Chronic and Transient Poverty in Rural Ethiopia: A New Decomposition

Natalie Quinn (University of Oxford, UK)

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Natalie Naïri Quinn*

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Abstract

I characterise a general class of intertemporal poverty measures with easily motivated properties, showing that they may be decomposed into a function that represents an ordering of trajectories of individual wellbeing over time and another function that establishes the social aggregation properties. I propose a new measure within this class that has trajectory ordering properties appropriate for the measurement of chronic poverty, showing that, although no such measure has been suggested in the existing literature, there is no fundamental inconsistency between continuity and sensitivity to persistence of poverty. Total poverty is decomposed into chronic and transient components using both the new measure and the method suggested by Jalan and Ravallion (2000). These measures are applied to household consumption data to determine the chronic and transient components of poverty in rural Ethiopia in the period 1994 to 2009.

Keywords: Poverty measurement, chronic poverty.

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1 Introduction

The primary reasons for conducting quantitative poverty measurement are to identify targets for and to evaluate poverty alleviation policies. It is widely accepted that different forms and causes of poverty require different policy interventions. For example, if poverty is transient, perhaps arising from an inability to smooth consumption in the face of income fluctuations, appropriate intervention could involve regulation of insurance markets, provision of social insurance or support for informal insurance institutions. When poverty is persistent, perhaps arising from an inability to accumulate human or physical capital (as a result of social, physical or economic constraints) then an insurance-focused policy would be less effective or appropriate.

If different forms of poverty require different policy interventions then methods of measurement and evaluation of poverty should be able to distinguish between these different forms. A particular concern is that with the contemporary policy focus on the Millennium Development Goals, in particular the goal of halving the $1 per day headcount poverty rate by 2015, individuals experiencing deep and persistent poverty are being neglected. These issues are discussed in detail by Hulme and Shepherd (2003). Those individuals experiencing persistent or chronic poverty comprise an important sub-group of the poor who may require targeted policy interventions. Several approaches have been used to identify the 'chronic poor' and quantify the degree of 'chronic poverty' in a population. As discussed by McKay and Lawson (2003), many of these may be categorised as 'spells' approaches or 'components' approaches.

'Spells' approaches to the measurement of chronic poverty identify households as chronically poor according to the duration or proportion of time in which their income (or some other welfare indicator) falls below a poverty line. For example, the global estimates of chronic poverty in the Chronic Poverty Research Centre's *Chronic Poverty Report 2004–05* are based on a definition of chronic poverty as 'still being poor after 5 years' where 'poor' describes an individual whose daily consumption is below $1 a day (purchasing power parity) (CPRC, 2004). The limitations of this approach are discussed in detail in Chapter 11 of the report. Gaiha and Deolalikar (1993) report that 87.8% of the ICRISAT survey households[1], whose subjects were surveyed annually from 1975–1976 to 1983–1984, were poor in at least one period of the survey, 'over 60%' were poor during 5 of the 9 sample years while 'a little more than one-fifth' (21.8%) were 'persistently poor', with incomes below the poverty line in all nine years.

Studies based on a 'spells' approach classify individuals or households as either chronically poor or not chronically poor, the latter category often being subdivided into the transiently poor and the never poor. Such discrete categorisation must necessarily involve a degree of arbitrariness analogous to that identified by Sen (1976) for the use of the headcount measure for cross-sectional poverty measurement. It may be difficult to justify the classification of many households whose trajectories of wellbeing are close to the borderline, while the measure is not sensitive to the depth of poverty experienced.

'Components' approaches to the measurement of chronic poverty involve the decomposition of a sequence of income or consumption values into a 'permanent component' and

[1]The International Crops Research Institute for the Semi-Arid Tropics' Village Level Studies (http://www.icrisat.org/gt-mpi/KnowledgeBase/Databases/vls.asp)

'transitory variations' around it. This may be conducted in various ways, depending on the motivation for the approach and the assumptions maintained by the analyst. Rodgers and Rodgers (1993) base their analysis of US data on the 'poverty-gap-squared' measure introduced by Foster, Greer, and Thorbecke (1984). Their 'chronic poverty' is that (constant) which would obtain if the household had borrowed and saved at prevailing interest rates so as to perfectly smooth consumption. Their transitory poverty is, in each period, the difference between income-poverty in that period and chronic poverty. The approach of Jalan and Ravallion (2000) is analytically similar, though they use consumption rather than income data and their 'chronic poverty' is calculated from the time average of consumption expenditure; that is, the consumption stream that would have arisen had the household had access to credit at zero interest and had chosen to smooth perfectly its consumption expenditures. A quite different approach calculates 'chronic poverty' from income levels predicted by an empirical model, given household observable characteristics; the 'expected' and 'innate' poverties of Gaiha and Deolalikar (1993) are computed following this approach, with different model specifications.

While these 'components' approaches avoid the arbitrariness inherent in the dichotomous classification of the 'spells' approaches, permitting degrees of chronicity of poverty, they do not capture any intuitive concept of chronicity, for example persistence or prolonged duration of *experienced* poverty.

Several new indices to measure chronic poverty have been proposed in the more recent literature. Like the earlier 'components' measures, the measures proposed by Calvo and Dercon (2009) and Foster and Santos (2013) are not sensitive to persistence or duration of poverty and thus, while they may serve as good measures of the total burden of poverty in an intertemporal context, they do not capture chronicity as such.[2] The headcount version of the measure proposed by Foster (2009) *is* sensitive to duration, but is simply a 'spells' measure as discussed above; the non-headcount versions of the measure have the counterintuitive property of sensitivity to duration where increased duration causes a non-chronic-poor trajectory to be identified as chronic poor, but *inverse* sensitivity where the trajectory is already identified as chronic poor.

Conversely, other measures have been proposed (Gradin, Del Rio, and Canto, 2011; Bossert, Chakravarty, and D'Ambrosio, 2012) that *are* sensitive to chronicity, but at the cost of significant discontinuities that lead to perversities in the ordering of trajectories of wellbeing embodied by these measures. The measures suggested and characterised by Hoy and Zheng (2011) are separable over time, which I shall argue below is not appropriate for the measurement of chronic poverty. They achieve sensitivity to persistence by means of a non-monotone concave weighting function which in fact yields this sensitivity as an artefact of asymmetric treatment of different time periods. It is difficult to find an

[2]Porter and Quinn (2012) showed (proposition 3) that an intertemporal poverty measure cannot simultaneously be sensitive to fluctuations of wellbeing and chronicity of poverty, as these are inconsistent properties of the trajectory ordering. This conflict, between ordering trajectories according to reasonable assumptions about intertemporal preferences and chronicity of poverty, may explain why these well-behaved 'chronic poverty' measures are in fact not sensitive to chronicity of poverty. Intuitively, consider two trajectories of wellbeing, one constant (and always poor), the other fluctuating between some periods of intense poverty and other periods of marginal poverty, but with the same average wellbeing. Assuming aversion to wellbeing-fluctuations (empirically evidenced by the ubiquity of consumption-smoothing behaviour) the fluctuating trajectory would be ranked as 'more poor'. However, the constant trajectory displays greater chronicity or persistence of poverty.

ethical justification for this asymmetry.

It therefore seems natural to return to the approach taken by Jalan and Ravallion (2000), who decompose a measure of 'total burden of intertemporal poverty' into chronic and transient components. A measure of total poverty may be chosen, which reflects reasonable assumptions about intertemporal preferences, and then be decomposed into transient and chronic components where the properties of the chronic component render it sensitive to chronicity or persistence of poverty.

The paper proceeds as follows. In section 2 I outline the framework in which measurement will be conducted and establish the general form of an intertemporal poverty measure that satisfies certain fundamental properties taken to be axiomatic. This general form is shown to involve the composition of a function that represents an ordering of trajectories and another that captures the poverty analyst's attitude to interpersonal comparisons. The poverty-gap-squared form introduced by Foster, Greer, and Thorbecke (1984) is chosen for the latter to reflect the convention in the literature on cross-sectional poverty measurement as well as the choice of Jalan and Ravallion (2000), whose chronic poverty decomposition is used as the main comparator for the new method.

In section 3 I propose a set of desired properties for a measure of chronic poverty, including sensitivity to duration and persistence of poverty, and continuity. I show that there is no fundamental incompatibility between these properties and propose a new measure of chronic poverty that satisfies them. I demonstrate that there is a natural way to decompose a measure of total burden of poverty over time into chronic and transient components, which may be applied to the new measure and is consistent with the measures introduced by Jalan and Ravallion (2000).

In section 4 the new measures are applied to longitudinal household data from the Ethiopian Rural Household Survey to analyse poverty in 15 villages in rural Ethiopia during the period 1994–2009. Total poverty is decomposed into chronic and transient components using the new measures and the results are contrasted with the decomposition according to the methods of Jalan and Ravallion (2000).

Section 5 concludes.

2 Framework and Form of the Poverty Measures

2.1 Analytical Framework and Notation

In order to evaluate poverty over time a poverty analyst must have relevant information about an appropriate sample of individuals $i = 1, 2, \ldots, n$ from the population being studied, over an extended period of time. The natural source for such data is a panel or longitudinal household survey in which the same households are surveyed repeatedly in a number of discrete time periods $t = 1, 2, \ldots, T$. In order to focus on the intertemporal aspects of the problem I shall assume the availability of a cardinally measurable indicator of wellbeing $x_{it} = r_{it}u$ for each individual i at each of the surveyed time periods t. $r_{it} \in \mathbb{R}$ and u is the unit of measurement; it should be emphasised that u is not the unit of *wellbeing*, but the unit of the *indicator* of wellbeing. Let the set of all possible values of the indicator of wellbeing be $\mathbb{X} \subseteq \{x = ru | r \in \mathbb{R}\}$.

As the data will be aggregated over both individuals and over time the indicator of wellbeing must be comparable in these dimensions. In practice, a real, per-adult-equivalent value of income or consumption may be an appropriate indicator, in which case $\mathbb{X} \subseteq \{x = ru | r \in \mathbb{R}_+\}$ which shall be assumed throughout this analysis. Ravallion (1994) discusses the practical and conceptual issues in the context of cross-sectional poverty evaluation, but equally relevant here; value of consumption may be a better proxy for wellbeing than income, as all desired and feasible consumption-smoothing has been taken into account.[3] I shall assume that the indicator is measured without error and that there are no missing data; in practice, the methodology should be extended to account for these possibilities but that is beyond the scope of this paper.

The **profile** of wellbeing indicators for all of the individuals in the sample in all time periods is the matrix

$$X = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1T} \\ x_{21} & x_{22} & \cdots & x_{2T} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nT} \end{pmatrix}$$

where each $x_{it} \in \mathbb{X}$. The number of individuals in a profile X is $n(X)$ and the number of time periods is $T(X)$.

The sequence or **trajectory** of wellbeings experienced by a particular individual i is the ith row of the profile matrix, $\mathbf{x}_i = (x_{i1}, x_{i2}, \ldots, x_{iT})$. A trajectory in which the individual's indicator of wellbeing is the same in every time period, $\mathbf{x}_i = (x_{i1}, x_{i1}, \ldots, x_{i1})$ is a

[3] Of course, the arguments made in the literature on multidimensional poverty measurement, for example Tsui (2002), Bourguignon and Chakravarty (2003) and Alkire and Foster (2011), will apply here. The poverty analyst may not wish to apply the market valuation to weight the various goods consumed and may wish to include non-market goods. The objective of the present study is to focus on the intertemporal aspects of the problem and the introduction of multiple dimensions – observed indicators – would raise issues that I do not seek to address here, in particular separability over time and/or dimensions. The poverty analyst may wish to consider the nature of the indicator when determining the degree of intertemporal substitutability to reflect in the poverty measure, an issue I shall return to in section 3.

constant-wellbeing trajectory, while a profile in which every individual's trajectory is a constant-wellbeing trajectory is a **profile of constant-wellbeing trajectories**.

If X and Y are profiles then

$$(X;Y) = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1T} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nT} \\ y_{11} & y_{12} & \cdots & y_{1T} \\ \vdots & \vdots & \ddots & \vdots \\ y_{m1} & y_{m2} & \cdots & y_{mT} \end{pmatrix}$$

where $n = n(X)$ and $m = n(Y)$ is also a profile.

The set of all possible profiles for n individuals over T time periods is $\mathbb{X}^{nT}$ while the set of all possible profiles for at least three individuals over T time periods is

$$\mathcal{X}_T = \bigcup_{n=3}^{\infty} \mathbb{X}^{nT}.$$

An **intertemporal poverty measure** is a function $\mathcal{P} : \mathcal{X}_T \to \mathbb{P}$ where p is the unit of poverty and $\mathbb{P} \subseteq \{q = rp | r \in \mathbb{R}\}$. It should be noted that the poverty analyst's choice of certain properties for the intertemporal poverty measure may well depend on her particular choice of u and p, that is, measurement units for the wellbeing indicator and the poverty measure.

2.2 Ethical Framework and General Form of the Measures

I follow the framework outlined by Porter and Quinn (2013) but formalise their definitions and results. Throughout this section I consider an intertemporal poverty measure $\mathcal{P} : \mathcal{X}_T \to \mathbb{R} \times \{p\}$ that evaluates poverty in wellbeing profiles of fixed duration T. I start by introducing mild ethical principles and characterise the class of intertemporal poverty measures that are consistent with these principles.

The first ethical principle followed by the poverty analyst is that individuals are treated completely symmetrically, or anonymously. Given that the indicator of wellbeing is comparable across individuals this means that any poverty measure must evaluate as equivalent any two profiles that differ only by a permutation of trajectories of wellbeings among individuals; such a principle is entirely conventional in social welfare and poverty analysis and it would be difficult to find ethical justification for any alternative.

(A) Anonymity: $\mathcal{P}(X) = \mathcal{P}(Y)$ *for all profile matrices* $X, Y \in \mathcal{X}_T$ *such that* $X = AY$ *where* A *is an* $(n(X) \times n(X))$ *permutation matrix.*

The second ethical principle reflects consistency in evaluation of poverty among subgroups of the population. If poverty increases in a subgroup of the population while the profile of

wellbeings remains unchanged in the rest of the population then poverty should increase overall, regardless of the profile of wellbeings or even the number of individuals in the rest of the population. The implication for cross-sectional poverty measures of a closely related principle in which the number of individuals in both groups is fixed was analysed by Foster and Shorrocks (1991). This slightly stronger version is no more difficult to motivate by appeal to consistency.

(SC) Subset Consistency: *For all profiles $X, X' \in \mathcal{X}_T$ with $n(X) = n(X')$ and for all profiles $Y \in \mathcal{X}_T$, $\mathcal{P}(X;Y) \geq \mathcal{P}(X';Y)$ if and only if $\mathcal{P}(X) \geq \mathcal{P}(X')$.*

The third principle is that the poverty analyst does not consider that population size has any intrinsic bearing on the measure of poverty. It is most straightforward, and sufficient, to formalise this only for that subset of the domain in which every individual experiences the *same* trajectories of wellbeing, as its combination with subset consistency (SC) allows its impact to extend to the whole domain. The poverty analyst may or may not want to accept this principle. The ethical issues that arise when population size is taken into account and their impact on social welfare measures are explored by Broome (2004) and Blackorby, Bossert, and Donaldson (2005); they are beyond the scope of the present study.

(PN) Population Size Neutrality: *$\mathcal{P}(X) = \mathcal{P}(Y)$ for all profiles $X, Y \in \mathcal{X}_T$ in which $\mathbf{x}_i = \mathbf{y}_j = \mathbf{x}_1$ for all $i \in \{1, 2, \ldots, n(X)\}$ and all $j \in \{1, 2, \ldots, n(Y)\}$.*

These three basic principles impose a significant restriction on the class of permissible intertemporal poverty measures.

Proposition 1. *An intertemporal poverty measure $\mathcal{P} : \mathcal{X}_T \to \mathbb{P}$ satisfies properties (A), (SC) and (PN) if and only if it has the form*

$$\mathcal{P}(X) = g\left(\frac{1}{n(X)} \sum_{i=1}^{n(X)} f(p(x_{i1}, x_{i2}, \ldots, x_{iT}))\right) \tag{2.1}$$

where $g : \mathbb{R} \to \mathbb{P}$ and $f : \mathbb{R} \to \mathbb{R}$ are strictly increasing and $p : \mathbb{X}^T \to \mathbb{R}$ is any function.

Proof. If: $\mathcal{P}$ is symmetric over the individual index i so will remain unchanged under any permutation of individuals, hence (A) is satisfied. (SC) follows immediately from additive separability of the summation (and is preserved under the transformation g). (PN) follows from the averaging of (identical) arguments and is also preserved under g.

Only if: Note that any intertemporal poverty measure $\mathcal{P} : \mathcal{X}_T \to \mathbb{P}$ induces a complete preorder $\precsim$ on the domain $\mathcal{X}_T$. The conditions are sufficient to invoke Quinn (2009) Corollary 3.6 and thus establish the existence of a function

$$Q(X) = \frac{1}{n(X)} \sum_{i=1}^{n(X)} \phi(\mathbf{x}_i)$$

where $\phi : \mathbb{X}^T \to \mathbb{R}$, which represents $\precsim$ on the domain $\mathcal{X}_T$. Order is preserved exactly under strictly increasing transformations, therefore there exists $g : \mathbb{R} \to \mathbb{P}$ strictly increasing

such that $\mathcal{P} = g \circ Q$. Without loss of generality ϕ may be decomposed into two functions $f : \mathbb{R} \to \mathbb{R}$ strictly increasing and $p : \mathbb{X}^T \to \mathbb{R}$, $\phi = f \circ p$, giving

$$\mathcal{P}(X) = g\left(\frac{1}{n(X)} \sum_{i=1}^{n(X)} f(p(x_{i1}, x_{i2}, \ldots, x_{iT}))\right)$$

as required. □

Observe that the function $p : \mathbb{X}^T \to \mathbb{R}$ induces an unambiguous ordering of the set of all possible individual trajectories of wellbeing.

A strong consensus on appropriate principles has emerged in the literature on cross-sectional or static poverty measurement; important contributions include Foster, Greer, and Thorbecke (1984) and Chakravarty (1983) while Foster and Shorrocks (1991) characterise the general class of measures that possess the accepted properties.

There is a direct analogy between cross-sectional poverty measures and intertemporal poverty measures, in the very restricted context that all individuals have wellbeings that remain constant over time. Before analysing the particular issues arising when time-varying trajectories are permitted, it is worth considering the evaluation of profiles of constant-wellbeing trajectories, as this enables us to further restrict the class of permissible measures.

The first of these properties establishes that the poverty measure is not sensitive to (constant) levels of wellbeing above some 'poverty line' $z \in \mathbb{X}$. While conventional in the poverty measurement literature, some have argued against the use of poverty lines and it should be noted that the poverty analyst may choose z arbitrarily high.

(CWF) CW-Focus: $\mathcal{P}(X) = \mathcal{P}(Y)$ *for all profiles of constant-wellbeing trajectories* $X, Y \in \mathcal{X}_T$ *with* $n(X) = n(Y)$ *and in which* $x_i > y_i \geq z$ *for some* $i \in \{1, 2, \ldots, n(X)\}$ *and* $x_j = y_j$ *for all* $j \neq i$.

The next property establishes sensitivity of the measure to a fall in (constant) wellbeing for any individual whose level of wellbeing is *below* the poverty line.

(CWM) CW-Strict Monotonicity: $\mathcal{P}(X) > \mathcal{P}(Y)$ *for all profiles of constant-wellbeing trajectories* $X, Y \in \mathcal{X}_T$ *with* $n(X) = n(Y)$ *and in which* $x_i < y_i \leq z$ *for some* $i \in \{1, 2, \ldots, n(X)\}$ *and* $x_j = y_j$ *for all* $j \neq i$.

The third property reflects an aversion to inequality: if some quantity of (constant) wellbeing is transferred from an individual below the poverty line to any individual with a higher level of (constant) wellbeing then overall poverty should increase. It should be noted that the poverty analyst may choose whether or not to invoke this property according to the particular *indicator* of wellbeing chosen. It does seem reasonable when value of consumption expenditure is the indicator; poverty analysts would regard a drop in consumption for a poorer person as worse than an equivalent drop for a less poor person. As this is the indicator that shall be used in the empirical application, I shall adopt this property for the present analysis.

(CWT) CW-Strict Transfer: *$\mathcal{P}(X) > \mathcal{P}(Y)$ for all profiles of constant-wellbeing trajectories $X, Y \in \mathcal{X}_T$ with $n(X) = n(Y)$ and in which $x_i < y_i \leq z$ and $x_j + x_i - y_i = y_j > y_i$ for some $i, j \in \{1, 2, \ldots, n(X)\}$ and $x_k = y_k$ for all $k \neq i, j$.*

Finally I shall invoke a technical property, appropriate to the choice of consumption expenditure for the wellbeing indicator, though not necessarily in general. Poverty is maximised when all individuals have zero consumption in all periods and minimised when all individuals have poverty-line consumption in all periods; furthermore all levels of poverty between these bounds may be achieved for some profile of equal and constant wellbeings.

(CWC) CW-Compactness: *$\mathcal{P}$ is bounded above by $\mathcal{P}(X)$ where $x_{it} = 0$ for all i, t and bounded below at 0 by $\mathcal{P}(Z)$ where $z_{it} = z$ for all i, t. Furthermore for all $p \in [0, \mathcal{P}(X)]$ there exists some profile of constant and equal trajectories Y (with $y_{it} = y \in [0, z]$ for all i, t) such that $\mathcal{P}(Y) = p$.*

These four properties significantly further restrict the form of the poverty measure.

Proposition 2. *An intertemporal poverty measure $\mathcal{P} : \mathcal{X}_T \to \mathbb{P}$ satisfies properties (A), (SC), (PN), (CWF), (CWM), (CWT) and (CWC) if and only if it has the form*

$$\mathcal{P}(X) = g\left(\frac{1}{n(X)} \sum_{i=1}^{n(X)} h(c_p(p(x_{i1}, x_{i2}, \ldots, x_{iT})))\right) \tag{2.2}$$

where $g : \mathbb{R} \to \mathbb{P}$ is strictly increasing, $h : [0, z] \to \mathbb{R}$ is strictly decreasing, continuous and convex with $h(z) = 0$, $c_p(p(x, x, \ldots, x)) = x$ for all $x \in [0, z]$, $c_p(p(x, x, \ldots, x)) = z$ for all $x \geq z$ and $p : \mathbb{X}^T \to \mathbb{R}$ with $p(x, x, \ldots, x)$ continuous and strictly decreasing for $x \in [0, z]$.

Proof. If: Let $f = h \circ c_p$ to see that (2.2) is of the form (2.1) and thus satisfies properties (A), (SC) and (PN). (CWF) follows from the form of c_p, (CWM) follows from the monotonicity of p, c_p and h, (CWT) follows from convexity of h and (CWC) follows from continuity of h.

Only if: By proposition 1 properties (A), (SC) and (PN) ensure that the poverty measure may be expressed in the form (2.1); g is thus strictly increasing. Let $p'(x) = p(x, x, \ldots, x)$, then define $h' = f \circ p'$, so for constant wellbeing trajectories $f(p(x, x, \ldots, x)) = h'(x)$. (CWC) ensures the existence for every trajectory $\mathbf{x}$ of a constant-wellbeing equivalent $c_p(p(\mathbf{x}))$ between 0 and z so without loss of generality this h' restricted to the domain $[0, z]$ may be identified with the h in (2.2). (CWM) ensures that h is strictly decreasing on $[0, z]$ and $p(x, x, \ldots, x)$ is strictly decreasing for $x \in [0, z]$, (CWT) ensures that h is convex on $[0, z]$ and (CWC) together with (CWT) ensures that h is continuous. (CWC) also determines the bound on h and continuity of $p(x, x, \ldots, x)$ on $[0, z]$. □

2.3 Particular Choices for Social Aggregation

Proposition 2 establishes a general class of intertemporal poverty measures. A great deal of flexibility is available through choice of the functions p, h and g. These functions should not be chosen arbitrarily as choice of these functions determines important properties of the measure. They all have very straightforward interpretations: p represents the poverty analyst's unambiguous ordering of trajectories, h is central to the aggregation over individuals, representing the tradeoffs that the poverty analyst is prepared to make between different individuals, while g determines the cardinality of the poverty measure which according to context may or may not be meaningful.

In the next section I shall explore in some detail choice of p appropriate for the measurement of chronic poverty. Before proceeding with that I observe that, as noted above, when the intertemporal poverty measure is applied to profiles of constant-wellbeing trajectories in which individual i has constant wellbeing x_i, there is a direct analogy with cross-sectional poverty measures. In that case (2.2) may be written

$$\mathcal{P}(X) = g\left(\frac{1}{n(X)}\sum_{i=1}^{n(X)} h'(x_i)\right) \tag{2.3}$$

where $h'(x) = h(c_p(p(x, x, \ldots, x)))$, which is closely related to the general class of cross-sectional poverty measures characterised by Foster and Shorrocks (1991). ((CWC) has precluded the possibility of a discontinuity at z, permitted by Foster and Shorrocks.) In the theoretical and applied literature on poverty measurement using income or value of consumption expenditure as the indicator, a fairly clear consensus has emerged around the 'poverty-gap-squared' measure suggested by Foster, Greer, and Thorbecke (1984). Therefore for this study I shall choose g and h' such that $\mathcal{P}$ coincides with that measure for constant-wellbeing trajectories. This requires $g(x) = x$ and

$$h'(x) = \begin{cases} \left(\frac{z-x}{z}\right)^2 & \text{if } 0 \le x \le z \\ 0 & \text{if } x > z \end{cases}$$

so the class of intertemporal poverty measures becomes

$$\mathcal{P}(X) = \frac{1}{n(X)}\sum_{i=1}^{n(X)} \left(\frac{z - c_p(p(x_{i1}, x_{i2}, \ldots, x_{iT}))}{z}\right)^2 \tag{2.4}$$

which is a subclass of the class of measures (2.2) established by proposition 2. There remains a great deal of flexibility through choice of the function p which represents the poverty analyst's ordering of trajectories of wellbeing. In the next section I consider the choice of p in the specific context of *chronic* poverty measurement.

3 Trajectory-Ordering Properties and the New Measure

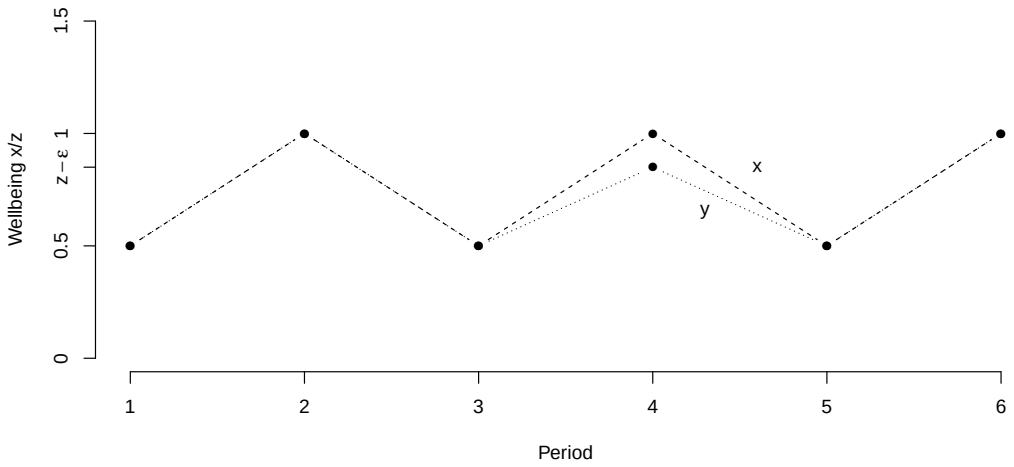
In this section I discuss properties of the trajectory ordering that are appropriate for chronic poverty measurement and propose a function $p : \mathbb{X}^T \to \mathbb{R}$ that has these desired properties. I assume throughout that the poverty measure has the elementary properties (A), (SC) and (PN), and constant-wellbeing properties (CWF), (CWM), (CWT) and (CWC) introduced in the previous section. It therefore has the form (2.2). Note that the function $p : \mathbb{X}^T \to \mathbb{R}$ induces a complete preorder $\precsim_p$ on the space of trajectories $\mathbb{X}^T$ such that $\mathbf{x} \precsim_p \mathbf{y}$ precisely when $p(\mathbf{x}) \leq p(\mathbf{y})$. This is what I refer to as the trajectory ordering.

It should be noted that only the ordinal properties of p are of interest; the transformation $c_p \circ p$ in (2.2) renders its level irrelevant for the form and properties of the intertemporal poverty measure. Therefore without loss of generality I shall restrict attention to functions $p : \mathbb{X}^T \to \mathbb{R}$ such that $p(z, z, \ldots, z) = 0$. A trajectory $\mathbf{x}$ for which $p(\mathbf{x}) > 0$ is thereby identified as *poor*, while a trajectory $\mathbf{x}$ for which $p(\mathbf{x}) = 0$ is identified as *non-poor*.

3.1 Continuity, Monotonicity and Focus

Recall from proposition 2 that $p(x, x, \ldots, x)$ is continuous and strictly decreasing for $x \in [0, z]$. These properties may, and I argue should, be extended to the whole domain $\mathbb{X}^T$ with a little modification in the case of monotonicity.

Continuity is a desirable property for the trajectory ordering function $p(\mathbf{x})$ not just for technical reasons. If p were not continuous there would be the possibility of perversities in the ordering of trajectories that conflict with a reasonable understanding of poverty. Even if that were not the case there would certainly be problems with the ordering of profiles analogous to those identified by Sen (1976) for the headcount measure; there would exist marginal transfers from poorer to less poor people that would significantly reduce the evaluated degree of poverty. The measures suggested in the recent literature that do capture the concept of chronicity, including Foster (2009) and Bossert, Chakravarty, and D'Ambrosio (2012), are not continuous. For example, consider the trajectories $\mathbf{x} = (0.5z, z, 0.5z, z, 0.5z, z)$ and $\mathbf{y} = (0.5z, z, 0.5z, z - \epsilon, 0.5z, z)$.



Both Foster's and Bossert, Chakravarty, and D'Ambrosio's measures (with reasonable parameter choices) maintain a finite difference between $p(\mathbf{x})$ and $p(\mathbf{y})$ as $\epsilon \to 0$. Nevertheless, continuity is not inconsistent with sensitivity to chronicity, as shall be demonstrated by example below. We directly require continuity of the trajectory ordering function p.

(C) Continuity: $p : \mathbb{X}^T \to \mathbb{R}$ *is a continuous function.*

Letting $p(z, z, \ldots, z) = 0$, it follows from (CWF) that $p(x, x, \ldots, x) = 0$ for all $x > z$, so the function cannot be strictly decreasing everywhere; we shall require it to be weakly decreasing. However, it is central to the concept of poverty that a reduction in wellbeing of a poor person *increases* their poverty; in the intertemporal context it is reasonable to require this for a reduction in a poor person's wellbeing in any period.

(M) Monotonicity: $p(\mathbf{x}) \geq p(\mathbf{y})$ *for all* $\mathbf{x}, \mathbf{y} \in \mathbb{X}^T$ *such that* $x_\tau < y_\tau$ *for some* $\tau \in \{1, 2, \ldots, T\}$ *and* $x_t = y_t$ *for all* $t \neq \tau$*, and* $p(\mathbf{x}) > p(\mathbf{y})$ *if* $p(\mathbf{y}) > 0$.

Note that we do not need to extend the focus property to the entire domain of trajectories $\mathbb{X}^T$. It follows directly from monotonicity (M) and constant-wellbeing focus (CWF) that $p(\mathbf{x}) = 0$ for all $\mathbf{x} \in \mathbb{X}^T$ such that $x_t \geq z$ for all t, that is, an individual with wellbeing above the poverty line in every period is not poor. This is essentially the *weak focus* property suggested in the literature. It *may* be the case that $p(\mathbf{x}) = 0$ for some trajectories $\mathbf{x}$ with $x_t < z$ for some t; this will be established by the properties discussed below.

3.2 Duration Sensitivity

Continuity and monotonicity are appropriate for any intertemporal poverty measure; I now introduce properties that are specific to the concept of *chronic* poverty. If the effect of a transfer of wellbeing between periods is to increase the number of periods spent below the poverty line then the *duration* and thus *chronicity* of poverty increases, even if its

intensity does not. This concept may be extended to wellbeing levels below the poverty line also.

(D) Duration-Sensitivity: $p(\mathbf{x}) > p(\mathbf{y})$ *for all* $\mathbf{x}, \mathbf{y} \in \mathbb{X}^T$ *such that* $x_\tau = y_\tau + \epsilon$, $x_\upsilon = y_\upsilon - \epsilon$ *and* $x_t = y_t$ *for* $t \neq \tau, \upsilon$ *and the number of periods in which* $x_t < \tilde{z}$ *is greater than the number of periods in which* $y_t < \tilde{z}$ *for some* $\tilde{z} \leq z$.

Maintaining continuity (C) and monotonicity (M) we may observe that, if the function $p(\mathbf{x})$ is twice continuously differentiable so that the marginal rate of compensation between any two periods $m_{\tau\upsilon}$ exists and is a continuous function throughout $\mathbb{X}^T$, then $-1 < m_{\tau\upsilon} < 0$ for all poor trajectories such that $x_\tau < x_\upsilon$ is sufficient for duration sensitivity (D) to hold.

Proposition 3. *The family of modified CES (constant elasticity of substitution) trajectory ordering functions*

$$p_\alpha(\mathbf{x}) = \max\left[0, 1 - \left(\frac{1}{T}\sum_{t=1}^{T}(x_t/z)^\alpha\right)^{1/\alpha}\right] \tag{3.1}$$

with $\alpha > 1$ *satisfy properties (C), (M) and (D).*

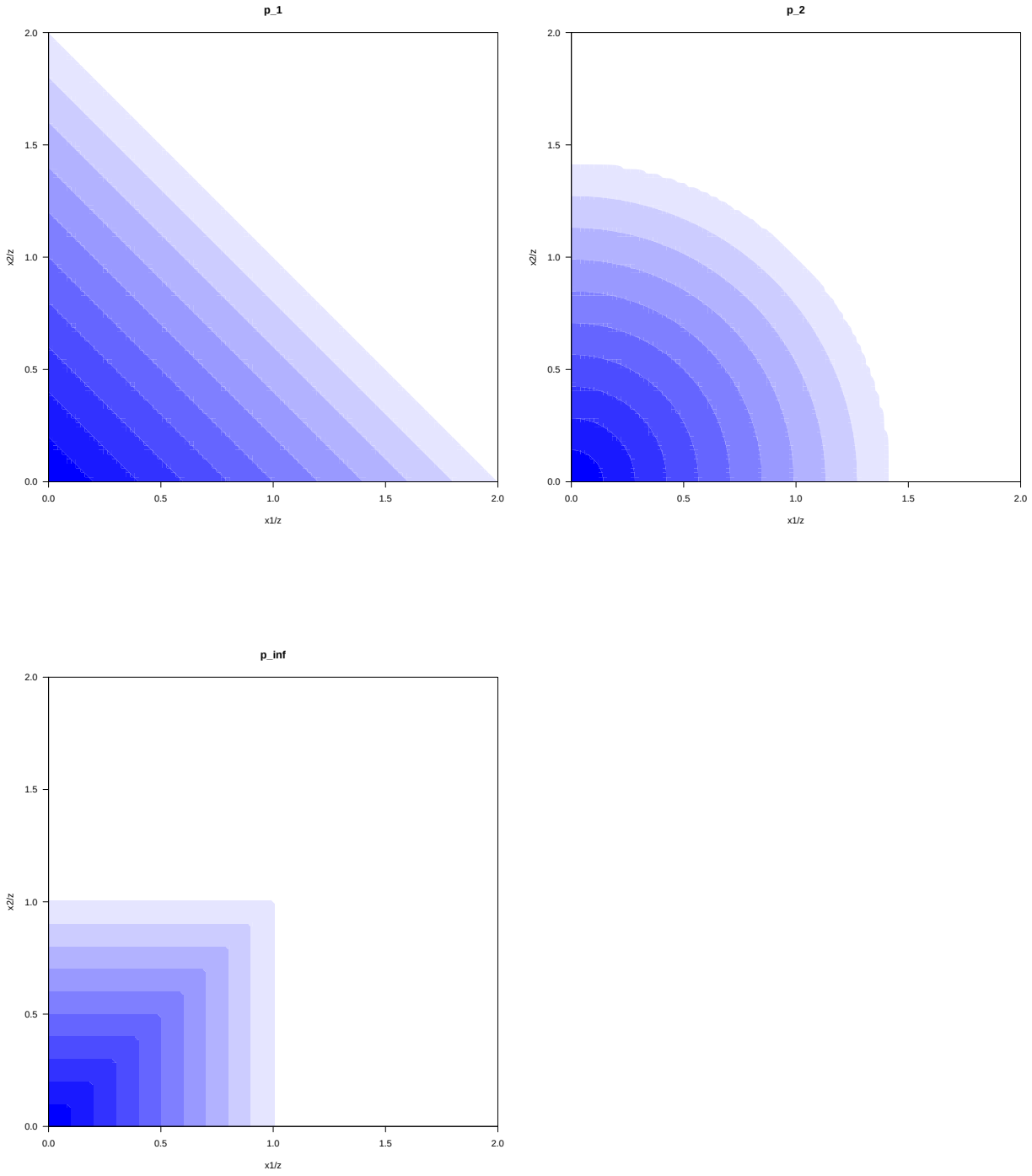
Proof. p is a continuous transformation of a continuous function of T variables and thus satisfies (C). p is differentiable and so monotonicity may be verified by partial differentiation; $p_{x_t} < 0$ where $p(\mathbf{x}) > 0$ and $p_{x_t} = 0$ where $p(\mathbf{x}) = 0$ for each t, so (M) holds. It follows immediately from $\alpha > 1$ that

$$m_{\tau\upsilon} = -\left(\frac{x_\tau}{x_\upsilon}\right)^{\alpha-1} \in (-1, 0)$$

for $x_\tau < x_\upsilon$, so (D) holds. □

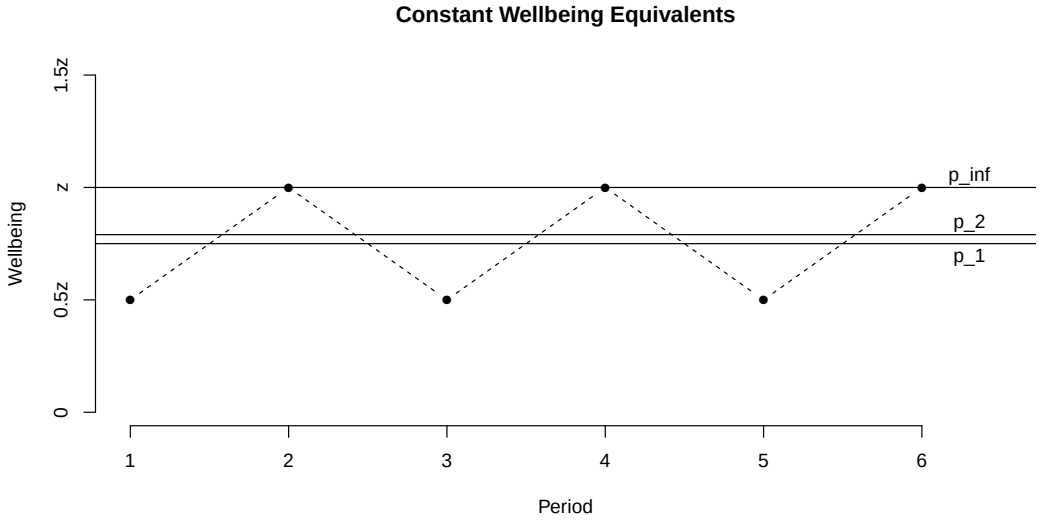
It is interesting to note that this class of measures is identical (in terms of the trajectory ordering, but not the social aggregation) to the class of 'chronic' poverty measures proposed by Foster and Santos (2013), except that they restrict the parameter α to be *less than* 1, from which it follows that duration sensitivity (D) cannot hold. I would argue that duration sensitivity is fundamental to the concept of chronicity, and thus while Foster and Santos' measure has many properties that make it an attractive measure of total poverty over time, it should not be described as a *chronic* poverty measure.

It is helpful to consider some particular members of this family of measures: The limiting case p_1 (not strictly a member of the class; (D) does not hold in strict form) gives a trajectory ordering identical to that generated by the 'chronic' poverty measure proposed by Jalan and Ravallion (2000) and orders each trajectory as equivalent to its mean value. The limiting case p_∞ orders each trajectory as equivalent to its maximum value, while the quadratic form p_2 is intermediate. The trajectory orderings induced by these three examples may be illustrated for the very simple case in which $T = 2$; the measures are separable over time (subject to $p > 0$), so the orderings of trajectories varying wellbeings in any two periods are identical for $T > 2$, provided the trajectories are 'poor'.



(Recall that it is the trajectory ordering induced by p, and not its level, that is of interest.)

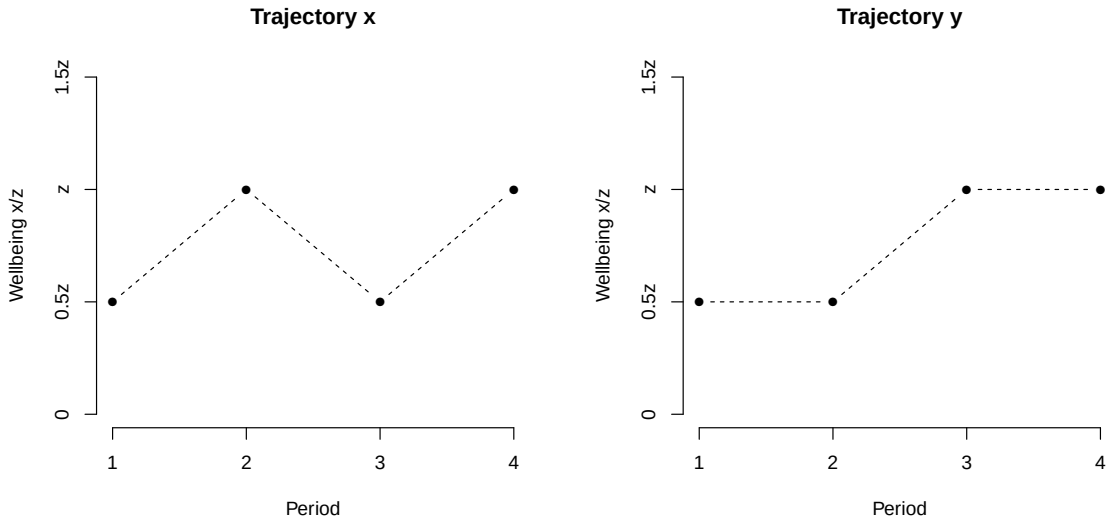
We may also consider the constant wellbeing equivalents induced by these three measures, for our example trajectory $\mathbf{x} = (0.5z, z, 0.5z, z, 0.5z, z)$; p_1 orders the trajectory as equivalent to its mean value, p_∞ orders it as equivalent to z, while p_2 is intermediate.



The extreme case p_∞ may not be so inappropriate as a measure of chronic poverty as it at first sight appears. It may be reasonable to take the 'least bad' level of wellbeing as reflecting the subject's degree of chronic poverty, as in every period they experience *at least* that degree of deprivation; further deprivation may be considered to be transient. However, this does mean that any individual who experiences at least one period above the poverty line is considered not to experience any chronic poverty at all, even if she does experience extended durations below the poverty line. Particularly given the arbitrary nature of the timing of observations when considering longitudinal data, it seems more reasonable to base our analysis on one of the intermediate measures, with α greater than 1 but not arbitrarily large.

3.3 Sensitivity to Persistence or Contiguity of Poverty

The trajectory orderings induced by the class of functions (3.1) are invariant to permutations of wellbeings over time periods (time symmetry). It seems quite reasonable that two contiguous periods of low wellbeing would be experienced differently from the same degree of poverty experienced in widely spaced periods; a chronic poverty measure should evaluate the former case as reflecting greater chronic poverty. For example, $\mathbf{x} = (0.5z, z, 0.5z, z)$ should be evaluated as reflecting *less* chronic poverty than $\mathbf{y} = (0.5z, 0.5z, z, z)$.



We may observe immediately that reflecting this property in the trajectory ordering induced by the chronic poverty measure will necessitate the relaxation of time-symmetry and (restricted to poor trajectories) time-separability. Informally, given the same distribution of wellbeings across time, the trajectory ordering should evaluate that trajectory with more contiguous periods of low wellbeing 'more poor'.

(CP) Contiguous Poverty: $p(\mathbf{x}) > p(\mathbf{y})$ *for all* $\mathbf{x}, \mathbf{y} \in \mathbb{X}^T$ *such that* $\mathbf{x} = A_T\mathbf{y}$ *where* A_T *is a* $(T \times T)$ *permutation matrix and in* $\mathbf{x}$ *more* $x_t < z$ *are contiguous than in* $\mathbf{y}$.

A trajectory ordering function with this property cannot be separable over time. In conjunction with contiguity (CP) it may be appropriate to relax duration sensitivity to hold strictly only for contiguous periods and weakly otherwise; this will be notated (D').

Recall that the trajectory ordering measure p_2 discussed above has a (separable) quadratic form; it may be expressed in the form:

$$p_2(\mathbf{x}) = \max\left[0, 1 - \left(\frac{1}{T}\mathbf{x}'\mathbf{I}\mathbf{x}\right)^{1/2}\right]$$

where $\mathbf{I}$ is the $T \times T$ identity matrix. A natural approach to relaxing separability is then to generalise the quadratic form to $\mathbf{x}'\mathbf{A}\mathbf{x}$ where $\mathbf{A}$ includes non-zero terms off its diagonal. As we are particularly interested in penalising contiguous periods in poverty, a matrix of the form

$$\mathbf{A} = \begin{pmatrix} 1+\beta & -\beta & 0 & \cdots & 0 & 0 \\ -\beta & 1+2\beta & -\beta & \cdots & 0 & 0 \\ 0 & -\beta & 1+2\beta & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & 1+2\beta & -\beta \\ 0 & 0 & 0 & \cdots & -\beta & 1+\beta \end{pmatrix}$$

is appropriate, suggesting the trajectory ordering function

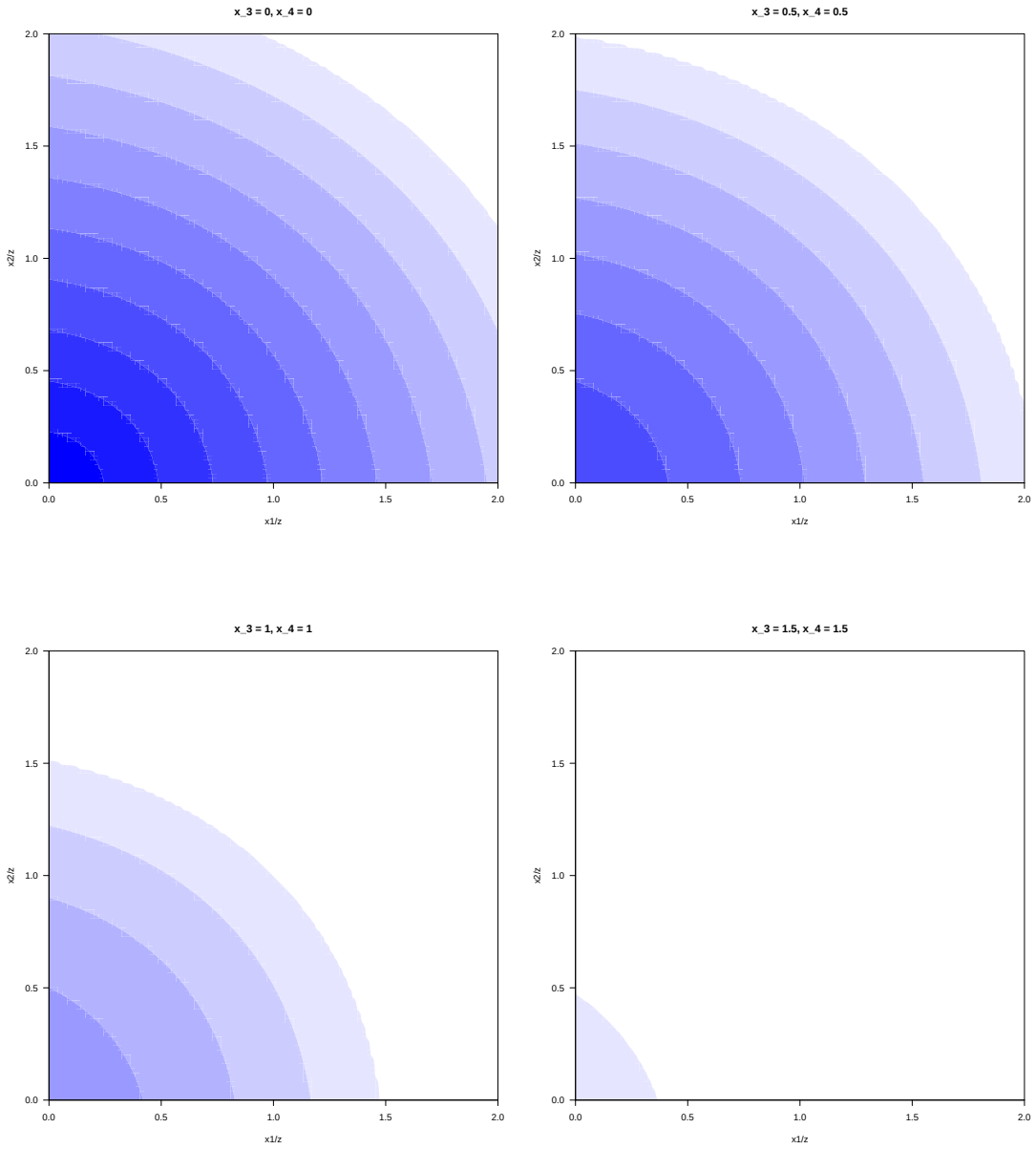
$$\tilde{p}(\mathbf{x}) = \max\left[0, 1 - \left(\frac{1}{T}\mathbf{x}'\mathbf{A}\mathbf{x}\right)^{1/2}\right].$$

This turns out to have the desired contiguity property (CP); with $\beta = 0.3$, $\tilde{p}(\mathbf{x}) = 0.175$ while $\tilde{p}(\mathbf{y}) = 0.198$, but this is obtained at the cost of monotonicity (M) which fails to hold near the axes where the cross terms with coefficient $-\beta$ dominate. Taking a mixture of the quadratic form and linear terms resolves this problem, yielding the trajectory ordering measure

$$\hat{p}(\mathbf{x}) = \max\left[0, 1 - \frac{1}{2}\left(\left(\frac{1}{T}\mathbf{x}'\mathbf{A}\mathbf{x}\right)^{1/2} + \frac{1}{T}\sum_{t=1}^{T} x_t\right)\right] \tag{3.2}$$

which (by graphical analysis) satisfies (C), (M), (D') and (CP).

The properties of this measure may be illustrated, for $T = 4$, by graphical representations of the ordering of trajectories allowing x_1 and x_2 to vary while holding x_3 and x_4 fixed at various levels.



Observe the asymmetry (reflecting contiguous poverty (CD); x_1 and x_2 are treated differently) and the non-separability (sets of equivalent trajectories do not exactly coincide when fixed at different levels).

It should be noted that there remains scope for further exploration of the class of poverty measures that satisfy the required properties. In particular, restricting attention to quadratic measures of the form (3.2), the structure of the matrix $\mathbf{A}$ may be modified to, for example, accommodate observations with irregular spacing.

The chronic poverty measure suggested by Jalan and Ravallion (2000) is of the form (2.4) with

$$p_{JR}(\mathbf{x}) = p_1(\mathbf{x}) = \max\left[0, 1 - \frac{1}{T}\sum_{t=1}^{T}\frac{x_t}{z}\right]. \tag{3.3}$$

This satisfies the trajectory ordering properties continuity (C) and monotonicity (M) but does not satisfy duration sensitivity (D) or contiguous poverty (CP), so I would argue that it does not measure *chronic* poverty as such. (It may be interpreted rather as poverty of average wellbeing.) It has, however, been widely used in the applied literature, for example Jalan and Ravallion's study of rural China and the application in rural Pakistan by McCulloch and Baulch (2000). It seems reasonable to use this measure as a comparator for the proposed measure.

3.4 Decomposition into Chronic and Transient Components

Given a measure of total intertemporal poverty $\mathcal{P}_T$ and a measure of chronic poverty $\mathcal{P}_C$, both of form (2.2), it is straightforward to decompose $\mathcal{P}$ into chronic and transient components provided the component functions g_T and g_C are identical, as are h_T and h_C. In that case, the measures coincide for all profiles of constant-wellbeing trajectories, for which it is natural to consider poverty to be entirely chronic. A measure of transient poverty may then be defined very straightforwardly as $\mathcal{P}_R(X) = \mathcal{P}_T(X) - \mathcal{P}_C(X)$. This is zero for all profiles of constant-wellbeing trajectories. Note that this measure need not be of the form (2.2) and thus care should be taken in its interpretation as it may not have the properties invoked in proposition 2.

As discussed above I shall restrict attention to measures of the form (2.4) that coincide with the poverty-gap-squared measure for profiles of constant-wellbeing trajectories. Jalan and Ravallion (2000) introduce a measure of total poverty that has this form, with

$$p_T(\mathbf{x}) = \max\left[0, \sum_{t=1}^{T}\left(1 - \frac{x_t}{z}\right)^2 \mathbb{I}(x_t \leq z)\right]. \tag{3.4}$$

I shall use this measure of total poverty, both for comparability with their decomposition, and because this 'total' poverty-gap-squared form fits naturally with the poverty-gap-squared form for the aggregation over individuals.

4 Chronic and Transient Poverty in Rural Ethiopia

4.1 Data

The Ethiopian Rural Household Survey was conducted by the Economics Department of Addis Ababa University, the Centre for the Study of African Economies at the University of Oxford and the International Food Policy Research Institute (IFPRI), based in Washington D.C.[4] Households in eighteen Peasant Associations[5] (PAs) in rural Ethiopia were surveyed twice in 1994, then in 1995, 1997, 1999, 2004 and 2009. Within each Peasant Association surveyed, the households were randomly sampled subject to stratification into female-headed/non-female-headed and landless/non-landless categories. (Six of the PAs had been included in a 1989 IFPRI study; in these PAs the sample was re-randomised.) The sample sizes in the eighteen PAs were chosen so that proportions in the pooled sample are representative of the agro-climatic zones of Ethiopia.[6]

The original analysis of poverty and poverty changes in the ERHS sample was made by Dercon and Krishnan (1998) who analysed data from the first three rounds, comparing with data from the 1989 IFPRI survey for those households included in both surveys. Dercon and Krishnan constructed a household aggregate consumption measure comprising the nominal value of purchased and non-purchased food items consumed as well as non-investment non-food items, but excluding expenditure on durables, house expenses, health and education. This was scaled according to the household composition to give a per-adult-equivalent monthly value, following World Health Organisation guidelines for weighting male and female adults and children.

Dercon and Krishnan conducted the poverty analysis relative to a poverty line determined by the cost-of-basic-needs approach; a food consumption basket typical of the diet of the nominally poorest half of the sample was constructed and scaled so as to provide 2300 Calories (kilocalories) per day. The non-food share of consumption for a household at the poverty line was estimated and the nominal value of the poverty line was computed for each PA in each period, using local prices. As all of the poverty analysis was conducted relative to the local period poverty line, it served as a deflator rendering the nominal consumption aggregate comparable across periods and locations. More details and a comprehensive discussion of the issues arising may be found in Dercon and Krishnan (1998).

Porter (2008) extended the analysis up to and including round 6 (2004), omitting round 2 (the second 1994 round) as the first three rounds had been conducted in a very short time frame in comparison to the rest of the survey. She conducted a detailed analysis of consumption and poverty dynamics, using the household per-adult-equivalent consumption aggregate deflated using local prices to 1994 prices, rendering it comparable across

[4]Funding was received from the UK Economic and Social Research Council (ESRC), the Swedish International Development Agency (SIDA), the US Agency for International Development (USAID) and the World Bank.

[5]Created after the 1974 revolution, Peasant Associations are the lowest level administrative division in rural Ethiopia. Each comprises one or a few villages.

[6]Detailed sampling documentation may be found at www.csae.ox.ac.uk/datasets/Ethiopia-ERHS/erhs/docoutline-erhs.html.

periods within each PA. The poverty analysis used the 1994 local values of the poverty line constructed by Dercon and Krishnan.

It is this deflated per-adult-equivalent consumption data (extended to include round 7) that I use as the indicator of wellbeing in the following analysis. In order to avoid the issue of irregular time periods I have restricted the analysis to rounds 1 (1994), 5 (1999), 6 (2004) and 7 (2009) giving a regular 5-year period. Clearly the long gaps between periods are not ideal; it is however beyond the scope of the present study to determine the impact of the issues that this might cause. Only those households for which consumption data is available in each of these rounds (1136 of the 1477 households in the initial round) are included in the analysis. There is therefore the potential for selection bias if the results are interpreted as estimates of poverty incidence in the sampled villages or in rural Ethiopia as a whole. The household has been treated as the unit of analysis; the data do not permit issues of intrahousehold allocation to be explored, while household composition changes over the 15-year time period so this seems to be the most straightforward approach. Again, we should be careful not to interpret the sample as representative for the rural population of Ethiopia.

4.2 Results: Jalan-Ravallion Decomposition

The first decomposition follows Jalan and Ravallion (2000). This approach was chosen because it has been widely used in the applied literature, for example Jalan and Ravallion's study of rural China and the application in rural Pakistan by McCulloch and Baulch (2000). It is a relatively straightforward approach; whilst our poverty analyst might argue that the 'chronic' poverty measure does not reflect chronicity or persistence as such, it does not possess any of the counter-intuitive properties of some of the measures suggested in the more recent literature.

As discussed above, the total and chronic poverty measures ($\mathcal{P}_T$ and $\mathcal{P}_{JR}$ respectively) are of the form (2.4), with

$$p_T(\mathbf{x}) = \max\left[0, \sum_{t=1}^{T}\left(1-\frac{x_t}{z}\right)^2 \mathbb{I}(x_t \leq z)\right]$$

which corresponds to Foster, Greer, and Thorbecke's (1984) squared-poverty-gap measure, aggregated over time periods as well as individuals, while

$$p_{JR}(\mathbf{x}) = \max\left[0, 1-\frac{1}{T}\sum_{t=1}^{T}\frac{x_t}{z}\right].$$

The total, chronic and transient measures are calculated for the 18 Peasant Associations in the ERHS sample. For each PA the percentage of the total poverty that is evaluated as 'chronic' and the percentage 'transient' is also given. The results are given in Table 1.

The total poverty level varies widely across the PAs, from a minimum of 0.0021 in Sirbana Godeti to a maximum of 0.1907 in Gara Godo. The percentage of the total poverty

Table 1: **Jalan-Ravallion Decomposition**

Peasant Association	$\mathcal{P}_T$	$\mathcal{P}_{JR}$	$\mathcal{P}_T - \mathcal{P}_{JR}$	**% chronic**	**% transient**
Haresaw	.0668342	.0028732	.063961	1.819242	98.18076
Geblen	.1504773	.0534743	.097003	26.02232	73.97768
Dinki	.0447244	.0084647	.0362596	6.997532	93.00247
Yetmen	.0058968	0	.0058968	0	100
Shumsha	.0040872	.0000118	.0040755	.0858117	99.91419
Sirbana Godeti	.0020922	0	.0020922	0	100
Adele Keke	.0379529	.0001914	.0377616	.1472317	99.85277
Korodegaga	.0553191	.0020981	.0532209	1.229197	98.7708
Trirufe Ketchema	.024877	.0041737	.0207033	4.218716	95.78128
Imdibir	.0407047	.0084567	.032248	9.250909	90.74909
Aze Deboa	.0411501	.0057057	.0354444	6.224927	93.77507
Adado	.043913	.0057793	.0381337	7.463637	92.53636
Gara Godo	.1907494	.0706493	.1201	25.97505	74.02495
Doma	.1148332	.0336721	.0811611	16.69212	83.30788
Debre Berhan Mil	.0112358	0	.0112358	0	100
Debre Berhan Kor	.0104418	0	.0104418	0	100
Debre Berhan Kar	.0095046	0	.0095046	0	100
Debre Berhan Bok	.013391	0	.013391	0	100
Total	.0515465	.011725	.0398215	8.929512	91.07049

Source: Ethiopian Rural Household Survey, rounds 1, 5, 6, 7; own calculations.

evaluated as chronic varies between zero, in several villages, and 26% in Geblen and Gara Godo. The burden of chronic poverty is strongly correlated with the total burden of poverty, with correlation coefficient 0.6755. The percentage chronic is fairly strongly correlated with total poverty across the whole sample, with correlation coefficient 0.5716.

4.3 Results: The New Decomposition

The second decomposition follows Jalan and Ravallion for the measure of total poverty, but uses the new measure of chronic poverty developed in section 3, of the form (2.4) with

$$\hat{p}(\mathbf{x}) = \max\left[0, 1 - \frac{1}{2}\left(\left(\frac{1}{T}\mathbf{x}'\mathbf{A}\mathbf{x}\right)^{1/2} + \frac{1}{T}\sum_{t=1}^{T} x_t\right)\right]$$

with $\beta = 0.3$, which as established in section 3 possesses appropriate properties for the measurement of chronic poverty.

The total poverty is as above. The percentage of the total poverty evaluated as chronic is slightly lower, as would be expected given the relationship between the trajectory orderings of the two measures (see figures in section 3.2 and 3.3). It varies between zero, in several villages, and 20% in Geblen. The burden of chronic poverty is slightly less strongly correlated with the total burden of poverty, with correlation coefficient 0.5957.

Table 2: **New Decomposition**

Peasant Association	$\mathcal{P}_T$	$\hat{\mathcal{P}}$	$\mathcal{P}_T - \hat{\mathcal{P}}$	**% chronic**	**% transient**
Haresaw	.0668342	.001397	.0654372	.8158793	99.18412
Geblen	.1504773	.0403895	.1100877	19.95914	80.04086
Dinki	.0447244	.0072844	.0374399	5.693457	94.30654
Yetmen	.0058968	0	.0058968	0	100
Shumsha	.0040872	3.66e-08	.0040872	.0002672	99.99973
Sirbana Godeti	.0020922	0	.0020922	0	100
Adele Keke	.0379529	1.07e-06	.0379519	.0009033	99.9991
Korodegaga	.0553191	.0010076	.0543115	.5452497	99.45475
Trirufe Ketchema	.024877	.0014383	.0234387	2.338542	97.66146
Imdibir	.0407047	.0060339	.0346708	6.398256	93.60174
Aze Deboa	.0411501	.0053228	.0358273	5.788729	94.21127
Adado	.043913	.0039839	.0399291	5.491945	94.50806
Gara Godo	.1907494	.0543188	.1364305	19.42926	80.57074
Doma	.1148332	.023139	.0916942	11.93101	88.06899
Debre Berhan Mil	.0112358	0	.0112358	0	100
Debre Berhan Kor	.0104418	0	.0104418	0	100
Debre Berhan Kar	.0095046	0	.0095046	0	100
Debre Berhan Bok	.013391	0	.013391	0	100
Total	.0515465	.0086653	.0428812	6.619913	93.38009

Source: Ethiopian Rural Household Survey, rounds 1, 5, 6, 7; own calculations.

The percentage chronic moderately correlated with the total poverty level (correlation coefficient 0.4921). (Again, the correlations are calculated across the whole sample without weighting.)

The incidence and burden of total and chronic poverty are found to vary widely across different communities. The burden of chronic poverty evaluated by both methods is found to be strongly correlated with the burden of total poverty. The proportion of poverty evaluated to be chronic according to the new method varies between 0% and 20% across different villages. Interestingly, according to the new method the proportion of chronic poverty is relatively weakly correlated with the total burden of poverty across villages. This perhaps reflects the different economic environments and vulnerabilities in the different agrico-climatic zones represented by the different villages. The correlation between proportion of chronic and burden of total poverty appears stronger when using Jalan and Ravallion's decomposition, reflecting the properties of their 'chronic' measure which actually reflects time-averaged levels of poverty rather than chronicity per se.

5 Concluding Remarks

Desirable properties for chronic poverty measures were discussed and their consequences for the form of the measure determined. A new measure of chronic poverty has been intro-

duced which has attractive properties; its potential for application in empirical poverty analysis has been illustrated by application to longitudinal household data from rural Ethiopia. It is interesting to see that the results obtained are not very dissimilar from those according to the method introduced by Jalan and Ravallion (2000). Further work is necessary to characterise the entire class of measures with appropriate properties for chronic poverty measurement and to choose the most appropriate from among that class. It will also be desirable to extend the analytical framework to allow for periods of variable duration and missing data.

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