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## Measuring Chronic Poverty

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### Abstract

A new class of chronic poverty measures is constructed that builds upon Jalan and Ravallion (1998) but does not require resources in different periods to be perfect substitutes when identifying the chronically poor. We use a general mean to combine the resources of a person into a permanent income standard that is then compared to a poverty line to determine when a person is chronically poor. The parameter $\beta \leq 1$ of the general mean allows for varying degrees of substitutability over time, from perfect substitutes at $\beta = 1$ to perfect complements as $\beta$ tends to -∞. The decomposable Clark, Hemming and Ulph (1981) poverty measure with the same parameter $\beta$ is applied to the distribution of permanent income standards to measure overall chronic poverty. Each measure has a convenient expression in terms of a censored matrix and satisfies a host of properties including decomposability. We provide an empirical application of the new measures using panel data from urban areas in Argentina.

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One of the least remarked-on problems of living with two dollars a day is that you do not literally get that amount each day. The two dollars a day is just an average over time. You make more on some days, less on others, and often get no income at all.

(Collins et al. 2009: 3)

## 1. Introduction

Time is an important additional dimension for understanding poverty and informing policy design.[1] A common way of incorporating time into the analysis of poverty is by separating the poor into two groups: the chronically poor and the transiently poor.[2] Hulme and Shepherd (2003) have described the chronically poor as follows: "intuitively, we are talking about people who remain poor for much of their life course, and who may "pass on" their poverty to subsequent generations" (p. 405). However, the specific criterion used to identify the chronically poor (and hence the transiently poor) is a subject of continuing debate. Two identification approaches can be distinguished: a *counting approach* and a *permanent income approach*.[3]

In the counting approach, also called the *spells approach*, the chronically poor are identified based on the number of periods or the proportion of time they are observed to be in poverty. This approach goes back to Levy (1977), among others, and is also used by Duncan and Rodgers (1991).[4] More recently, Foster (2009) proposed a new family of chronic poverty measures within this general approach.[5] A related variant is that of Bane and Ellwood (1986) who estimate the exit probabilities associated with continuous poverty spells of different lengths.

The permanent income approach, also called the *components approach*, compares the resources a person has over time to the poverty line. Lillard and Willis (1978) and Duncan and Rodgers (1991) estimate permanent income as a person's intercept in a fixed-effects earnings model, while the transitory component is given by the error term. Persistent poverty is measured as the proportion of individuals with permanent income below the poverty line. A different method, proposed in Ravallion (1988) and later used by Jalan and Ravallion (1998), defines people as chronically poor when their mean resources through time are below the poverty line and measures chronic poverty using a traditional static measure

1 The present paper focuses purely on income (or consumption) and lets multiple observations create a kind of multidimensionality over time. Many recent papers have considered dimensions beyond income (or consumption) in identifying and measuring poverty. See, for example, Atkinson (2003), Bourguignon and Chakravarty (2003), Alkire and Foster (2007, 2011), and Alkire and Santos (2010). In the future, both aspects of poverty – its dynamics and its multidimensionality – may be combined into a single analysis.

2 A related study of poverty dynamics does not focus on the chronically poor but rather constructs measures of lifetime or intertemporal poverty. See, for example, Calvo and Dercon (2009), Hoy and Zheng (2011), Bossert, Chakravarty and D'Ambrosio (2012), Porter and Quinn (2008), Dutta, Roope and Zank (2011), Gradin, del Rio and Cantó (2012) and Mendola and Buseta (2012). Duclos, Araar and Giles (2010) propose measures of chronic and transient poverty but these categories apply to aggregates and not to individuals; there is no identification criterion for the chronically poor.

3 Yaqub (2000) uses the terms "spells approach" and "components approach".

4 For further references on early uses of this approach see the excellent discussion in Rodgers and Rodgers (1993).

5 Alkire and Foster (2011) propose a related methodology for multidimensional poverty measurement.

applied to the distribution of means.[6] This method effectively maps the problem of multi-period poverty assessment into the traditional static framework using an income standard.[7]

These two approaches for identifying the chronically poor make very different assumptions regarding substitutability across periods. The counting approach assumes that resources observed in a time period are consumed in that time period and are not transferred across periods. The permanent income approach freely averages up resources, effectively assuming perfect substitutability over time.[8] In view of this, Rodgers and Rodgers (1993) expand upon the permanent income approach by explicitly accounting for the individual's potential saving and borrowing behavior. Their proposed measure of an individual's permanent income is "the maximum sustainable annual consumption level that the agent could achieve with his or her actual income stream over the same $T$ years, if the agent could save and borrow at prevailing interest rates" (p. 31). When positive interest rates are explicitly considered in the present value calculation, the permanent income level is below the mean income.

Yet modeling permanent income using interest rates may not reflect the full complexity of the transaction costs the poor face in transferring income and other resources over time. In their account of over 250 financial diaries of poor households across India, Bangladesh and South Africa, Collins et al. (2009) find that poor households use a host of different methods to save and borrow, namely:

> …storing savings at home, with others, and with banking institutions, joining savings clubs, savings-and-loan clubs, and insurance clubs, and borrowing from neighbors, relatives, employers, moneylenders, or financial institutions. At any one time the average poor household has a fistful of financial institutions relationships on the go (p. 3).

Not only are the effective interest rate spreads faced by the poor far greater than the spreads in the formal market, but the other transaction costs of shifting resources can also be much higher. These vary from the extra time they must spend in a long queue, to the cost of the bus ride to reach the local bank, to an implicit obligation to work some days at a low wage in return for financial services (Collins et al. 2009: 135).

We propose a new methodology for chronic poverty measurement that follows the permanent income approach but explicitly allows an imperfect degree of substitutability across periods. As a result, volatility or inequality in the distribution of a person's resources over time is reflected in a lower measured level of permanent income. The methodology is based on a well-known class of income standards – namely, Atkinson's (1970) parametric family of "equally distributed equivalent income" functions, also known as the general means of order $\beta$ – which exhibits lower levels of substitutability as its parameter $\beta$ falls from 1 (the usual mean) to $-\infty$ (the limiting case of perfect complements). The general mean is used to convert each person's resource stream over time into a permanent income standard, and then a corresponding member of the Clark, Hemming and Ulph (1981) decomposable family of poverty measures is applied to the distribution of permanent income standards. The resulting class of chronic poverty measures is shown to have many attractive properties.

The paper is organized as follows. Section 2 presents the notation used in the paper, while Section 3 reviews previous chronic poverty measures. Section 4 presents the new class of chronic poverty

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6 See also Rodgers and Rodgers (1993) whose chronic poverty measure reduces to this case when the interest rate is zero.

7 An "income standard" is a function that reduces a distribution or vector of some resource variable to a representative level of that variable; see Foster and Szekely (2008) for a general definition including properties. When the aggregation is over time we will call it a "permanent income standard".

8 Note, though, that both implicitly assume perfect substitutability *within* each time period.

measures and Section 5 describes the properties satisfied by this class. The transient component of poverty is the focus of Section 6, while Section 7 provides an empirical application using panel data from urban Argentina. Section 8 concludes.

## 2. Notation

Let $M^{n,T}$ denote the set of all $n \times T$ matrices with positive entries, and interpret a typical element $Y \in M^{n,T}$ as containing a panel of income observations for *n* different individuals over $T$ periods.[9] Where *N* denotes the positive integers, the set $M = U_{n,T \in N} M^{n,T}$ contains all possible panels of data for any finite number of individuals, while $M^n = U_{T \in N} M^{n,T}$ contains all possible arrays across *n* individuals and $M^{\bullet T} = U_{n \in N} M^{n,T}$ is the set of *T*-period arrays. The population size and horizon associated with a given distribution *Y* are denoted by $n(Y)$ and $T(Y)$, respectively, or by *n* and *T* when fixed. For every $i = 1,2,...,n$ and $t = 1,2,...,T$, the typical entry $y_{it}$ of *Y* is individual $i$´s income in period *t*, where we assume that $y_{it} \in R_{++} := (0,\infty)$.[10] The row vector $y_i = (y_{i1}, y_{i2},...., y_{iT})$ contains individual $i$ ´s incomes across time; the column vector $y_{\bullet t} = (y_{1t}, y_{2t},...., y_{nt})'$ gives the income distribution across individuals in period *t*. The sum of entries in any given vector or matrix *v* will be denoted by $|v|$, while $\mu(v)$ will be used to represent the mean of *v* (or $|v|$ divided by the number of entries in *v*). It is assumed that all incomes have been adjusted by price differences over time and by the demographic characteristics of the individual, so that the same poverty line $z \in R_{++}$ can be used for all individuals and periods.[11]

The measurement of chronic poverty can be broken down into an identification step and an aggregation step analogous to Sen's (1976) presentation in the single period case. The first step results in an *identification function* $\rho(y_i; z)$, which determines whether individual *i* with income stream $y_i$ is chronically poor given the poverty line *z*. The identification function indicates that individual *i* is in chronic poverty when $\rho(y_i; z) = 1$, while $\rho(y_i; z) = 0$ signals that the individual is not chronically poor. In contrast to the one period case, which entails a straightforward comparison of the income to the poverty line, the identification step here must consider the entire income stream to determine the chronic poverty status of the individual. Even so, the solution is immediate in two cases. When individual *i* is "never poor" so that $y_{it} \geq z$ for all *t*, every reasonable identification method would conclude $\rho(y_i; z) = 0$. Likewise, $\rho(y_i; z) = 1$ naturally arises when individual *i* is "always poor" so that $y_{it} < z$ for all *t*. Identification methods can significantly differ when individual *i* is "sometimes poor" so that $y_{it} < z$ for some *t* and $y_{it} \geq z$ at some other, and the issue then revolves around how poor and nonpoor spells are to be compared.

The aggregation step builds upon the identification step to construct a *measure of chronic poverty* $P(Y; z)$ that combines the data of the chronically poor to obtain an overall level of chronic poverty. The basic

9 The term "income" is meant to represent a generic resource variable, which may in fact be income, consumption, or expenditure.

10 In what follows we make the practical assumption that income (or consumption) levels are positive, which is needed for some of the measures we discuss.

11 Equivalently, one could reflect differences in local prices or demographics in the poverty line and normalize; see Foster (1998). Our example incorporates demographics into the income variable and price change into the poverty line.

*headcount ratio* $H(Y;z)=Q(Y;z)/n(Y)$ is found by counting the number $Q(Y;z)$ of chronically poor individuals and dividing by the total population size $n(Y)$. This is a useful partial index of chronic poverty, but like its single period version, it is rather insensitive to certain basic changes in the distribution that should arguably change the measured level of chronic poverty. Alternative chronic poverty measures have been proposed, with all methods up to now making use of standard one-period poverty measures. Solutions to both steps determine the *chronic poverty methodology* $\mathcal{M}=(\rho,P)$, where $\rho: M^1 \times R_{++} \to \{0,1\}$ identifies the chronically poor individuals and $P: M \times R_{++} \to R_+$ aggregates the data into an overall level of chronic poverty in $R_+ := [0,\infty)$. The next section presents two existing chronic poverty methodologies.

## 3. Previous chronic poverty measures

There are two main approaches to measuring chronic poverty, distinguished primarily by their methods of identifying people who are chronically poor. One approach, exemplified by Foster (2009), is based on the number of periods that an individual is poor and implicitly assumes that the observed income is not subsequently transferred across periods. A second method, proposed by Ravallion (1988) and used by Jalan and Ravallion (1998), compares a person's mean income across time to the poverty line, which presumes that the resource variable can be transferred freely across periods.[12]

Foster (2009) begins by counting the periods of poverty experienced by individual $i$ or, equivalently, the number of dates $t$ for which $y_{it} < z$, and then expresses this poverty duration as a fraction $d_i$ of the $T$ periods. The identification function $\rho_\tau(y_i;z)$ is based on a fixed cutoff $\tau \in (0,1]$, with an individual being chronically poor if the individual is poor at least $\tau$ share of the time. In symbols, $\rho_\tau(y_i;z)=1$ if $d_i \geq \tau$, and $\rho_\tau(y_i;z)=0$ if $d_i < \tau$.

As for the aggregation method, it is noted that the headcount ratio $H(Y;z)$ is insensitive to duration in that $H$ does not change if the fraction $d_i$ of time a chronically poor individual spends in poverty rises. This problem can be addressed by adjusting $H$ and other single period measures to account for duration. The static measures used are from the Foster, Greer, and Thorbecke (1984) or FGT class, which is defined as follows. Let $w \in M^{n,1}$ be a distribution of income over a single period. For any $\alpha \geq 0$, the $i^{th}$ entry of the vector $g^\alpha(z)=(g_1^\alpha(z),...,g_n^\alpha(z))$ is given by $g_i^\alpha(z)=0$ if $w_i \geq z$, and $g_i^\alpha(z)=((z-w_i)/z)^\alpha$ if $w_i < z$. In words, $g_i^\alpha(z)$ is the $\alpha$ power of the normalized income shortfall if individual $i$'s income falls below the poverty line, and zero if not. The FGT class of measures is then $F_\alpha(w;z)=\mu(g^\alpha(z))$, or the mean of the vector $g^\alpha(z)$, with $F_0$ being the standard headcount ratio, $F_1$ being the per capita poverty gap, and $F_2$ being the squared gap FGT index.

The associated chronic poverty indices are defined in a similar fashion but take into account the duration cutoff $\tau$ defined above. For any matrix $Y \in M$, define the normalized gap matrix $G^\alpha(z)=[g_{it}^\alpha(z)]$ by $g_{it}^\alpha(z)=0$ if $y_{it} \geq z$, and $g_{it}^\alpha(z)=((z-y_{it})/z)^\alpha$ if $y_{it} < z$, and note that $G^\alpha(z)$ gives the $\alpha$ power of the normalized gaps across all individuals and periods, irrespective of whether an individual has been identified as being chronically poor. Identification is incorporated into the censored matrix $G^\alpha(z,\tau)$,

12 See also Jalan and Ravallion (2000).

whose typical entry is $g_{it}^{\alpha}(z,\tau) = g_{it}^{\alpha}(z)\rho_{\tau}(y_i;z)$; in other words, the entries are unchanged for the chronically poor, while the entries for the remaining persons are censored to zero.

The *duration adjusted FGT indices* are then defined as $K_{\alpha}(Y;z,\tau) = \mu(G^{\alpha}(z,\tau))$, or the mean of the censored matrix $G^{\alpha}(z,\tau)$. When $\alpha = 0$, the measure becomes the *duration adjusted headcount ratio* $K_0 = HD$, which is the product of the headcount ratio $H(Y;z) = Q/n$ and the average duration of poverty among the chronically poor, given by $D(Y;z,\tau) = |G^0(z,\tau)|/(QT)$. For $\alpha = 1$, the measure becomes the *duration adjusted poverty gap* $K_1 = HDA$, where $A(Y;z,\tau) = |G^1(z,\tau)|/|G^0(z,\tau)|$ is the average gap across the poverty spells of the chronically poor. Finally, $\alpha = 2$ yields the *duration adjusted squared poverty gap* $K_2 = HDS$, where $S(Y;z,\tau) = |G^2(z,\tau)|/|G^0(z,\tau)|$ is the average squared gap derived from the poverty spells of the chronically poor. The resulting methodology $(\rho_{\tau}, K_{\alpha})$ for evaluating chronic poverty satisfies a range of useful properties including *population decomposability*.[13]

In contrast, the chronic poverty methodology of Jalan and Ravallion (1998) uses an identification approach that ignores per-period poverty status and focuses on a specific income standard: the mean across periods. Their identification function $\rho_{\mu}(y_i,z)$ is defined by $\rho_{\mu}(y_i,z) = 1$ if $\mu(y_i) < z$, and $\rho_{\mu}(y_i,z) = 0$ if $\mu(y_i) \geq z$; in other words, an individual is chronically poor when the mean income is below the poverty line. For the aggregation step, they apply the single period FGT measure $F_2$ to the distribution $\bar{y} = (\bar{y}_1,\ldots,\bar{y}_n)$ of mean incomes $\bar{y}_i = \mu(y_i)$ drawn from *Y*, and hence their chronic poverty measure is simply $J(Y;z) = F_2(\bar{y};z)$.

The methodology $(\rho_{\mu}, J)$ of Jalan and Ravallion (1998) can be readily linked to the Foster (2009) methodology. Consider the "smoothed" matrix $\bar{Y}$ defined by $y_{it} = \bar{y}_i$ for all *i* and *t*. In words, the individual's income in a given period is replaced by the mean income across all periods, as might be expected if an individual could freely transfer income through time. For matrices like $\bar{Y}$, chronic poverty identification becomes as simple as the single period case, since every individual is seen as either "never poor" or "always poor" while the contested category "sometimes poor" is absent. Every reasonable identification method would in fact agree on the set of chronically poor individuals in this situation, including the functions $\rho_{\tau}$ used by Foster (2009). Moreover, since the mean of squared normalized gaps is the same for the vector $\bar{y}$ and the matrix $\bar{Y}$, we see that the measure *J* is just the duration adjusted FGT measure $K_2$ applied to the smoothed matrix $\bar{Y}$, that is, $J(Y;z) = K_2(\bar{Y};z)$. Hence the chronic poverty methodology $(\rho_{\mu}, J)$ of Jalan and Ravallion (1998) can be viewed as the Foster (2009) methodology $(\rho_{\tau}, K_2)$ applied to the smoothed matrix $\bar{Y}$ rather than $Y$ itself.

The counting approach of Foster (2009) interprets the observed data in a given period as the amount that is actually consumed in that period, with no subsequent resource movement across periods. Of course, this is more applicable to consumption data than for income data (which is presumably more fungible across periods), but it does provide one point of view from which the data may be evaluated. In contrast, by using the mean over time as the income standard, Jalan and Ravallion (1998) implicitly assume that resources can be costlessly transferred across periods. Such an assumption would seem to be more applicable when using income as the resource variable.

13 For a list of these properties and their definitions, see Foster (2007).

We argue that, in many circumstances, an intermediate level of substitutability between these two extremes may be more relevant, whether the resource variable is consumption or income. For consumption, some smoothing can be presumed to take place across time via storage or durable goods. For income, Collins et al. (2009: 3) note that households living on less than a dollar a day per person manage their money by saving when they can and borrowing when they need to, but due to their use of informal financial institutions, face high and variable interest rates as well as other transaction costs.[14] These cases are consistent with imperfect substitutability, whereby less than the full amount of what is drawn from one period will be available in another, as if the income were being carried in a "leaky bucket" (Atkinson 1973; Okun, 1975). Variability lowers the effective pool of resources available to the family in accordance with the extent of the imperfection. In the next section, we develop a new class of chronic poverty measures whose identification step is consistent with an intermediate level of substitutability across time periods.

## 4. A new class of chronic poverty measures

The methodology we propose is analogous to Jalan and Ravallion's chronic poverty measure in that it makes use of a permanent income standard and a single period poverty measure. The income standard used here is a general mean (of order $\beta$), while the static poverty measure used is Atkinson's (1987) decomposable version of the Clark, Hemming and Ulph (1981) or CHU class of poverty measures.[15] We introduce each of these components in turn.

Given an individual's income distribution $y_i$ **,** the general mean income over time is defined as:

$$\mu_\beta(y_i) = \begin{cases} \left(\sum_{t=1}^{T} y_{it}^{\beta} \big/ T\right)^{1/\beta} & \beta \neq 0 \\ \prod_{t=1}^{T} y_{it}^{1/T} & \beta = 0 \end{cases} \tag{1}$$

Each general mean can be interpreted as a permanent income standard, which summarizes $y_i$ in a single income level.[16] When $\beta = 1$, the general mean reduces to the *arithmetic mean*. For $\beta > 1$, more weight is placed on higher incomes and the general mean is higher than the arithmetic mean, approaching the maximum income as $\beta$ tends to ∞. For $\beta < 1$ more weight is placed on lower incomes, and the general mean is lower than the arithmetic mean, approaching the minimum income as $\beta$ tends to -∞. The case of $\beta = 0$ is known as the *geometric mean* and $\beta = -1$ is the *harmonic mean.*

As noted by Foster and Szekely (2008), this class of income standards satisfies a number of desirable properties.[17] For $\beta < 1$ the standard will decrease when a mean-preserving income transfer from a period of lower income to a period of higher income increases dispersion; for $\beta = 1$ it will be unaffected; and for $\beta > 1$ it will increase. The range $\beta \leq 1$ yields the family of *equally distributed equivalent incomes* introduced by Atkinson (1970). The quantity $(1-\beta)$ represents the income standard's aversion to

14 For a detailed discussion on the transaction costs of informal risk sharing see Morduch (1999).

15 Also included are the measures of Watts (1969) and Chakravarty (1983).

16 Note that $\mu_\beta(y_i)$ is weakly increasing in $\beta$ and also that $\lim_{\beta \to 0} \mu_\beta(y_i) = \mu_0(y_i)$

17 In fact, it is the only class of income standards satisfying symmetry, replication invariance, linear homogeneity, normalization, continuity, *and* subgroup consistency (Foster and Szekely, 2008, p. 1149). Foster and Shneyerov (1999, 2000) highlight the special role of the general means in inequality measurement.

inequality over time or, equivalently, the cost or "leakage" when income is transferred across periods; $1/(1-\beta)$ is the standard's elasticity of substitution. We focus on the case $\beta < 1$ for which income is imperfectly substitutable over time, so that a more unequal income stream will produce a lower income standard. We also include the case $\beta = 1$ for which income is perfectly substitutable and inequality is ignored.

The general mean $\mu_\beta(y_i)$ with $\beta \le 1$ can be used to construct an identification function $\rho_\beta(y_i, z)$ as follows: $\rho_\beta(y_i, z) = 1$ if $\mu_\beta(y_i) < z$, and $\rho_\beta(y_i, z) = 0$ if $\mu_\beta(y_i) \ge z$. In words, an individual is identified as chronically poor when that person's permanent income level is below the poverty line. Note that when $\beta = 1$ the identification function $\rho_\beta$ becomes $\rho_\mu$, which corresponds to the case of Jalan and Ravallion (1998). The general means, however, allow for imperfect substitutability and the possibility that a person having an arithmetic mean above the poverty line will be identified as chronically poor due to variations in income and the costs of transferring it across time.[18]

We now turn to the class of static poverty measures that will be used. Let $w \in M^{n,1}$ be any distribution of income over a single period and let $w^*$ denote the associated censored distribution given by $w_i^* = w_i$ for $w_i < z$, and $w_i^* = z$ otherwise. The CHU class of indices is defined by:

$$C_\beta(w; z) = \begin{cases} \frac{1}{\beta}\left[1 - \left(\mu_\beta(w^*/z)\right)^\beta\right] & \beta \le 1; \beta \ne 0 \\ -\ln\left(\mu_0(w^*/z)\right) & \beta = 0 \end{cases} \qquad (2)$$

Just as the FGT measures are based on income gaps among the poor, the CHU measures can be seen as being based on utility gaps, or the difference between the utility level of the poverty line income and the utility of the poor person's actual income. The utility function is given by $U_\beta(w_i) = w_i^\beta / \beta$ when $\beta \le 1$ and $\beta \ne 0$, or by $U_\beta(w_i) = \ln w_i$ when $\beta = 0$. The indices can be interpreted as measuring the average utility loss due to poverty where parameter $(1-\beta)$ indicates the underlying aversion to inequality among the poor.[19]

The new class of chronic poverty measures can now be defined. From the original income matrix $Y$, a vector of permanent income standards $\bar{y}_\beta = (\bar{y}_\beta^1, ..., \bar{y}_\beta^n)$ is constructed, where $\bar{y}_\beta^i = \mu_\beta(y_i)$ is the $i^{th}$ person's general mean across time. The proposed family $P_\beta$ of chronic poverty measures is defined by:

$$P_\beta(Y; z) = C_\beta(\bar{y}_\beta, z) \qquad \beta \le 1 \qquad (3)$$

In words, $P_\beta$ is the decomposable CHU measure $C_\beta$ applied to the vector $\bar{y}_\beta$ of general means with the same value of $\beta$. Our overall methodology for measuring chronic poverty is then given by $(\rho_\beta, P_\beta)$.

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18 The general mean over time is also used in the identification step of other studies. Cruces and Wodon (2007) combine it with the FGT measure $F_2$ to create a measure of "risk-adjusted poverty". Aaberge and Mogstad (2007) use an "equally allocated equivalent income" to identify the chronically poor, but do not have an aggregation step. See also Porter and Quinn (2008).

19 The utility-loss interpretation is discussed extensively in Foster and Jin (1999), who also provide a characterization of the CHU measures. Note that $C_\beta$ converges to $C_0$, the Watts (1969) poverty index, as $\beta$ tends to 0.

Requiring the same $\beta$ for both components ensures that the chronic poverty measure has the same degree of aversion to inequality among the poor as to inequality over time.

It also leads to a simplified, matrix-based definition. Let $Y^*$ be the censored matrix whose typical element is given by $y_{it}^* = y_{it}$ if $\mu_\beta(y_i) < z$, and $y_{it}^* = z$ otherwise. In other words, the incomes of the chronically poor, whether above or below the poverty line, are left unchanged, while the incomes of those not chronically poor are replaced by the poverty line. The new class $P_\beta$ can equivalently be defined as:

$$P_\beta(Y;z) = \begin{cases} \frac{1}{\beta}\left[1-\left(\mu_\beta(Y^*/z)\right)^\beta\right] & \beta \le 1; \beta \ne 0 \\ -\ln\left(\mu_0(Y^*/z)\right) & \beta = 0 \end{cases} \qquad (4)$$

The resulting formula resembles the original CHU formula but uses a censored matrix instead of a censored vector.

Each of the measures also has the following intuitive interpretation in terms of utility gaps

$$P_\beta(Y;z) = A(z)\frac{1}{n}\sum_{i=1}^{n}\left[U_\beta(z) - \frac{1}{T}\sum_{t=1}^{T}U_\beta(y_{it}^*)\right] \qquad (5)$$

where $A(z) > 0$ is a normalization factor.[20] If person $i$ is not chronically poor, then $y_{it}^* = z$ and the utility gap – or the expression in brackets – is 0. If $i$ is chronically poor, then $y_{it}^* = y_{it}$ , and since the average utility over time is below the utility at the poverty line, the utility gap is positive. The use of a utility function with diminishing marginal utility ensures that variance across time lowers the average utility. Indeed, $(1-\beta)$ is the elasticity of the marginal utility with respect to the resource, so that a higher $(1-\beta)$ means that marginal utility falls more quickly as income rises and there is greater sensitivity of the average utility to variations over time.

## 5. Properties

Which properties are satisfied by this family of chronic poverty measures given the identification functions? We now present several properties that are natural extensions of requirements for static poverty measures. Our first set of properties requires chronic poverty to be unchanged under certain basic transformations.

We say that $X$ is obtained from $Y$ by a *permutation of incomes across people (across time)* if $X = \Pi Y$ (resp. $X = Y\Pi$), where $\Pi$ is a $n \times n$ (resp. $T \times T$) permutation matrix. Matrix $X$ is matrix $Y$ with rows (respectively, columns) interchanged according to the particular permutation matrix. A permutation of incomes across people implies that entire distributions of income over time are switched among persons, while a permutation of incomes across time implies that, for every individual in the population, incomes are switched across periods.

20 This follows immediately from equation (5) and the definition of $U_\beta$, where $A(z) = 1$ for the case of $\beta = 0$ and $A(z) = 1/\beta U_\beta(z)$ for the case $\beta \le 1$ and $\beta \ne 0$.

***P1. Population Symmetry:*** If $X$ is obtained from $Y$ by a permutation of incomes across people then $P(X;z) = P(Y;z)$.

***P2. Time Symmetry:*** If $X$ is obtained from $Y$ by a permutation of incomes across time, then $P(X;z) = P(Y;z)$.

Population symmetry corresponds to the standard anonymity property for static poverty measures; time symmetry requires that the order in which one receives income should not affect the measure.

At first glance, time symmetry may appear to be quite restrictive. In particular, one could argue that incomes from later periods should be discounted to obtain a present value measure (Calvo and Dercon 2009; Hoy and Zheng 2011; Aaberge and Mogstad 2007) or, alternatively, from an ex-post point of view, that incomes in earlier periods should be discounted (Calvo and Dercon 2009). Rather than entering into this discussion, the time symmetry axiom takes the middle ground and treats each period's income with equal importance. Alternatively, one might assume that $Y$ is composed of incomes already discounted for time, in which case time symmetry may be less controversial.

A second critique of time symmetry is that it ignores the specific sequencing of incomes and hence of poverty spells. For example, one might argue that consecutive spells should be disproportionally weighted in measuring poverty over time.[21] Note, however, that even the richest panel data sets do not contain information on the *lifetime* income stream. Information is necessarily truncated. Any penalization of consecutiveness is at risk of being misleading. Time symmetry reflects this concern and ensures that the poverty measure is not unduly reliant on the observed sequencing of incomes.

We say that $X$ is obtained from $Y$ by a *population (time) replication* if $X = [Y';\ldots;Y']'$ is constructed from multiple copies of $Y$ stacked on top of one another, where $X$ is in $M^{n,kT}$ and $Y$ is in $M^{n,T}$ for integers $n \geq 1$ and $k \geq 2$ (respectively, if $X = [Y;\ldots;Y]$ is constructed from multiple copies of $Y$ placed adjacent to one another where $X$ is in $M^{n,kT}$ and $Y$ is in $M^{n,T}$ for integers $T \geq 1$ and $k \geq 2$).

***P3. Population Replication Invariance:*** If $X$ is obtained from $Y$ by a population replication, then $P(X;z) = P(Y;z)$.

***P4. Time Replication Invariance:*** If $X$ is obtained from $Y$ by a time replication, then $P(X;z) = P(Y;z)$.

The two replication invariance axioms ensure comparability across different population sizes and number of periods.

We say that $(Y';z')$ is obtained from $(Y;z)$ by a *proportional change* if $(Y';z') = (\alpha Y;\alpha z)$ for some $\alpha > 0$.

***P5. Scale Invariance:*** If $(Y';z')$ is obtained from $(Y;z)$ by a proportional change, then $P(Y';z') = P(Y;z)$.

Scale invariance ensures that chronic poverty is unchanged when incomes and poverty lines are altered, so long as incomes expressed in poverty line units remain unchanged.

21 See for example Bossert, Chakravarty and D'Ambrosio (2012), Hoy and Zheng (2011), Guenther and Maier (2008), Dutta, Roope and Zank (2011), Gradin, del Rio, and Canto (2012), and Mendola and Buseta (2012).

We say that $X$ is obtained from $Y$ by a *simple increment among the non-chronically poor* if $x_{kj} > y_{kj}$ for a given $(k, j)$ with $\rho(y_k; z) = 0$, while $x_{it} = y_{it}$ for every other $(i,t) \neq (k, j)$.

***P6. Focus:*** If $X$ is obtained from $Y$ by an increment among the non-chronically poor, then $P(X; z) = P(Y; z)$.

The focus axiom ensures that the measure is not affected by income changes among the non-chronically poor. Note that changes in non-poor incomes of the chronically poor can have an impact on the level of chronic poverty. This is consistent with an identification step that allows substitutability of income over time.

We now turn to a set of properties that require the chronic poverty measure to move in a specific direction under certain transformations.

We say that $X$ is obtained from $Y$ by an *increment among the chronically poor* if $x_{kj} > y_{kj}$ for a given $(k, j)$ with $\rho(y_k; z) = 1$, while $x_{it} = y_{it}$ for every other $(i,t) \neq (k, j)$.

***P7. Monotonicity:*** If $X$ is obtained from $Y$ by an increment among the chronically poor, then $P(X; z) < P(Y; z)$.

Monotonicity ensures that chronic poverty falls when an income of a chronically poor person rises. Note that this is true for *any* income of a chronically poor person – either below or above the poverty line – which is consistent with the assumed substitutability of income over time.

We now introduce a Kolm (1977) transformation that smooths each period's income distribution in the same way using a bistochastic matrix.[22] We say that $X$ is obtained from $Y$ by a *smoothing of incomes among the chronically poor* if $X = BY$ for an $n \times n$ bistochastic matrix $B$ satisfying $b_{ii} = 1$ for every non-chronically poor household $i$ where $X$ is not a permutation of $Y$. The condition on $B$ ensures that only the chronically poor are affected.

***P8. Weak Transfer:*** If $X$ is obtained from $Y$ by a smoothing of incomes among the chronically poor, then $P(X; z) \leq P(Y; z)$.

Under weak transfer, when incomes are smoothed so that inequality among the chronically poor unambiguously falls, chronic poverty should not increase.

The next axiom ensures that if all incomes are $z$ or higher then there will be no chronic poverty.

***P9. Normalization:*** If $Y$ is completely equal with $y_{it} = z$ for all $i$ and $t$, then $P(Y; z) = 0$.

Next is a strong form of continuity, which rules out abrupt changes in chronic poverty as incomes gradually increase or decrease, even when the number of chronically poor persons is altered.

***P10. Continuity:*** For every $z \in R_{++}$, $P(Y; z)$ is continuous as a function of $Y$ on $M$.

22 A bistochastic matrix is a square matrix whose entries are nonnegative and each column and row sums to 1; it is a convex combination of permutation matrices. Multiplying by such a matrix gives each person a convex combination of the income streams in society (Bourguignon and Chakravarty 2003: 30–31).

This is a convenient property for measures, especially given the errors inherent in data and the essential arbitrariness of a poverty line. Other chronic poverty measures that reflect the number of persons in chronic poverty, or the extent of their duration, typically will not satisfy this property, although alternative restrictive versions of continuity may well be satisfied.[23]

Finally, there is a well-accepted property for traditional poverty measures that requires overall poverty to be expressible as a population-share weighted sum of subgroup poverty levels. The following is the analogous property for chronic poverty measures.

***P11. Population Decomposability:*** For all *X* and *Y* satisfying $T(X) = T(Y)$, we have

$$P(X,Y;z) = \frac{n(X)}{n(X,Y)} P(X;z) + \frac{n(Y)}{n(X,Y)} P(Y;z) \qquad (6)$$

Measures satisfying this property allow a subgroup's contribution to overall chronic poverty to be evaluated.

It can be verified that the proposed family of measures satisfies all the above properties (P1–P10). One may also consider a "time decomposability" axiom, but since identification depends on every period's income, it is not possible to obtain a full decomposition in terms of the original income matrix. However, after identification, when the censored matrix *Y** has been constructed, overall chronic poverty can be broken down period by period as follows:

$$P_\beta(Y;z) = \begin{cases} (1/T)\sum_{t=1}^{T} (1/\beta)\left(1-[\mu_\beta(y^*_{\bullet t}/z)]^\beta\right) & \beta \le 1, \beta \ne 0 \\ (1/T)\sum_{t=1}^{T} -\ln\left(\mu_0(y^*_{\bullet t}/z)\right) & \beta = 0 \end{cases} \qquad (7)$$

where $y^*_{\bullet t}$ is the *t*-th column of the censored matrix *Y**. This "time breakdown" over time can be useful in an ex-post evaluation of the relative contribution of each time period to overall chronic poverty.[24] Note that such a breakdown is possible because the $\beta$ values of $\mu_\beta$ and $C_\beta$ coincide; if they did not, the measure would lose this additional feature. Similar issues ensure that Jalan and Ravallion's chronic poverty measure cannot be broken down in an analogous way. However, the variant $F_1(\bar{y};z)$ of their approach, which matches the poverty gap to their arithmetic mean, is just our $C_1(\bar{y}_1;z)$ and hence can be broken down over time. Foster's (2007) measures $K_\alpha$ also can be broken down over time after identification.

## 6. Transient poverty

A measure of chronic poverty *P* requires panel data linked through time; the associated static poverty measure *F* does not. How far off would we be if we simply evaluated static poverty period by period and

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23 See Foster and Shorrocks (1991) and Foster (2006) for discussions of restricted and unrestricted continuity in the context of traditional poverty measures.

24 The censored vector $y^*_i$ can include entries that exceed *z* and diminish the contribution of period *t* to overall chronic poverty. In the unlikely case where enough entries exceed *z*, the contribution of period *t* could be negative, indicating that the period was one of general affluence that reduced chronic poverty via the assumed substitution across time.

averaged up? The answer is provided by a transient poverty measure $P^T = P^A - P$ where $P^A$ is average static poverty, or $\sum_{t=1}^{T} F(y_{\bullet t};z)/T$, and $P$ is chronic poverty. We now present the transient poverty measure for our class of chronic poverty measures and contrast it to $P^T$ for previous measures.

The transient poverty measure for Foster's (2007) chronic poverty measure is $K_\alpha^T(Y;z,\tau) = \sum_{t=1}^{T} F_\alpha(y_{\bullet t};z)/T - K_\alpha(Y;z,\tau)$ where the static poverty measure $F_\alpha$ is an FGT index. Using the notation of Section 3, it follows that $K_\alpha^T(Y;z,\tau) = \mu(G^\alpha(z) - G^\alpha(z,\tau))$, where the positive entries of the matrix $G^\alpha(z) - G^\alpha(z,\tau)$ arise only from the "transiently poor" or people with spells of poverty who do not have enough spells to be chronically poor. Transient poverty is composed of the poverty episodes of the transiently poor, while chronic poverty is all that is generated by the chronically poor. The two notions are mutually exclusive in the approach of Foster (2009).

The transient poverty measure for Jalan and Ravallion (1998) is $J^T(Y;z) = \sum_{t=1}^{T} F_2(y_{\bullet t};z)/T - J(Y;z)$ where the FGT measure, $F_2$, is the static poverty measure. Note that the average poverty measure can be expressed as $\mu(G^2(z))$, the mean of the squared gap matrix, while the chronic poverty measure can be viewed as $\mu(\overline{G}^2(z))$, the mean of the matrix of squared gaps obtained from the smoothed matrix $\overline{Y}$ (so that the entries of $\overline{G}^2(z)$ are $\overline{g}_{it}^2(z) = ((z - \overline{y}_i)/z)^2$ if $\overline{y}_i < z$ and $\overline{g}_{it}^2(z) = 0$ otherwise). It follows that $J^T(Y;z) = \mu(G^2(z) - \overline{G}^2(z))$ where the entries in the matrix $G^2(z) - \overline{G}^2(z)$ may be positive, negative or zero.

A chronically poor person will have a mean income below the poverty line and hence all entries in the person's row in $\overline{G}^2(z)$ are an identical positive number. A person having all zeroes in $\overline{G}^2(z)$ and at least one positive entry in $G^2(z)$ has a spell of poverty but is not chronically poor and hence can be called transiently poor. A person with all zero entries in both $\overline{G}^2(z)$ and $G^2(z)$ is neither. All chronic poverty originates from the chronically poor, but in this approach not all transient poverty is due to the transiently poor; instead, there are two additional components associated with the chronically poor. First, it is possible for the average gap to exceed the gap of the average, due to the censoring of incomes above the poverty line. Second, even if the average gap were the same as the gap of the average, the average squared gap can exceed the squared gap of the average, due to variation in incomes over time.

Finally, for our chronic poverty measure, the transient poverty measure is $P_\beta^T(Y;z) = \sum_{t=1}^{T} C_\beta(y_{\bullet t};z)/T - P_\beta(Y;z)$ where the CHU measure $C_\beta$ is used to measure static poverty. Note that the average poverty measure can be expressed as $\mu(V^\beta(z))$, the mean of the normalized utility gap matrix $V^\beta(z)$ whose entries for the case of $\beta \leq 1, \beta \neq 0$ are $v_{it}^\beta = (1-(y_{it}/z)^\beta)/\beta$ for $y_{it} < z$ and $v_{it}^\beta = 0$ for $y_{it} \geq z$, while for the case of $\beta = 0$ are $v_{it}^\beta = -\ln(y_{it}/z)$ for $y_{it} < z$ and $v_{it}^\beta = 0$ for $y_{it} \geq z$. In contrast, the chronic poverty measure is the mean of the matrix of utility gaps obtained from the censored matrix $Y$*, or $\mu(V^{*\beta}(z))$ where the entries of $V^{*\beta}(z)$ are given by $v_{it}^{*\beta}(z) = (1 - (y_{it}^*/z)^\beta)/\beta$ for $\beta \leq 1, \beta \neq 0$ and $v_{it}^{*\beta}(z) = -\ln(y_{it}^*/z)$ for $\beta = 0$. It follows that $P^T(Y;z) = \mu(V^\beta(z) - V^{*\beta}(z))$ where (as we show below) the entries in the matrix $V^\beta(z) - V^{*\beta}(z)$ may be positive or zero.

Let $i$ be a chronically poor person so that $\mu_\beta(y_i) < z$ and the entry $v_{it}^{*\beta}(z)$ from $V^{*\beta}(z)$ is always based on $y_{it}$. Now if $y_{it} < z$, we have $v_{it}^\beta(z) - v_{it}^{*\beta}(z) = 0$ since in this case both gaps are based on $y_{it}$. On the other hand, if $y_{it} \geq z$, we have $v_{it}^\beta(z) = 0$ while $v_{it}^{*\beta}(z) < 0$ which implies that $v_{it}^\beta(z) - v_{it}^{*\beta}(z) = -v_{it}^{*\beta}(z)$ is positive. The static poverty term censors income to the poverty line, while the chronic poverty term views this income as lowering chronic poverty, and so the difference between the two is positive. Now suppose that $i$ is a transiently poor person so that $\mu_\beta(y_i) \geq z$ with $y_{it'} < z$ for some $t'$. Clearly, for all $t$ we have $v_{it}^{*\beta}(z) = 0$ and $v_{it}^{\beta}(z) \geq 0$ and hence $v_{it}^{\beta}(z) - v_{it}^{*\beta}(z) \geq 0$; for $t = t'$ we have $v_{it}^{*\beta}(z) = 0$ and $v_{it}^{\beta}(z) > 0$ and so $v_{it}^{\beta}(z) - v_{it}^{*\beta}(z) > 0$. The transiently poor have at least one period of positive static poverty while their chronic poverty is always zero, and hence the difference is positive. Finally, a person who is neither chronically nor transiently poor has zero entries for both terms.

As with the Jalan and Ravallion approach, not all transient poverty here arises from the transiently poor. However, in the present case only one component of transient poverty is associated with the chronically poor. It arises from the censoring that occurs in the average poverty term and reflects the absence of information linking observations across time. There is no separate term reflecting the variations in income; instead, variations are incorporated into the permanent income standard and are evaluated using a matched poverty measure.[25]

Our measure of transient poverty can be viewed as the extent to which average CHU poverty from cross-sections would fall if our chronic poverty measure were applied to the associated panel, thereby linking observations over time. The reduction has two sources: (*i*) a person who is viewed as poor in a given period may have sufficient excess resources in other periods to avoid being chronically poor and (ii) a person who is viewed as poor in a given period may have enough excess resources in other periods to moderate the level of chronic poverty. These are the sources of transient poverty for our measure.

## 7. Empirical illustration for Argentina

We now illustrate the family of chronic poverty measures proposed in this paper using data from urban Argentina. The data correspond to the Encuesta Permanente de Hogares (Permanent Individual Survey, or EPH), a survey that was conducted twice a year in the main urban areas of Argentina by the National Institute of Statistics and Census (INDEC) in the months of May and October until May 2003. The survey represents 61 per cent of the country's population and 70 per cent of the urban population according to the 1991 census. The survey used a rotating panel where 25 per cent of the sample was replaced in each wave. Thus, it is possible to observe households along four waves of the survey, following them for about a year and a half. For this illustration we work with the panel formed by the observations of October 2001, May 2002, October 2002 and May 2003. Clearly, four observations over a year and a half is a short period of time to evaluate chronic poverty, but it allows us to illustrate the new methodology. The panel is formed with observations from 27 urban agglomerations. Total sample size is 2387 households and 8704 people. However, only households with complete and valid information on income were considered, so the sample was reduced to 1731 households and 6362 people.

Estimates of chronic poverty are obtained using the household's equivalent income as the resource variable, normalized by the poverty line for the corresponding time period and region. We use the poverty lines and equivalent adult scale provided by INDEC (2003). To obtain population-based estimates, households are weighted by their size.[26]

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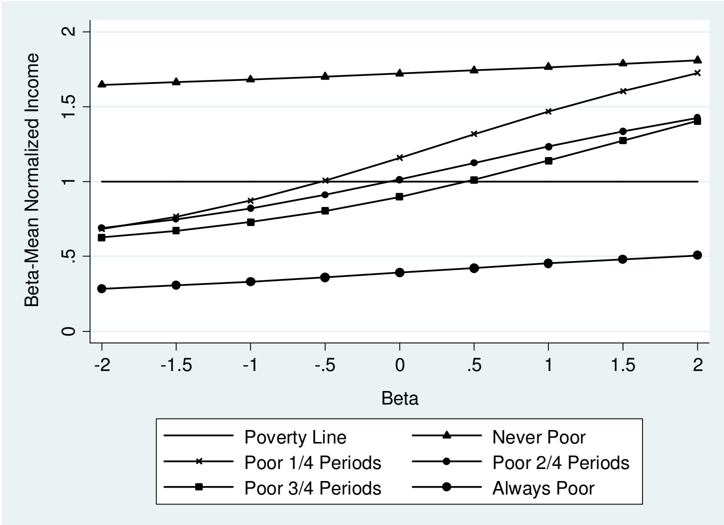
25 In both in Jalan and Ravallion's approach and ours, when there is an increase in a non-poor income of a chronically poor individual, average poverty is unaffected, chronic poverty falls, and transient poverty rises.

26 For families in which the household size changed over the four observations of the panel, all household members were considered to calculate the equivalent income in each period, but only household members who were present in the four waves of the panel were considered to compute the poverty estimates.

Figure 1 presents the normalized general mean incomes $\mu_\beta(y_i)/z$ for an individual who is *never* poor, three individuals who are *sometimes* poor in a different number of periods and one who is *always* poor. The figure illustrates how the general mean income increases with the value of $\beta$. For the individual who is never poor, the general mean income lies above the poverty line for all values of $\beta$; whereas, for the individual who is always poor, the general mean income lies below the poverty line for all $\beta$. For each of the three persons who are sometimes poor, the general mean income crosses the poverty line at a different $\beta$ value. This $\beta$ cutoff identifies the lowest parameter value at which the person would escape chronic poverty. If it is above 1, the person will be identified as chronically poor by all our measures. If it is below 1, then the person avoids chronic poverty over the range [$\beta$, 1] – a range that expands as the person's resources rise or become more evenly spread over time.[27]

**Figure 1: Normalized general mean incomes for five persons as $\beta$ varies**




The second column in Table 1 presents the percentage of chronically poor people for different values of $\beta$. By definition, such a percentage increases as $\beta$ decreases, in this case from 53 per cent to 58.5 per cent. The fourth column in the table contains the estimates of the chronic poverty measure. Again, the lower the income substitutability across periods, the higher the chronic poverty estimates. The table also presents the estimates of average poverty in the four periods (third column), and transient poverty (sixth column), obtained as the difference between average and chronic poverty. For all $\beta$ values, chronic poverty accounts for most of the average poverty in the panel (between 89 and 98 per cent). This percentage naturally increases as $\beta$ decreases, since part of the transiently poor start to be considered chronically poor.

27 In this way, the value of the parameter $\beta$ at which each individual starts to be considered chronically poor can be nicely linked to the fuzzy sets approach to poverty measurement (Cerioli and Zanni 1990; Cheli and Lemmi 1995); in fact $1/(2-\beta)$ may be interpreted as a measure of the degree of membership to the group of the chronically poor. Alternatively, such value may be seen as a measure of vulnerability to poverty.

**Table 1: Average, chronic and transient poverty for different values of $\beta$**
**Argentina October 2001–May 2003**

| Beta | % of Chronically Poor People | Average Poverty $P_\beta^A(Y;z)$ | Chronic Poverty Measure $P_\beta^C(Y;z)$ | Chronic Poverty *Percent Contrib.* | Transient Poverty Measure $P_\beta^T(Y;z)$ | Transient Poverty *Percent Contrib.* |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1 | 52.9 | 0.27 | 0.24 | *88.9* | 0.03 | *11.1* |
| 0.5 | 54.1 | 0.34 | 0.31 | *91.2* | 0.03 | *8.8* |
| 0 | 55.6 | 0.45 | 0.43 | *95.5* | 0.02 | *4.5* |
| -0.5 | 57.1 | 0.66 | 0.63 | *95.6* | 0.03 | *4.4* |
| -1 | 58.5 | 1.09 | 1.07 | *98.2* | 0.02 | *1.8* |

It is interesting to compare the chronic poverty estimates presented in Table 1 with per-period CHU poverty estimates, which are presented in Table 2.[28] It is worth recalling that, following the economic collapse of December 2001, the year 2002 was one of deep economic recession. This is reflected in the substantially higher per-period poverty estimates of May and October 2002 and May 2003. Interestingly, the chronic poverty estimates, which consider the income in the four points in time and allow varying degrees of income substitutability across periods, lie in between the lower estimates of the CHU index in October 2001 and the higher estimates of the subsequent observations.

**Table 2: One-period CHU poverty estimates**
**Argentina October 2001-May 2003**

| Beta | October 2001 | May 2002 | October 2002 | May 2003 |
|---|---|---|---|---|
| 1 | 0.18 | 0.29 | 0.31 | 0.29 |
| 0.5 | 0.22 | 0.38 | 0.39 | 0.36 |
| 0 | 0.29 | 0.52 | 0.52 | 0.48 |
| -0.5 | 0.40 | 0.79 | 0.76 | 0.70 |
| -1 | 0.59 | 1.40 | 1.22 | 1.16 |

One of the advantages of the proposed measure is that it can be broken down by population subgroup and (post identification) by time period. Tables 3 and 4 present examples of both types of analyses. Table 3 presents the chronic poverty estimates in each of the (main urban areas of the) six geographic regions of the country – their contribution to overall chronic poverty alongside their population share. Notice that the northern regions are the two bigger contributors to overall chronic poverty. Although

28 Note that because of the decomposability property of the CHU indices, for each value of $\beta$, the (row) average of the per-period CHU estimates presented in Table 2 equals the average poverty reported in the third column of Table 1.

the Northeast contributes only 15 per cent of the urban population, it makes up 22 to 25 per cent of overall urban chronic poverty, depending on the value of $\beta$. At the other extreme, while the Patagonia region represents 13.4 per cent of the urban population, it contributes 6 per cent or less of overall chronic poverty.

**Table 3: Decomposition of chronic poverty by region**

| Region | Pop. Share* | Beta | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 0.5 | 0 | -0.5 | -1 |
| **NORTHEAST** | 15% | 0.36 | 0.47 | 0.66 | 1.00 | 1.77 |
| *Percentage Contrib.* | | *22.3%* | *22.6%* | *22.9%* | *23.6%* | *24.7%* |
| **NORTHWEST** | 30% | 0.29 | 0.38 | 0.51 | 0.75 | 1.26 |
| *Percentage Contrib.* | | *36.1%* | *35.8%* | *33.4%* | *35%* | *28%* |
| **GBA** | 8.2% | 0.17 | 0.23 | 0.30 | 0.43 | 0.65 |
| *Percentage Contrib.* | | *6%* | *6%* | *5.8%* | *5.6%* | *5%* |
| **PAMPEANA** | 21% | 0.22 | 0.29 | 0.40 | 0.62 | 1.06 |
| *Percentage Contrib.* | | *19.6%* | *20%* | *20.3%* | *20.9%* | *21.3%* |
| **CUYO** | 12.4% | 0.21 | 0.27 | 0.36 | 0.51 | 0.84 |
| *Percentage Contrib.* | | *11.4%* | *11%* | *10.4%* | *10%* | *9.7%* |
| **PATAGONIA** | 13.4% | 0.09 | 0.12 | 0.16 | 0.23 | 0.35 |
| *Percentage Contrib.* | | *6%* | *5.1%* | *5.1%* | *4.9%* | *4.36%* |

*The population shares correspond to those of the sample of the conformed panel, and thus may differ from the population shares when all urban and rural areas are considered.

Table 4 shows that the first period of the panel contributed only 12.8 to 14.5 per cent of overall chronic poverty (varying with the value of $\beta$); whereas, the other three periods – associated with the crisis and subsequent recession – contributed 26 to 32 per cent each.

**Table 4: Decomposition of chronic poverty by period**

| Period | Beta | | | | |
|---|---|---|---|---|---|
| | 1 | 0.5 | 0 | -0.5 | -1 |
| **October 2001** | 0.14 | 0.18 | 0.24 | 0.35 | 0.55 |
| *Percentage Contrib.* | *14.5%* | *14.3%* | *14.1%* | *13.7%* | *12.8%* |
| **May 2002** | 0.27 | 0.36 | 0.50 | 0.77 | 1.39 |
| *Percentage Contrib.* | *28.5%* | *28.8%* | *29.4%* | *30.5%* | *32.4%* |
| **October 2002** | 0.28 | 0.37 | 0.50 | 0.74 | 1.20 |
| *Percentage Contrib.* | *29.4%* | *29.4%* | *29.3%* | *29%* | *28.0%* |
| **May 2003** | 0.27 | 0.34 | 0.46 | 0.68 | 1.15 |
| *Percentage Contrib.* | *27.6%* | *27.5%* | *27.2%* | *26.8%* | *26.8%* |

## 8. Concluding Remarks

This paper has introduced a new class of chronic poverty measures that has two components: a permanent income standard for identification purposes and a static poverty measure for aggregation. We summarize the resource stream over time using a general mean $\mu_\beta$ with parameter $\beta \leq 1$, and a person is defined as chronically poor if the permanent income standard falls below the poverty line. The structure accommodates perfect substitutability ($\beta = 1$) and imperfect substitutability ($\beta < 1$) of resources across time, and the parameter may be adjusted to fit the conditions facing the poor and the particular resource variable (e.g., consumption or income) at hand. As our static poverty measure we use the decomposable CHU index $C_\beta$, which has the same parameter value $\beta$ as the general mean. Our class $P_\beta$ of chronic poverty measures is obtained by applying the CHU poverty measure to the distribution of general means.

The resulting methodology for identifying and measuring chronic poverty has several convenient features. It satisfies a set of properties that are natural extensions of the static case, including population decomposability. It has a policy-relevant breakdown by time period, after identification of the chronically poor, by which the contribution of a given time period to overall chronic poverty can be ascertained. This helpful property arises because the same parameter value is used in the general mean and the CHU poverty measure. The chronic poverty measure also has a concise definition as the mean of a matrix, which should facilitate its calculation and the application of statistical tests.

The measure has a natural welfare interpretation in terms of utility shortfalls, or the difference between the utility of the poverty line and the average utility from the resource stream over time. The utility loss is greater for higher elasticity of the marginal utility with respect to the resource $(1-\beta)$, hence for lower values of $\beta$. An alternative interpretation of $(1-\beta)$ is that it represents the cost or "leakage" of transferring income over time. When this value is *assumed*, empirical implementations of $P_\beta$ should consider a range of values to test the robustness of the estimations, as was done in the illustration above.

An interesting exercise might be to calibrate $\beta$ in line with the explicit and implicit costs of transferring income through time in the particular context under analysis. If such calibration were possible, $\beta$ could then perhaps become a variable affected by policies: A reduction in the cost of intertemporal transfers for poor people would be reflected in a higher $\beta$ value and this in turn could result in a reduction of chronic poverty. The policy relevance of $\beta$ is in line with recommendations based on studies from the ground: "…if poor households enjoyed assured access to a handful of better financial tools, their chances of improving their lives would surely be much higher" (Collins et al., 2009: 4).

The focus of this paper has been chronic poverty, with transient poverty being a residual component between the average poverty level from cross sections and the level of chronic poverty. Some of the transient poverty originates with the chronically poor. This differs from the spells approach in which chronic (transient) poverty is associated exclusively with the chronically (transiently) poor. It is also distinct from Jalan and Ravallion's approach in which transient poverty may additionally arise from the variations in resource levels below the poverty line. It would be interesting to study further the different forms of transient poverty and, indeed, to identify properties that a reasonable measure of transient poverty should display.

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