p(x_i) = (1-x_i)^\alpha$, the condition $\alpha > 1$ satisfies this assumption. For this reason, all of the existing studies on the chronic and transient poverty decomposition employed an FGT measure with $\alpha = 2$, the squared poverty gap index (a measure of poverty severity) (Ravallion, 1988; Jalan and Ravallion, 1998; Ravallion et al., 1995; Baulch and Hoddinott, 2000). The use of the squared poverty gap index is equivalent to assuming a quadratic utility function for the social planner.

However, the existing studies did not investigate what this functional form implies for the social planner's preferences and for the empirical robustness of the decomposition with respect to the poverty line and expected consumption. This paper will explore this issue and derive the sensitivity of transient poverty measurement with respect to the choice of a poverty measure, when income grows (the expected level of c_i increases for everybody), or consumption risk rises (the variability of c_i increases for everybody), or the poverty line z changes. This exercise will thus make sure that the transient/chronic poverty decomposition analysis has solid theoretical foundations and is empirically robust

2.2 Comparative Static Analysis

The stochastic nature of consumption is specified as $c_i = \bar{c}_i + \epsilon_i$, where ϵ_i is a zero mean disturbance with its cumulative distribution function $F_i(\epsilon_i)$. It is assumed 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, the possibility of sustained growth or decline of $\bar{c}_i$ over time is ruled out in this specification but the possibility can be incorporated by making $\bar{c}_i$ and σ_i^2 time-varying.[4] Across individuals, three cumulative distribution functions are defined as $G_M(.)$ for the mean consumption $\bar{c}_i$, $G_L(.)$ for the minimum consumption $\bar{c}_i + \underline{\epsilon}_i$, and $G_H(.)$ for the maximum consumption $\bar{c}_i + \bar{\epsilon}_i$.

Given these assumptions and depending on the values of $\bar{c}_i$, $\bar{c}_i + \underline{\epsilon}_i$, and $\bar{c}_i + \bar{\epsilon}_i$, each individual in the population of size N is classified into either of the four poverty statuses: (1) *always poor*, (2) transiently poor with $\bar{c}_i$ below z, (3) transiently poor with $\bar{c}_i$ equal to or above z, and (4) *always non-poor*. Borrowing the terminology from Hulme and Shepherd (2003), the second category is called the *usually poor* and the third is called the *occasionally poor* in this paper. Their definitions and the shares in the population are summarized in table 1.

Thus, to clarify these statuses, 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

[4] When $\bar{c}_i$ and σ_i^2 are time-varying, the theoretical argument in Section 2 holds with the addition of time subscript to the chronic and transient components.

non-poor ($N = N_1 + N_2 + N_3 + N_4$). Noting that $x_i = \bar{c}_i/z + \epsilon_i/z \equiv \bar{x}_i + \epsilon_i/z$, equations (3) and (4) can be rewritten as

$$P^C = \frac{1}{N}\sum_{i=1}^{N} p(\bar{x}_i) \equiv \frac{1}{N}\sum_{i=1}^{N} p_i^C = \frac{N_1}{N}\left(\frac{1}{N_1}\sum_{i\in S_1} p_i^C\right) + \frac{N_2}{N}\left(\frac{1}{N_2}\sum_{i\in S_2} p_i^C\right), \quad (5)$$

$$\begin{aligned} P^T &= \frac{1}{N}\sum_{i=1}^{N}\{E[p(\bar{x}_i + \epsilon_i/z)] - p(\bar{x}_i)\} \equiv \frac{1}{N}\sum_{i=1}^{N} p_i^T \\ &= \frac{N_1}{N}\left(\frac{1}{N_1}\sum_{i\in S_1} p_i^T\right) + \frac{N_2}{N}\left(\frac{1}{N_2}\sum_{i\in S_2} p_i^T\right) + \frac{N_3}{N}\left(\frac{1}{N_3}\sum_{i\in S_3} p_i^T\right), \end{aligned} \quad (6)$$

where newly defined functions p_i^C and p_i^T are chronic and transient poverty scores at the individual level. The term in the first parenthesis of the last expression in equation (5) shows the chronic poverty components attributable to the always poor group and the term in the second shows those attributable to the usually poor group. Similarly, the term in the first parenthesis of the last expression in equation (6) shows the transient poverty components attributable to the always poor group, the term in the second shows those attributable to the usually poor group, and the term in the third shows those attributable to the occasionally poor group. By definition (see table 1), the always non-poor contribute neither to the transient poverty P^T nor to the chronic poverty P^C, and the occasionally poor do not contribute to the chronic poverty P^C.

When $\bar{c}_i$, σ_i^2, or z changes, N_k, p_i^C, and p_i^T will respond. For an *infinitely small change*, however, the changes in N_k are cancelled out according to equations (5) and (6) so that the response can be investigated by a comparative static analysis of p_i^C and p_i^T with respect to $\bar{c}_i$, σ_i^2, and z, differentiated by an individual's poverty status k. By definition, $\partial p_i^C/\partial\sigma_i^2 = 0$. If $p(x_i)$ belongs to a class of Atkinson's poverty measures, $\partial p_i^C/\partial\bar{x}_i < 0$ so that $\partial p_i^C/\partial\bar{c}_i < 0$ and $\partial p_i^C/\partial z > 0$ for all individuals with $p_i^C > 0$ (i.e., chronic poverty increases when the expected deprivation from the poverty line increases). In other words, the assumption of a quasi-concave utility function for the social planner is sufficient to assign signs in the comparative static analysis of the chronic poverty measure.

Regarding the transient poverty measure, Ravallion (1988, Proposition 2) has already shown that $\partial p_i^T/\partial\sigma_i^2 > 0$ for all individuals with $p_i^T > 0$ if $p(x_i)$ belongs to a narrower class of strictly convex functions of Atkinson's poverty measures. This assures that transient poverty increases when risk increases and corresponds to the assumption of a strictly concave utility function for the social planner (i.e., risk-averse preference). Therefore, the task for this paper is to assign signs of $\partial p_i^T/\partial\bar{c}_i$ and $\partial p_i^T/\partial z$ for individuals with $p_i^T > 0$ (table 2).

Taking the second-order Taylor approximation to the total poverty score for individual i who belongs to S_1,

$$p_i^P \equiv E[p(\bar{x}_i + \epsilon_i/z)] \approx p(\bar{x}_i) + p'(\bar{x}_i)E[\epsilon_i/z] + \frac{1}{2}p''(\bar{x}_i)E[\epsilon_i^2/z^2] = p_i^C + \frac{1}{2z^2}p''(\bar{x}_i)\sigma_i^2, \quad (7)$$

which indicates that

$$p_i^T \approx \frac{1}{2z^2}p''(\bar{x}_i)\sigma_i^2. \quad (8)$$

Since $\partial\bar{x}_i/\partial c_i = 1/z > 0$, equation (8) indicates that the sign of $\partial p_i^T/\partial\bar{c}_i$ is the same as that of $p'''(\bar{x}_i)$. This paper argues that the welfare cost of consumption fluctuation should be evaluated heavier when an individual's permanent consumption level is lower and that this view should be reflected in the magnitude of a transient poverty measure. The reason is that the same variance of consumption puts a heavier welfare burden on the extreme poor than on the moderately poor or on the non-poor, and this burden would not have occurred if there was no fluctuation so that the burden should be attributed to the transient poverty measure. If this argument is accepted, a desirable property is $\partial p_i^T/\partial\bar{c}_i < 0$. If one believes instead that the additional welfare burden due to consumption fluctuation occurring at a deeper poverty level should only be reflected in a chronic poverty measure, the transient poverty measure should show $\partial p_i^T/\partial\bar{c}_i = 0$. It is difficult to find an axiomatic reason to support $\partial p_i^T/\partial\bar{c}_i > 0$ because this inequality implies that the welfare cost of the same variance of consumption is given a lighter weight for the poorer than for the less poor.

Interpreting the poverty score function as a negative of utility function for the social planner, $p'''(\bar{x}_i) < 0$ corresponds to "prudence" discussed in the expected utility theory (Kimball, 1990). When consumers maximize their expected utility defined over a strictly concave von-Neumann Morgenstein utility function, they are said to be *prudent* when the marginal utility is decreasing and convex in the average wealth level. Prudent risk preferences guarantee that the welfare cost of consumption fluctuation decreases with the level of expected consumption.

Poverty score functions associated with prudent risk preferences have another characteristic. Such poverty score functions have a property that the same amount of income transfer between a relatively rich person and a relatively poor person, both below the poverty line, matter more if the transfer takes place at the lower level of expected wealth. Thus Kakwani's (1980) "Transfer-Sensitivity II Axiom" is satisfied when such poverty score functions are adopted. Since "Transfer-Sensitivity II Axiom" is meant for the measure of "total poverty" in the terminology of this paper, the adoption of such functional forms has never been discussed in the context of the transient poverty measurement. The analysis here shows that the adoption of poverty score functions associated with prudence has the advantage that the transient poverty measure behaves in a more desirable way. The response of p_i^T to σ_i^2 is related to the sign of the second derivative of $p(.)$ and thus depends on whether the social planner is risk-averse, and poverty score functions associated with risk aversion satisfy Sen's "Transfer Axiom" for the total poverty measure. In contrast, the response of p_i^T to $\bar{c}_i$ is related to the sign of the third derivative of $p(.)$ and thus depends on whether the social planner is prudent, and poverty score functions associated with prudence satisfy the transfer sensitivity axiom for the total poverty measure.

Based on the approximation given in (8), the sign of $\partial p_i^T / \partial z$ when $i \in S_1$ can be investigated as

$$\frac{\partial p_i^T}{\partial z} \approx -\frac{p''(\bar{x}_i)}{z^3}\sigma_i^2 \left(1 - \frac{1}{2}\psi_i(\bar{x}_i)\right), \tag{9}$$

where $\psi_i(\bar{x}_i) \equiv -\frac{p'''(\bar{x}_i)}{p''(\bar{x}_i)}\bar{x}_i$, which is the coefficient of relative prudence suggested by Kimball (1990). The net impact of an increase in z depends on the two impacts of such an increase: the decrease in ϵ_i/z and its effect through decreasing $\bar{x}_i$. Equation (9) indicates that the sign of the net impact depends on the degree of prudence. This paper treats it as desirable to have a property $\partial p_i^T/\partial z \geq 0$ because the same risk should not be evaluated lighter in measuring transient poverty when the community reference level of welfare, which is summarized in z, is raised.

From a practical perspective, another reason to oppose a transient poverty measure with the property $\partial p_i^T/\partial z < 0$ is that this implies that p_i^C and p_i^T move in the opposite directions when z is changed marginally. Given the arbitrariness involved in determining z, the literature emphasizes the importance of investigating the sensitivity of poverty measures with respect to the poverty line (Atkinson, 1987). When the dynamics of poverty is analyzed using the transient/chronic poverty decomposition, the relative magnitudes may be highly sensitive to the poverty line if their partials move in the opposite directions. Instead, if the partials move in the same directions, the relative magnitudes of transient/chronic poverty components become more robust to the level of z. Therefore, poverty measures associated with $\partial p_i^T/\partial z \geq 0$ are appealing from a practical reason as well. From equation (9), it is obvious that a high degree of prudence is required for p_i^T to increase with z. More specifically, $\psi_i(\bar{x}_i) > 2$ implies that $\partial p_i^T/\partial z > 0$. The threshold value of $\psi_i(\bar{x}_i) = 2$ is associated with a logarithmic utility function of the social planner.

For occasionally poor individuals ($i \in S_3$), signs of $\partial p_i^T/\partial \bar{c}_i$ and $\partial p_i^T/\partial z$ are determinate. For such individuals, $p_i^T = p_i^P$ by definition and the level of poverty score is decreasing in $\bar{c}_i$ and increasing in z for all states of nature when $x_i < 1$, as long as

$\partial p/\partial x_i < 0$. Therefore, the assumption of a quasi-concave utility function is sufficient to obtain the desirable properties that $\partial p_i^T/\partial \bar{c}_i < 0$ and $\partial p_i^T/\partial z > 0$.

For usually poor individuals ($i \in S_2$), it is not possible to assign signs to $\partial p_i^T/\partial \bar{c}_i$ and $\partial p_i^T/\partial z$ without making additional assumptions about the distribution of ϵ_i. This is because $p_i^T \equiv E[p(x_i)] - p(\bar{x}_i)$, where the response of the second term may dominate in several 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 the definition of the usually poor. This indicates that a high degree of prudence is required for $i \in S_2$ to have $\partial p_i^T/\partial \bar{c}_i < 0$.

To summarize, first, a decrease in the expected welfare level ($\bar{c}_i$) will increase transient poverty of the always poor if the transient poverty is measured by the Atkinson class of poverty measures with a negative third derivative (i.e., if the social planner is prudent). Second, an increase in the poverty line (z) will increase transient poverty of the always poor if the transient poverty is measured by the Atkinson class of poverty measures with a sufficiently negative third derivative (i.e., if the social planner is sufficiently prudent).

2.3 Examples

Two groups of poverty measures are investigated, for which exact conditions can be derived without using Taylor approximation, to determine the signs of $\partial p_i^T/\partial \bar{c}_i$ and $\partial p_i^T/\partial z$ when $i \in S_1$. The first was proposed by Foster et al. (1985), in a general functional form

$$p(x_i) = (1 - x_i)^{\alpha}, \tag{10}$$

when $x_i < 1$, and $p(x_i) = 0$ when $x_i \geq 1$, where α is a non-negative parameter. This group, known as FGT poverty measures, is widely used in empirical applications. The headcount index ($\alpha = 0$), the poverty gap index ($\alpha = 1$), and the squared poverty gap index ($\alpha = 2$) are special cases included in this group. When $\alpha > 1$, the function becomes strictly convex so that it has a property of $\partial p_i^T/\partial \sigma_i^2 > 0$. When $\alpha > 2$, the function is associated with prudent risk preferences.

Another group of poverty measures was proposed by Clark et al. (1981) and its general form is

$$p(x_i) = \frac{1}{\beta}(1 - x_i^{\beta}), \tag{11}$$

when $x_i < 1$, and $p(x_i) = 0$ when $x_i \geq 1$, where $\beta \leq 1$. This group, known as Clark-Watts poverty measures, includes the poverty gap index ($\beta = 1$) and Watts' measure ($\beta = 0$) as special cases.[5] When $\beta < 1$, the function becomes strictly convex so that it has a property that risk always increases transient poverty. Clark-Watts poverty measures are associated with constant relative risk aversion where Arrow-Pratt's coefficient of relative risk aversion equals $1 - \beta$. Therefore, risk aversion ($\beta < 1$) also implies prudence.

Results are summarized in table 3 whose derivation is given in the appendix. First of all, the arguments in the previous subsection are perfectly valid for these two measures when $i \in S_1$. For FGT measures, prudence requires $\alpha > 2$, which is required for $\partial p^T(c_i, z)/\partial \bar{c}_i < 0$. Kimball's coefficient of relative prudence (ψ_i) is greater than 2 when $\alpha > 2z/\bar{c}_i$, which is required for $\partial p^T(c_i, z)/\partial z > 0$. For Clark-Watts measures, prudence implies $\beta < 1$, which is required for $\partial p^T(c_i, z)/\partial \bar{c}_i < 0$ and $\psi_i > 2$ is equivalent to $\beta < 0$, which is required for $\partial p^T(c_i, z)/\partial z > 0$. Therefore, 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 not satisfied by the FGT measures usually employed in the literature. The squared poverty gap index ($\alpha = 2$), which is popular in the empirical studies, has the 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 FGT measure for severity is justified only if one accepts that the welfare cost of consumption fluctuation is independent of the depth of chronic poverty captured by $\bar{c}_i$.

In sharp contrast, the theoretically appealing combination of $\partial p^T(c_i, z)/\partial \bar{c}_i \leq 0$ and

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

$\partial p^T(c_i, z)/\partial z \geq 0$ is found for a wider range of values of the parameter β that appears in the Clark-Watts 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 a constant relative risk aversion utility function, the condition $\beta < 0$ can be translated as a relative risk aversion coefficient larger than one. This is not off the mark of the ranges found in the empirical literature on risk preferences in developing economies (Kurosaki and Fafchamps, 2002).

From the analytical results given in table 3, it is however not possible to predict the response of the transient-chronic decomposition to a *finite change* in the poverty line because the result depends also on the distribution of individual consumption, that is, on the parameters characterizing $F_i(.)$, $G_M(.)$, $G_L(.)$, and $G_H(.)$. Another reason for the indeterminacy is the ambiguity of signs in the comparative static analysis when individuals belong to the usually poor ($i \in S_2$). Therefore, the total response to a finite change in the poverty line is investigated empirically in the next section.

3 Application to Rural Pakistan

3.1 Data

This section applies the transient/chronic poverty decomposition to a panel dataset compiled from sample household surveys implemented in 1996 and 1999 in the Peshawar District of Pakistan's North-West Frontier Province (NWFP). NWFP is one of the four provinces of Pakistan. The incidence of income poverty in this area was estimated at around 40 to 50% throughout the 1990s and it was the highest among the four provinces (World Bank, 2002).

Details of the 1996 household survey are given by Kurosaki and Hussain (1999) and those of the 1999 household survey are given by Kurosaki and Khan (2001). The three villages surveyed are similar in their size, socio-historical background, and tenancy structure, but are different in levels of economic development (irrigation and market access). Table 4 summarizes the characteristics of the sample villages and households. Village A is rainfed and is located at some distance from the main roads. This village serves as an example of the least developed villages with high risk in farming. Village C is fully irrigated and is located close to a national highway, serving thus 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, 304 households were resurveyed in 1999. Among those resurveyed, three had been divided into multiple households[6] and two had incomplete information on consumption. Therefore, a balanced panel of 299 households with two periods is employed in this section. As shown by Kurosaki (2006), attrition bias from using this subsample does not seem to be serious.

Average household sizes are larger in village A than in villages B and C, reflecting the stronger prevalence of an extended family system in village A. Average landholding sizes are also larger in village A than in villages B and C. Since the productivity of 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, and 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.[7] Average consumption per capita

[6]In the survey, a household is defined as a unit of coresidence and shared 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 a kitchen.

[7]The actual number of household members was used in this paper as a measure of household size. Alternatively, the household size can be estimated in terms of an equivalence scale that reflects differences in the sex/age structure and corrects for economies of scale (Lanjouw and Ravallion, 1995). Results under the alternative specifications were qualitatively the same as those reported in this paper.

is lowest in village A and highest in village C (table 4), although intra-village variation is much larger than inter-village variation. During the three years following 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 villages during the study period.

3.2 Empirical Results

To apply the theoretical decomposition to the dataset thus described, the official poverty line of the Government of Pakistan (CRPRID, 2002) is adopted as a reference poverty line. Based on this poverty line, 55.0% of individuals are classified as *always poor*, 13.1% as *usually poor*, 16.4% as *occasionally poor*, and 15.5% as *always non-poor* (see the last rows of table 5).

Table 5 reports decomposition results for several choices of popular poverty measures. The total poverty P^P according to equation (2) is defined as the average of poverty measures calculated for each period using the observed consumption. Using the poverty gap index, P^P is estimated at 21.3%. Reflecting the low living standard in the study villages, this figure is substantially higher than the one estimated for the entire country (7.0%) by the World Bank (2002). A sensitivity analysis shows that when the poverty line is reduced to 90% of the official poverty line,[8] the poverty gap index becomes equal to 16.4%.

The chronic poverty P^C according to equation (3) is calculated on the basis of the two-period mean consumption. By subtracting P^C from P^P, one derives the measure for transient poverty (P^T) . Since the properties of the total poverty measure P^P are examined in detail in the existing literature and those of P^C can be examined in an analogous way, the focus here is on the absolute value of P^T and its relative importance.

[8] A wider range of alternative values for the poverty line was examined than the one listed in Table 5. See figure 1.

The relative measure, $P^T/P^P = P^T/(P^C + P^T)$ is adopted for two reasons: first, it has the intuitive meaning of how much of the observed poverty can be attributable to the variability of consumption, and, second, it is widely used in the literature (Ravallion, 1988; Jalan and Ravallion, 1998; Ravallion et al., 1995; Baulch and Hoddinott, 2000).[9] Transient poverty is indeed large in this sample – it is estimated at 0.017 (19.5% of the total poverty) when the squared poverty gap index is used and 0.040 (14.3% of the total poverty) when Watts' poverty measure is used. As expected from the definition of these poverty measures, the relative importance of transient 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. When the poverty line is reduced to 90% of the official poverty line, all of the figures for chronic poverty (P^C) in table 5 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 2). In contrast, the direction of change in transient poverty (P^T) is indeterminate theoretically (tables 2-3). Table 5 shows that P^T decreases empirically regardless of the choice of a poverty measure. However, when a wider range of the poverty line is examined, the direction of change can take both signs when the poverty gap or the squared poverty gap indices are used (see the top panel of figure 1).

To investigate the sensitivity of the relative importance of transient poverty to the choice of a poverty measure, the last column of table 5 reports the ratio of changes due to a decrease in z. The transient poverty share (P^T/P^P) increases by 25.1% when the squared poverty gap is used and by 21.1% when Watts' poverty measure is used. Under this criteria, a Clark-Watts measure with $\beta = -2$ performs the best among those shown

[9] Results under the alternative measure of P^T/P^C were qualitatively the same as those reported in this paper.

in table 5: it predicts only an increase of 12.0% when the poverty line is decreased by 10%. An FGT measure with $\alpha = 3$ does not improve the situation much. The dependence of the results on the choice of the poverty measure is shown graphically in the bottom panel of figure 1. The response of the transient poverty ratio to a decline in the poverty line is much smaller when a Clark-Watts measure with $\beta = -2$ is used than when the poverty gap or the squared poverty gap measures are used. A Clark-Watts measure with $\beta = -2$ corresponds to a coefficient of relative risk aversion of 3, which seems high but consistent with empirical studies based on farmers' behavior in South Asia (Kurosaki and Fafchamps, 2002). The relative magnitudes of transient versus chronic poverty are therefore more robust to changes in the poverty line when Clark-Watts measures are used than when FGT poverty measures are used.

In calculating these numbers, the observed changes in consumption are treated as actual changes that happened to households due to transient shocks such as weather, diseases/injuries, and macroeconomic fluctuations. It is however possible that some of the actual changes were attributable to sustained growth or decline (i.e., social mobility) and some of the observed changes were due to measurement errors. Since the field survey indicates that cases with sustained growth or decline were very rare, it is safe to rule out the possibility of social mobility in the empirical analysis as in the theoretical section. To control for measurement errors, a decomposition based on fitted values of chronic and transient consumption was also attempted, in which instrument variables such as household characteristics that contribute to generating permanent income and various variables that proxy transient shocks were employed to identify each component of consumption. The results, which are reported by Kurosaki (2003), were qualitatively the same as those reported here: Clark-Watts measures perform better than FGT measures in terms of the robustness of the transient poverty shares to changes in z.

4 Conclusion

This paper investigated the measurement of transient poverty when each person's welfare level fluctuates due to exogenous risk. It examined the sensitivity of Ravallion's (1988) decomposition into transient and chronic poverty components to the poverty line and to the expected welfare level and presented a decomposition analysis that was based on solid theoretical foundations and was empirically robust.

The theoretical investigation based on a comparative static analysis showed that poverty measures associated with prudent risk preferences are superior in the sense that they guarantee that transient poverty measures behave in a desirable way. The use of FGT poverty measures developed by Foster et al. (1985) with $\alpha \leq 2$ is not recommended if one accepts that the welfare cost of consumption fluctuation should increase with the depth of chronic deprivation and that the decomposition into transient/chronic poverty should not be highly sensitive to the poverty line. Other poverty measures such as those associated with constant relative risk aversion (Clark et al., 1981) are superior in these respects. Analytical results cannot however completely predict the response of the transient/chronic decomposition to a finite change in the poverty line because the result depends also on the shapes of the entire distribution of individual consumption. The sensitivity was, therefore, investigated empirically using a two-period household panel dataset collected in Pakistan. Decomposition results showed that a Clark-Watts measure with moderate risk aversion and prudence performs better than FGT measures in terms of the robustness of the decomposition to changes in the poverty line.

The findings of this paper tend thus to warn us against the use of only three measures of FGT families (headcount, poverty gap, and squared poverty gap indices) in the dynamic analysis of poverty. The size of transient poverty and its relative importance in total poverty convey useful information that helps understanding the nature of poverty across regions and across social strata, thereby potentially contributing to better targeting and adjusting poverty reduction policies when risk plays an important role. It is therefore critically important to use robust measures. From this viewpoint, the use of Clark-Watts poverty measures with moderate risk aversion should be recommended, especially when implementing a transient/chronic poverty decomposition analysis.

The analysis in this paper can be extended in several directions. Empirically, similar exercises using panel datasets with a longer time horizon, with more households, or for countries with higher incomes could be interesting. They would complement the case examined here that was based on a small household dataset with a short time horizon where the incidence of income poverty is very high.

Appendix: Comparative Statics for FGT and Clark-Watts Poverty Measures

Since $\partial p_i^T/\partial \bar{c}_i < 0$ and $\partial p_i^T/\partial z > 0$ when $i \in S_3$, as discussed in the text, this appendix deals with cases $i \in S_1$ or S_2.

(1) FGT Poverty Measures

From equations (4) and (10),

$$\frac{\partial p_i^T}{\partial \bar{c}_i} = -\frac{\alpha}{z}\left[E\left(1-\frac{\bar{c}_i+\epsilon_i}{z}\right)^{\alpha-1} - (1-\bar{x}_i)^{\alpha-1}\right], \qquad i \in S_1, \tag{12}$$

$$\frac{\partial p_i^T}{\partial \bar{c}_i} = -\frac{\alpha}{z}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} dF_i(e_i) - (1-\bar{x}_i)^{\alpha-1}\right], \quad i \in S_2. \tag{13}$$

The sign of expression (12) can be evaluated by investigating the curvature of $(1-x_i)^{\alpha-1}$ with respect to x_i. When $\alpha > 2$, the function becomes strictly convex so that the whole expression within the bracket in expression (12) becomes positive, resulting in $\partial p_i^T/\partial \bar{c}_i < 0$. When $1 < \alpha < 2$, the opposite occurs so that the derivative becomes positive.

The sign of expression (13) 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 (13) can be transformed further as

$$\begin{aligned}\frac{\partial p_i^T}{\partial \bar{c}_i} &= -\frac{\alpha}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} - (1-\bar{x}_i)^{\alpha-1}\right) dF_i(e_i) \\ &\quad +\frac{\alpha}{z}(1-\bar{x}_i)^{\alpha-1}(1-F_i(1-\bar{x}_i)).\end{aligned} \tag{14}$$

Since the last term in equation (14) is positive, the sign of the whole is also positive if the first term is non-negative, which occurs when $\alpha \leq 2$. If $\alpha > 2$, the sign of the whole is indeterminate in general. It becomes negative when α is sufficiently large because the first term dominates the second term in equation (14).

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

$$\frac{\partial p_i^T}{\partial z} = \frac{\alpha}{z}\left[E\left((\frac{\bar{c}_i+\epsilon_i}{z})\left(1-\frac{\bar{c}_i+\epsilon_i}{z}\right)^{\alpha-1}\right) - \bar{x}_i(1-\bar{x}_i)^{\alpha-1}\right], \qquad i \in S_1, \tag{15}$$

$$\begin{aligned}\frac{\partial p_i^T}{\partial z} &= \frac{\alpha}{z}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left((\frac{\bar{c}_i+e_i}{z})\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1}\right) dF_i(e_i) - \bar{x}_i(1-\bar{x}_i)^{\alpha-1}\right] \\ &= \frac{\alpha}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left((\frac{\bar{c}_i+e_i}{z})\left(1-\frac{\bar{c}_i+e_i}{z}\right)^{\alpha-1} - \bar{x}_i(1-\bar{x}_i)^{\alpha-1}\right) dF_i(e_i) \\ &\quad -\frac{\alpha}{z}\bar{x}_i(1-\bar{x}_i)^{\alpha-1}(1-F_i(1-\bar{x}_i)), \qquad i \in S_2.\end{aligned} \tag{16}$$

The sign of expression (15) can be evaluated by investigating the curvature of $x_i(1-x_i)^{\alpha-1}$ with respect to x_i. When $\alpha > 2z/\bar{c}_i$, the function becomes strictly convex so that the whole expression within the bracket in expression (15) becomes positive, resulting in $\partial p_i^T/\partial z > 0$. When $1 < \alpha < 2z/\bar{c}_i$, the opposite occurs so that the derivative becomes negative.

The sign of equation (16) 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 (16) 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 becomes positive when α is sufficiently large.

(2) Clark-Watts Poverty Measures

From equations (4) and (11),

$$\frac{\partial p_i^T}{\partial \bar{c}_i} = -\frac{1}{z}\left[E\left(\frac{\bar{c}_i+\epsilon_i}{z}\right)^{\beta-1} - \bar{x}_i^{\beta-1}\right], \qquad i \in S_1, \tag{17}$$

$$\begin{aligned}\frac{\partial p_i^T}{\partial \bar{c}_i} &= -\frac{1}{z}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta-1} dF_i(e_i) - \bar{x}_i^{\beta-1}\right] \\ &= -\frac{1}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta-1} - \bar{x}_i^{\beta-1}\right) dF_i(e_i) \\ &\quad +\frac{1}{z}\bar{x}_i^{\beta-1}(1-F_i(1-\bar{x}_i)), \qquad i \in S_2. \end{aligned} \tag{18}$$

The sign of expression (17) can be evaluated by investigating the curvature of $x_i^{\beta-1}$ with respect to x_i. When $\beta < 1$, the function becomes convex so that the whole expression within the bracket in expression (17) is positive, resulting in $\partial p^T(c_i, z)/\partial \bar{c}_i < 0$. This implies that expression (18) is the sum of a negative term as in expression (17) and a positive term. Its sign is therefore indeterminate, although it becomes negative when β is sufficiently negative.

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

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

$$\begin{aligned}\frac{\partial p_i^T}{\partial z} &= \frac{1}{z}\left[\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta} dF_i(e_i) - \bar{x}_i^{\beta}\right] \\ &= \frac{1}{z}\int_{\underline{\epsilon}_i}^{z-\bar{c}_i}\left(\left(\frac{\bar{c}_i+e_i}{z}\right)^{\beta} - \bar{x}_i^{\beta}\right) dF_i(e_i) \\ &\quad -\frac{1}{z}\bar{x}_i^{\beta}(1-F_i(1-\bar{x}_i)), \qquad i \in S_2. \end{aligned} \tag{20}$$

The sign of expression (19) can be evaluated by investigating the curvature of x_i^β with respect to x_i. When $\beta < 0$, the function becomes strictly convex so that the whole expression within the bracket in expression (19) becomes positive, resulting in $\partial p_i^T / \partial z > 0$. When $0 < \beta < 1$, the opposite occurs so that the derivative becomes negative.

The sign of expression (20) is indeterminate in general. When $\beta \geq 0$, the first term in the last expression becomes non-positive and the second term becomes negative, implying that the sign of the whole is negative. When $\beta < 0$, these two terms have opposite signs. The sign of the whole expression is therefore indeterminate, although it becomes positive when β is sufficiently negative.

References

[1] Atkinson, A.B., "On the Measurement of Poverty," *Econometrica* 55 (1987), 749-764.

[2] Baulch, B. and Hoddinott, J. (eds.), "Special Issue on Economic Mobility and Poverty Dynamics in Developing Countries," *Journal of Development Studies* 36 (2000), 1-180.

[3] Calvo, C. and S. Dercon, "Measuring Individual Vulnerability," Department of Economics Discussion Paper Series No.229 (2005), Oxford University.

[4] Clark, S., Hemming, R., and Ulph, D., "On Indices for the Measurement of Poverty," *Economic Journal* 91 (1981), 515-526.

[5] CRPRID [Centre for Research on Poverty Reduction and Income Distribution], *Pakistan Human Condition Report 2002* (2002), CRPRID, Government of Pakistan, Islamabad.

[6] Foster, J.E., Greer, J., and Thorbecke, E., "A Class of Decomposable Poverty Measures," *Econometrica* 52 (1984), 761-765.

[7] Hulme, D. and Shepherd, A., "Conceptualizing Chronic Poverty," *World Development* 31 (2003), 403-423.

[8] Jalan, J. and Ravallion, M., "Transient Poverty in Postreform Rural China," *Journal of Comparative Economics* 26 (1998), 338-357.

[9] Ligon E. and Schechter, L., "Measuring Vulnerability," *Economic Journal* 113 (2003), C95-C102.

[10] Kakwani, N., "On a Class of Poverty Measures," *Econometrica* 48 (1980), 437-446.

[11] Kimball, M.S., "Precautionary Saving in the Small and in the Large," *Econometrica* 58 (1990), 53-73.

[12] Kurosaki, T., "Measurement of Chronic and Transient Poverty: Theory and Application to Pakistan," paper presented at the Chronic Poverty Research Centre Conference "Staying Poor: Chronic Poverty and Development Policy" (2003), University of Manchester, Manchester.

[13] ——, "Consumption Vulnerability to Risk in Rural Pakistan," *Journal of Development Studies* 42 (2006), 70-89.

[14] Kurosaki, T. and Fafchamps, M., "Insurance Market Efficiency and Crop Choices in Pakistan," *Journal of Development Economics* 67 (2002), 419-453.

[15] Kurosaki, T. and Hussain, A., "Poverty, Risk, and Human Capital in the Rural North-West Frontier Province, Pakistan," IER Discussion Paper Series B No.24 (1999), Hitotsubashi University, Tokyo.

[16] Kurosaki, T. and Khan, H., "Human Capital and Elimination of Rural Poverty: A Case Study of the North-West Frontier Province, Pakistan," IER Discussion Paper Series B No. 25 (2001), Hitotsubashi University, Tokyo.

[17] Lanjouw, P. and Ravallion, M., "Poverty and Household Size," *Economic Journal* 105 (1995), 1415-1434.

[18] Ravallion, M., "Expected Poverty under Risk-Induced Welfare Variability," *Economic Journal* 98 (1988), 1171-82.

[19] Ravallion, M., van de Walle, D., and Gautam, M., "Testing a Social Safety Net," *Journal of Public Economics* 57 (1995), 175-199.

[20] Sen, A., *Poverty and Famines: An Essay on Entitlement and Deprivation* (1981), Oxford, Clarendon Press.

[21] Walker, T.S. and Ryan, J.G., *Village and Household Economies in India's Semi-arid Tropics* (1990), Baltimore, Johns Hopkins University Press.

[22] World Bank, *World Development Report 2000/2001: Attacking Poverty* (2000), New York, Oxford University Press.

[23] ——, *Pakistan Poverty Assessment — Poverty in Pakistan: Vulnerabilities, Social Gaps, and Rural Dynamics*, Report No. 24296-PAK (2002), World Bank, Washington D.C.

Table 1. Definitions of Poverty Statuses

Status	Definition	Sign of the individual poverty scores		Share in the population
		p_i^C	p_i^T	(N_k/N)
Always poor	$\bar{c}_i + \bar{\epsilon}_i < z$	$+$	$+$	$G_H(z)$
Usually poor	$\bar{c}_i + \bar{\epsilon}_i \geq z$ and $\bar{c}_i < z$	$+$	$+$	$G_M(z) - G_H(z)$
Occasionally poor	$\bar{c}_i + \underline{\epsilon}_i < z$ and $\bar{c}_i \geq z$	0	$+$	$G_L(z) - G_M(z)$
Always non-poor	$\bar{c}_i + \underline{\epsilon}_i \geq z$	0	0	$1 - G_L(z)$

Table 2. Comparative Statics of Individual Poverty Scores

	Expected poverty attributable to:	
	Chronic poverty p_i^C	Transient poverty p_i^T
$\bar{c}_i$	$-$	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 3. Examples of Comparative Statics

	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 changes from + to – (from – to +) when the parameter moves farther away from the threshold.
(4) See the appendix for details.

Table 4. Sample Villages and 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 sample households.

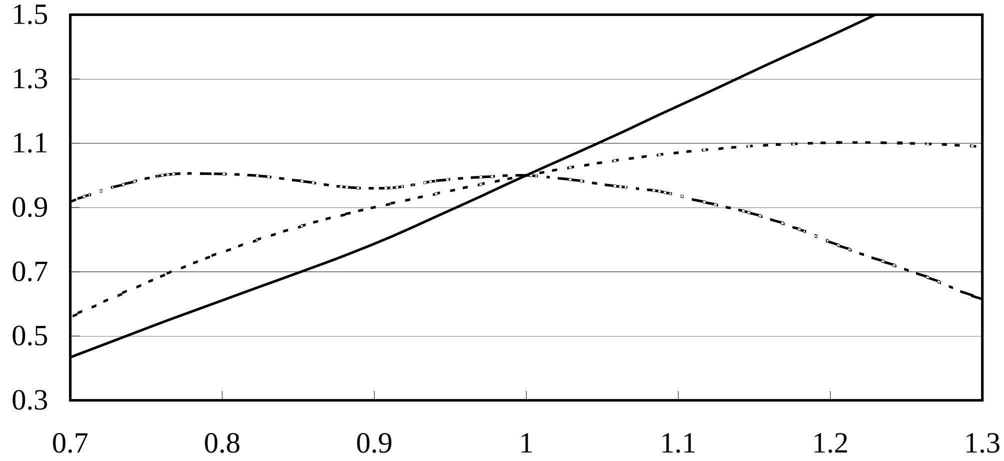
Table 5. Estimates for Transient and Chronic Poverty Measures (NWFP, Pakistan)

		Based on z at the official poverty line (1)	Based on z at 90% of the official poverty line (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^P	0.213	0.164	–23.1
	P^T	0.024	0.023	– 4.1
	P^C	0.189	0.141	–25.5
	P^T/P^P	0.114	0.142	+24.6
FGT measures with $\alpha > 1$				
$\alpha = 2$	P^P	0.086	0.062	–28.0
	P^T	0.017	0.015	–10.0
	P^C	0.069	0.047	–32.4
	P^T/P^P	0.195	0.244	+25.1
$\alpha = 3$	P^P	0.040	0.027	–31.9
	P^T	0.011	0.009	–17.9
	P^C	0.029	0.018	–37.1
	P^T/P^P	0.270	0.326	+20.5
Clark-Watts measures with $\beta < 1$				
$\beta = 0.5$	P^P	0.242	0.184	–23.8
	P^T	0.031	0.029	– 6.3
	P^C	0.211	0.155	–26.4
	P^T/P^P	0.127	0.157	+23.0
$\beta = 0$	P^P	0.279	0.210	–24.7
	P^T	0.040	0.036	– 8.8
	P^C	0.239	0.173	–27.4
	P^T/P^P	0.143	0.174	+21.1
$\beta = -1$	P^P	0.386	0.282	–26.9
	P^T	0.071	0.061	–14.7
	P^C	0.315	0.221	–29.7
	P^T/P^P	0.185	0.215	+16.7
$\beta = -2$	P^P	0.577	0.405	–29.7
	P^T	0.139	0.110	–21.3
	P^C	0.437	0.296	–32.4
	P^T/P^P	0.242	0.271	+12.0
N_1/N		0.550	0.437	–20.4
N_2/N		0.131	0.137	+ 4.1
N_3/N		0.164	0.194	+17.8
N_4/N		0.155	0.232	+50.1

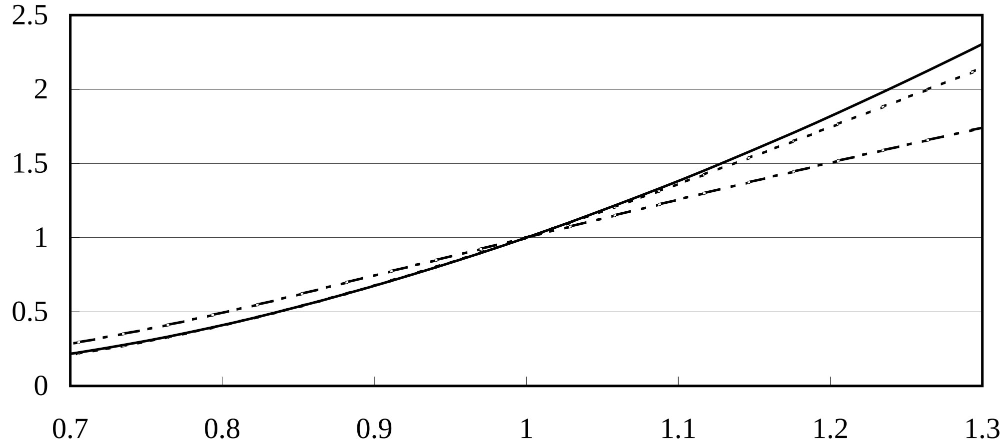
Note: P^T and P^C measure transient and chronic poverty respectively, according to the definition given in equations (3) and (4).

Figure 1: Chronic and Transient Poverty Measures in NWFP, Pakistan

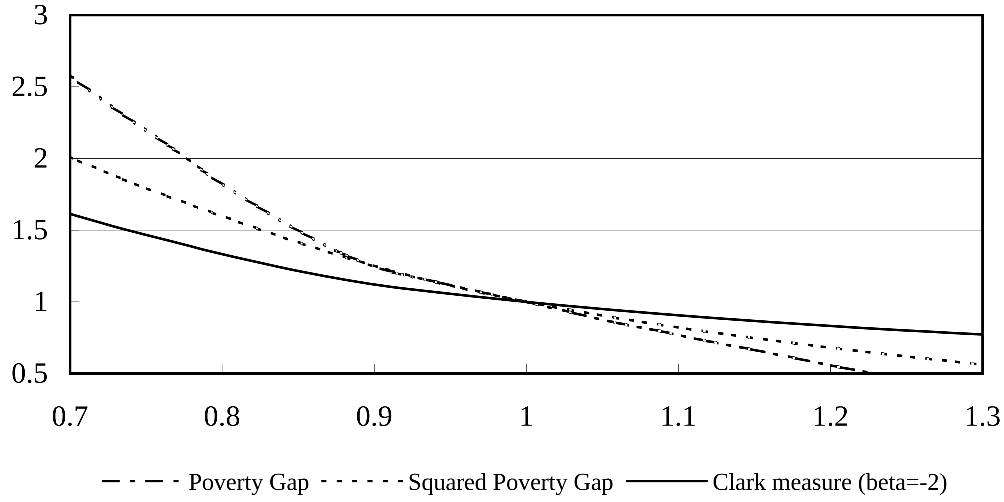
A: Transient Poverty



B: Chronic Poverty



C: Ratio of Transient Poverty to the Total Poverty



Notes: (1) The horizontal axis shows the ratio of alternative poverty lines to the official poverty line.
(2) The vertical axis shows an index: the value of each measure at alternative poverty lines divided by that at the official poverty line (= 1.0 when *z* is at the official poverty line).