Accounting for Income Fluctuations in Distributional Analysis: Theory and Evidence for Argentina

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Abstract

This paper studies the impact of income fluctuations on poverty, motivated by the recurring economic crises that affect developing countries and the incidence of income fluctuations on household welfare. The paper presents a set of tools for empirical work based on theoretically sound extensions of the existing methodology for static distributional analysis. Results form longitudinal data for Argentina in the 1995-2002 period find that the large fluctuations in household income due to the repeated economic crises in the country in this period had a significant effect on household welfare.
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Contents

1 Introduction

This paper studies the impact of income fluctuations on poverty, motivated by the recurring economic crises that affect developing countries and the incidence of income fluctuations on household welfare. While the increasing availability of household panel data has been exploited in theoretical analysis and empirical applications, the methodological and applied literatures still lack a unified framework. Echoing Atkinson (1987), this paper addresses the question of how poverty should be measured *over time* – or, in more general terms, how to measure well-being based on repeated observations of household income. The paper presents a set of tools for empirical work based on theoretically sound extensions of the existing methodology for static distributional analysis. The framework accounts explicitly for the negative effects of income variability. This welfare criteria is based on the intuition, derived from the risk aversion literature, that households will prefer a steady stream of income to a variable one with the same mean.

The paper presents results from longitudinal data for Argentina in the 1995-2002 period, which is well suited for this type of analysis given the large fluctuations in household income due to the repeated economic crises in the country. During the 1990s the country's economy underwent a process of market-oriented structural reforms. The resulting openness of the economy and the hard peg of the local currency to the US dollar contributed to a high degree of vulnerability to the succession of international financial crises of the second half of the decade, which was characterised as a period of "boom and bust." This series of external macroeconomic shocks and the weaknesses of the Argentine economy led to a severe economic and social crisis that started at the end of 2001 and continued well into 2002.

The discussion starts in Section 2 by describing a general methodology for the measurement of well-being based on panel data. Section 4 then presents an application of this methodology to Argentina. Section 4.1 briefly introduces the survey data and the income aggregate, and discusses methodological issues on poverty measurement in Argentina. Finally, Section 4.2 illustrates the uses of the evaluation framework with a rotating panel from the Greater Buenos Aires region in the 1995-2002 period. Conclusions follow.

2 Income Fluctuations, Poverty and Well-Being Over Time

2.1 Distributional analysis and panel data

A myriad of papers on poverty dynamics investigate the movements into and out of poverty in two consecutive periods. This paper addresses a related but different question: echoing Atkinson (1987), it deals with the problem of how poverty should be measured *over time* – or, in more general terms, how to measure well-being based on repeated observations of household income. The framework presented in the following pages accounts explicitly for the negative effects of income variability. This welfare criteria is based on the intuition, derived from the risk aversion literature, that households will prefer a steady stream of income to a variable one with the same mean, at least in a second-best world with incomplete insurance and capital markets (Cowell, 1989).

The evaluation of well-being with panel data can be thought of as an extension of the standard model of distributional analysis. Cowell (2000) describes the welfare theory of income distribution in terms of $\mathcal{F}$, "the space of all univariate probability distributions" F of income y_i, and defines a "welfare ordering" $W : \mathcal{F} \rightarrow \mathbb{R}$ as a function that maps income distributions into the real line – for instance, the Gini coefficient transforms a distribution into a single index. The analysis of repeated observations is based on the distribution of N vectors of T observations y_{it} over the period $t = 1$ to T, defined as $\mathbf{y}_i = [y_{i1}, ..., y_{iT}]$, in a population with N households. Slightly abusing Cowell's (2000) notation, the evaluation framework developed in the following pages maps from $\mathcal{F}^T$, the space of distributions F^T of vectors $\mathbf{y}_i$, into the real line, with a transformation of the form $W^T : \mathcal{F}^T \rightarrow \mathbb{R}$. The methodology used in this paper transforms a series of income distributions into a single index of intertemporal poverty.

The results in this paper are based on a transformation W^T in two steps, exploiting analogies with well-established results in economics and distributional analysis theory in each stage.[1] The first step is the definition of an aggregate of the observations of income over time for household i that maps each vector $\mathbf{y}_i$ (the incomes of a household over time) into the real line. The average income is the obvious reference point for this type of aggregation. However, as discussed below, the average $\bar{y}_i$ does not account for the welfare effects of income variability. The insight in the methodology of this paper is to exploit the formal analogy between states of the world in the expected utility model and past incomes in a multi-period setting, introducing the welfare criteria of "variability aversion". Building on the concept of the certainty equivalent of income, the first step reduces a distribution F^T of N vectors $\mathbf{y}_i$ to F, a distribution of N scalars $\tilde{y}_i$.

The second stage of the proposed W^T transformation involves an additional analogy: by showing that the scalars $\tilde{y}_i$ (the incomes over time adjusted by variability) are appropriate money metrics of well-being, all the available tools of distributional analysis can be directly applied to the distribution F. For instance, it is possible to compute poverty measures or the Gini index on the distribution of the aggregate $\tilde{y}_i$. The W^T transformation is done first from each vector $\mathbf{y}_i$ to a scalar $\tilde{y}_i$,

[1]Cruces (2005a), a companion paper to this article, presents a much more detailed discussion of the relation between ex-ante income risk and ex-post income variability (see Section 2.1 and the discussion of Figures 1 and 2 in Section 2.2.2 of that paper).

and then from $F(\tilde{y}_i)$ into some distributional index.

The two-step methodology described in this Section is similar in spirit to the process of equivalisation in distributional analysis. Survey data usually contain information about a number of income-earners in a household. The equivalisation process converts a vector of incomes from different members of a household into a single measure, according to some welfare criteria – usually taking into account the gender and age composition of the household. The analysis is then carried out on the distribution of the scalar equivalised aggregate. This methodology owes a great deal to the standard model of risk (Pratt, 1964; Arrow, 1970) and to its reinterpretation in the social welfare context (Atkinson, 1970), as well as to the literature on lifetime income (Cowell, 1979). In terms of recent work in the poverty literature, the methodology is related to (and draws from) the concept of expected poverty (Ravallion, 1988), the transient-chronic decomposition (Jalan and Ravallion, 1998) and the recent body of work on economic vulnerability (Ligon and Schechter, 2003; Calvo and Dercon, 2003).

2.2 A framework for the evaluation of household welfare over time

A general formulation for an aggregate of household income over time, defined by the vector $\mathbf{y} = [y_1, ..., y_T]$, is given by an evaluation function V that maps a vector of T observations into the real line:

$$V(\mathbf{y}) = V(y_1, ..., y_T) \tag{1}$$

In terms of the terminology of the previous pages, V defines a transformation $W : \mathcal{F} \rightarrow \mathbb{R}$, from the observed distribution of past incomes for a household into the real line. The problem remains in defining a functional form for V, which determines the normative criteria associated with the evaluation of $\mathbf{y}$. The presence of the time dimension introduces a higher degree of complexity with respect to the analysis of an income distribution at one point in time.

The framework described here concentrates on a series of intuitive criteria. As a starting point, it is reasonable to assume that V should be non-decreasing in its arguments. Moreover, the aggregate level of welfare over the T periods should depend not only on the level of $\mathbf{y}$, but also on its variability. The idea, pervasive in economic theory, is that risk averse agents are willing to trade off a reduction in expected income for certainty. In an ex-post setting, the concept of risk aversion translates into a "dislike" of fluctuations, or variability aversion (to be formally defined below).

These two basic normative principles can be incorporated into the evaluation function V based on the results and intuitions of the standard model of choice under uncertainty in a single period, with an expected utility formulation of the form:

$$U = E[u(\hat{y})] = \sum_{\omega \in \Omega} \tau_\omega u(y_\omega) \tag{2}$$

where E is the expectations operator, $\hat{y}$ the uncertain income prospect and y_ω the contingent income in state of the world ω, with an associated probability τ_ω.

The evaluation framework, however, does not rely on utility functions u: the function V is interpreted within a social welfare context as a judgement on the welfare value of the experienced income stream. This approach, followed by Cruces and Wodon (2003b) and Ligon and Schechter (2003) among others, implies that it is not necessary to impute a utility function and assume homogeneous preferences in the population.

In this evaluation framework, the stream of past income $\mathbf{y} = [y_1, ..., y_T]$ is assessed retrospectively from the point of view of period $T + 1$. The parallelism of V with the expected utility formulation in Equation 2 means that each past income y_t is evaluated by a sub-function – or instantaneous evaluation – $v(y_t)$, assumed to be continuous, strictly increasing and twice-differentiable. A simple implementation of these ideas is the discounted average of the instantaneous evaluation function v for each period from $t = 1$ to T, resulting in the following characterisation of V as an additive, time-separable evaluation function of the form:

$$V(\mathbf{y}) = \sum_{t=1}^{T} \Delta(t) v\left(y_t\right) \tag{3}$$

The weights are given by a discounting function $\Delta(t)$, with $0 < \Delta(t) \leq 1$, and normalised (without loss of generality) so that $\sum_{t=1}^{T} \Delta(t) = 1$.[2]

The structure imposed by Equation 3 implies the following analogy: the model of choice under uncertainty in a single period (Equation 2) and the evaluation of past incomes based on an additive, time-separable evaluation function as in Equation 3 are formally equivalent. The results from the former can be applied to the latter by: a) replacing the function u by its analogue v, b) replacing state-contingent incomes y_ω by observed incomes y_t, and c) replacing probabilities τ_ω by $\Delta(t)$.

[2]The evaluation framework is based on an exponential discounting function, although $\Delta(t)$ can in principle accommodate hyperbolic discounting or other suitable principles (O'Donoghue and Rabin, 1999). In what follows, $\Delta(t)$ is given by:

$$\Delta(t, T, \delta) = \frac{\delta^{T-t}}{\sum_{t=1}^{T} \delta^{T-t}} \tag{4}$$

with a bounded discount factor, $0 < \delta \leq 1$. The formulation in Equation 4 and the bounds in the parameter δ ensure that $\sum_{t=1}^{T} \Delta(t) = 1$ and that the function is increasing in t. The motivation for an increasing $\Delta(t)$ derives from pure time preferences, which give more weight to events closer to the present. The parameter δ is the discount factor, which defines the relative weight given to the recent past with respect to events further in away in time. The case of no discounting, which corresponds to $\delta = 1$: this implies that the "discount weights" simplify to $\Delta(t) = 1/T$. In this case, the evaluation function V becomes the average of $v(y_t)$, and Equation **??** represents $\bar{y}$.

This analogy is established by inspection of Equations 2 and 3: ranking vectors of past incomes $\mathbf{y}$ according to V is formally identical to ranking probability distributions according to the expected utility criterion. The formulation for V in Equation 3 implies that the formal results from risk theory can be applied directly to the evaluation framework, although the interpretation of these results differs: the theory of uncertainty deals with ex-ante income risk, while the present framework evaluates ex-post income fluctuations.[3]

The main difference between risk and the formulation of Equation 3 is the presence of the discounting function $\Delta(t)$, which accounts explicitly for the time dimension of the problem of evaluating past incomes. The motivation for the incorporation of $\Delta(t)$ into V is the presence of pure time preferences: it is usually assumed that a household would not be indifferent to the ordering of past incomes, giving more weight to events closer in time. The function $\Delta(t)$ is thus required to increase as t approaches T. Since the discount factors are normalised to sum one, they can be interpreted as "discounting weights." In the simplest form of aggregation, every period of time is given an equal weight so that $\Delta(t) = 1/T$.

The parallel with the theory of risk is completed by building "variability aversion" into v, the evaluation framework's analogue of risk aversion. The function v is thus assumed to be strictly concave, which implies that $V(\mathbf{y})$ is strictly decreasing in the dispersion of $\mathbf{y} = [y_1, ..., y_T]$ weighted by the discounting function $\Delta(t)$. This implies that for a given average discounted income over time, $\bar{y}_\Delta = \sum_{t=1}^{T} \Delta(t) y_t$, a higher variability in the underlying stream reduces welfare as captured by V. The properties of V and v adapt the concept of risk aversion to the intertemporal setting, incorporating in the evaluation framework the principle that past fluctuations reduce welfare, and should be penalised by an evaluation function. While not all fluctuations might be considered bad, for instance when income grows over time (Cowell, 1989), the variability aversion is based on the effects of riskiness on household utility.

The concept of variability aversion and the structure of V given by Definition **??** imply that another important notion from the theory of choice under uncertainty can be adapted to the evaluation of past incomes. The analogue of the certainty equivalent income is given by the stability equivalent income $\tilde{y}_{se}$, a real number such that:

$$V(\mathbf{y}) = v\left(\tilde{y}_{se}\right) \tag{5}$$

The aggregate $\tilde{y}_{se}$ is the level of income that, if received in every past period $t = 1$ to T, as $\tilde{\mathbf{y}} = [\tilde{y}_{se}, ..., \tilde{y}_{se}]$, would result in the same level $V(\mathbf{y})$ of the evaluation function as the observed stream $\mathbf{y} = [y_1, ..., y_T]$.

[3]The idea of borrowing results from risk theory is at the basis of Atkinson's (1970) re-interpretation of choice under uncertainty in a social welfare context. However, a social welfare function aggregates the distribution of income in a point in time for a population, while V is a social evaluation of *household* welfare as defined by Equation 1.

The continuity of v guarantees that $\tilde{y}_{se}$ exists, and its concavity implies that it is decreasing in the dispersion of $\mathbf{y}$. Both results are formally analogous to those for the certainty-equivalent in risk theory (Pratt, 1964).[4]

The counterfactual stability equivalent $\tilde{y}_{se}$ is a function of the shape of v and the level and distribution of y_t in $\mathbf{y}$. Under the assumption that the variability of past income reduces well-being, the $\tilde{y}_{se}$ can be interpreted as a "variability adjusted" income. It constitutes a welfare-based counterpart to the statistical measure $\bar{y}_\Delta$ (the weighted mean), and it is thus superior to the discounted average income as an indicator of well-being.

Finally, another concept that can be adapted from the theory of choice under uncertainty is the risk premium. Since $\tilde{y}_{se}$ is lower than the average income $\bar{y}_\Delta$ because of the concavity of v, the difference between the two provides a money metric of the loss in household welfare attributable to income fluctuations, given by the variability premium π_v and the relative variability premium Π:

$$\pi_v(\mathbf{y}) = \bar{y}_\Delta - \tilde{y}_{se} \tag{6}$$
$$\Pi(\mathbf{y}) = \frac{\pi_v}{\bar{y}_\Delta} \tag{7}$$

where $\bar{y}_\Delta$ is the weighted average income over time given by $\bar{y}_\Delta = \sum_{t=1}^{T} \Delta(t) y_t$.

Figure 1 depicts $\tilde{y}_{se}$ and π_v for $T = 2$ in the evaluation-income space.[5] As in risk theory, the stability equivalent falls and the variability premium increases with a higher dispersion in past incomes due to the concavity of v. For a fixed level of dispersion, the effect of an increase in the curvature of v is the same.

2.3 "Fluctuation adjusted" population measures of well-being

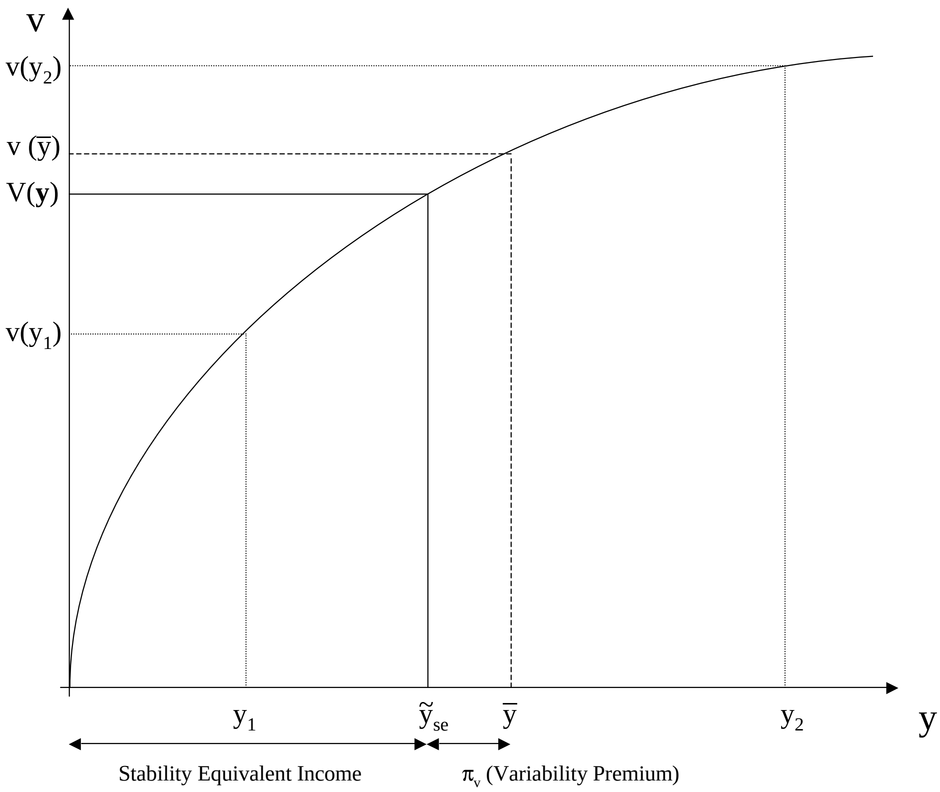
In terms of the terminology defined previously, both V and $\tilde{y}_{se}$ define transformations $W : \mathcal{F} \to \mathbb{R}$ that result in scalar measures of well-being based on a household's past incomes. While $V(\mathbf{y})$ and $\tilde{y}_{se}$ provide equivalent measures, the unit of $V(\mathbf{y})$ is given by the specific functional form of v. This implies that simple transformations of v will lead to different values of $V(\mathbf{y})$. Moreover, the resulting measures from two functions, $V(\mathbf{y})$ and $V'(\mathbf{y})$, are not directly comparable since they are not necessarily in the same scale.

The importance of the stability equivalent income $\tilde{y}_{se}$ resides in the fact that it provides a money metric of household welfare as captured by the evaluation function V. The stability equivalent income $\tilde{y}_{se}$, given by Equation 5, is a sufficient money metric statistic of household welfare defined by the evaluation functions v

[4]This stability equivalent income is formally equivalent to Atkinson's (1970) "equally distributed equivalent level of income," and it is closely related to Ravallion's (1988) notion of "stabilised income."

[5]For expositional convenience, all the diagrams in this paper are based on the no discounting case, in which $\Delta(t) = 1/T$. This implies that $V(\mathbf{y})$ represents the simple average of $v(y_t)$ and that $\bar{y}_\Delta = \bar{y} = (1/T)\sum_{t=1}^{T} y_t$.

Figure 1: Stability Equivalent Income and Variability Premium



and V. This result is derived from the uniqueness of the certainty equivalent in risk theory (Pratt, 1964). This result ensures that all the tools of univariate distributional analysis can be applied to the distribution of $\tilde{y}_{se}$.

This procedure constitutes a second $W : \mathcal{F} \to \mathbb{R}$ transformation. The problem of studying the distribution of vectors **y** in the population is reduced, by means of the evaluation function V, to the study of $F(\tilde{y}_{se})$, the univariate distribution of the stability equivalent income. This means that any poverty measure P, inequality measure I, and social welfare function W defined over the distribution of incomes y at one point in time can also be applied to the distribution of $\tilde{y}_{se}$. Moreover, since $\tilde{y}_{se}$ is money metric, its distribution can be compared to that of the average over time for each household, $\bar{y}$. This exercise is akin to the comparison of distributions before and after tax or transfers, for which there exists an extensive literature and a standard set of tools (Cowell, 1995).

2.4 Empirical implementation: alternative evaluation functions

This Section adds structure to the formulation in the previous pages by stipulating a series of functional forms for v and studying the characteristics of the resulting stability equivalent incomes $\tilde{y}_{se}$.

The definition of V in Equation 3 relies on the function v. Intuitive functional forms for v are derived from the instantaneous utility functions used in the theory of risk. A first alternative is the analogue of the isoelastic utility function,[6] the Constant Relative Variability Aversion (CRVA). The following Equations describe this function and the implied stability equivalent income:

$$v(y) = \begin{cases} \frac{y^{1-\rho}}{1-\rho} & \text{if } \rho \neq 1 \\ \ln y & \text{if } \rho = 1 \end{cases} \tag{8}$$

which results in

$$\tilde{y}_{se} = \begin{cases} \left[\sum_{t=1}^{T} \Delta(t) y_t^{1-\rho}\right]^{\frac{1}{1-\rho}} & \text{if } \rho \neq 1 \\ \prod_{t=1}^{T} y_t^{\Delta(t)} & \text{if } \rho = 1 \end{cases} \tag{9}$$

This functional form allows for a sensitivity parameter ρ, the analogue of the relative risk aversion parameter in the Constant Relative Risk Aversion (CRRA) utility function. Since $\tilde{y}_{se}$ is decreasing in ρ, it quantifies the effect of past variability on well-being: for a fixed dispersion of past incomes, higher values of ρ result in lower stability equivalent incomes.

An alternative to the CRVA functional form is given by the analogue of the Constant Absolute Risk Aversion (CARA) utility function, which is also widely used in the risk literature. The Constant Absolute Variability Aversion (CAVA) is given by:

$$v(y) = -\frac{1}{\eta} e^{-\eta y} \tag{10}$$

resulting in the stability equivalent:

$$\tilde{y}_{se} = -\frac{1}{\eta} \ln \left[\sum_{t=1}^{T} \Delta(t) e^{-\eta y_t}\right] \tag{11}$$

Equation 10 also allows for a sensitivity parameter, $\eta \neq 0$, which captures the degree of variability aversion, since larger values of η imply lower stability equivalents $\tilde{y}_{se}$. Moreover, this formulation is also compatible with the intuition mentioned above: as income grows, households are willing to accept larger fluctuations.

Finally, two extreme cases are presented for illustration. The first case, in which v is not strictly concave, is given by a linear evaluation function:

$$v(y) = y \tag{12}$$

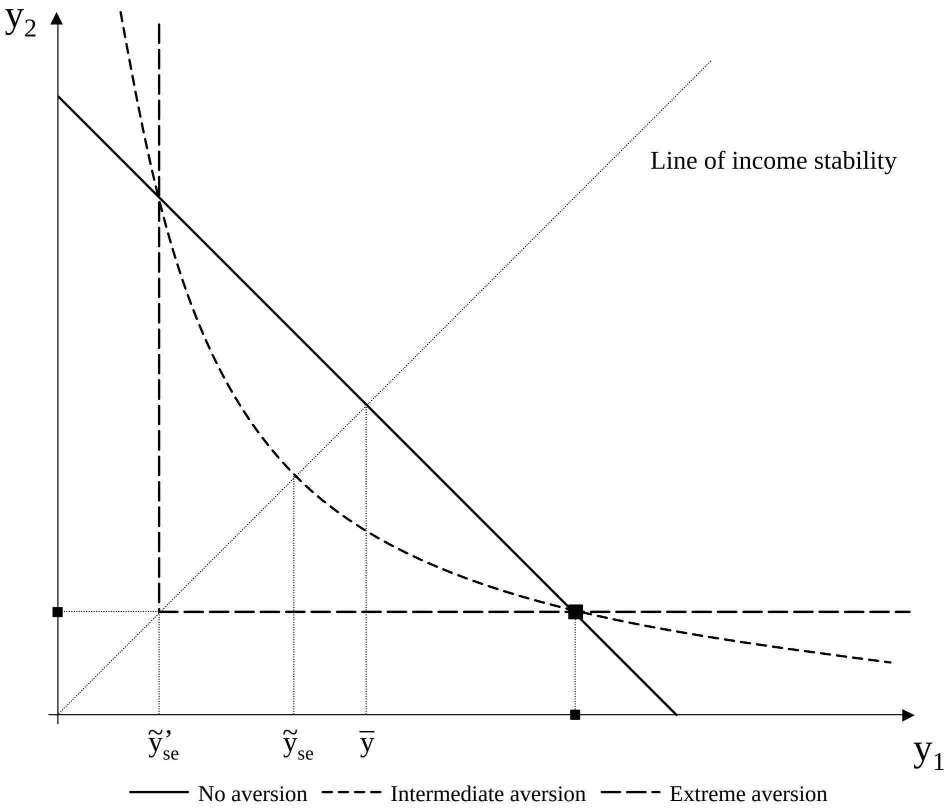
resulting in

$$\tilde{y}_{se} = \bar{y}_{\Delta} = \sum_{t=1}^{T} \Delta(t) y_t \tag{13}$$

This formulation can be interpreted as the limit case of the CRRA function with $\rho = 0$: with no variability aversion, the fluctuation adjusted income reduces to the

[6] This formulation is also known as the the Constant Relative Risk Aversion (CRRA) utility function.

Figure 2: Evaluation Function Contours for Different Degrees of Variability Aversion



discounted average over time.

The opposite case to Equation 12 is given by extreme variability aversion, corresponding to the limit case of the CRRA function with $\rho \to +\infty$. In the case of no discounting, this formulation results in:

$$\tilde{y}_{se} = \min(y_t) \tag{14}$$

The implied evaluation function only takes into account the lowest of past incomes, and it is the analogue, in the evaluation context, of a "Rawlsian" social welfare function (Hammond, 1975).

Figure 2 illustrates the difference between these different degrees of variability aversion. With $T = 2$, the Figure represents the stability equivalent income in the y_1, y_2 space for evaluation function contours with different degrees of variability aversion and no discounting. The CRVA and CAVA cases are represented by the "intermediate aversion" curve in the Figure, while the contour implied by Equation 12 is the "no aversion" solid straight line, which results in $\tilde{y}_{se} = \bar{y}$. Finally, the extreme aversion case is depicted by the kinked contour in Figure 2.

3 Comparison with Alternative Approaches

3.1 Ex-post measures: transient and chronic poverty

The evaluation framework has a series of advantages over the existing approaches for the analysis of panel data on incomes. This Section reviews the results from the two main alternatives in the literature.

The first approach, widely used in empirical applications, is the transient-chronic poverty decomposition. This methodology originates in Ravallion's (1988) contribution on poverty and welfare variability, on which Jalan and Ravallion (1998; 2000) base their definitions of transient and chronic poverty – Cruces and Wodon (2003c) build on these categories to study the Argentine case.

The approach applies Atkinson's (1987) family of additive poverty measures to a multi-period setting. A household's poverty in time t is given by the evaluation function $p(y_t)$, where p is required to be additive, strictly convex and decreasing up to the poverty line,and taking a value of zero thereafter. Intertemporal poverty P_i, chronic poverty C_i and transient poverty T_i are defined as:

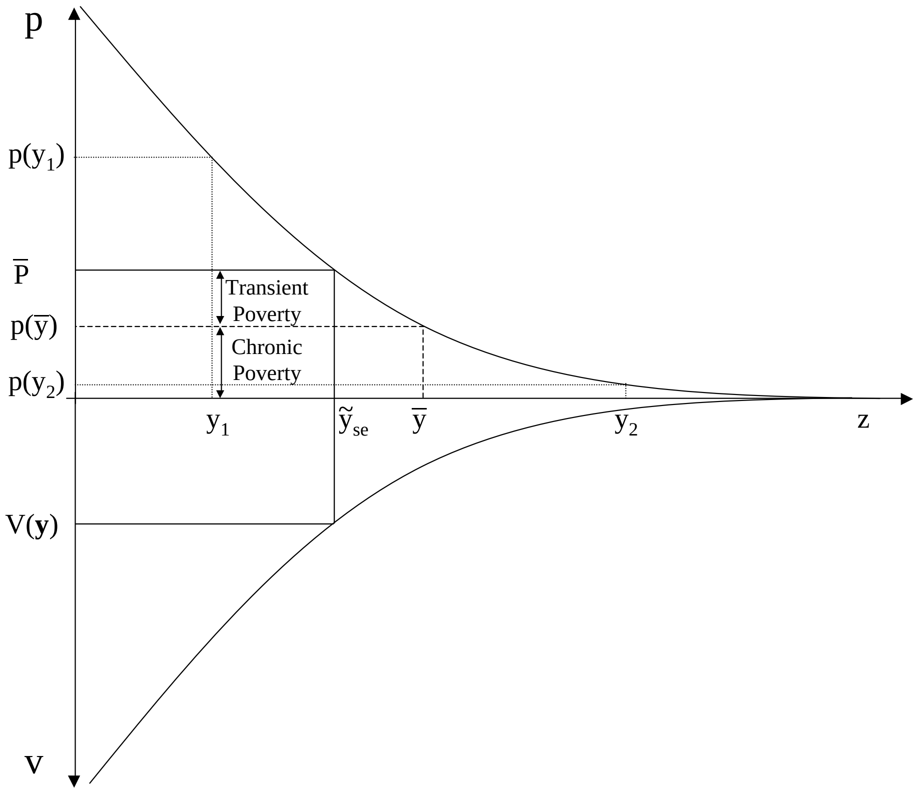
$$\begin{aligned} P_i &= \tfrac{1}{T} \sum_{t=0}^{T} p(y_{it}), \\ C_i &= p(\bar{y}_i) \text{ and} \\ T_i &= P_i - C_i \end{aligned} \tag{15}$$

Intertemporal poverty is the average of the poverty evaluations over time for a household, while chronic poverty reflects the poverty evaluation at the average income over time for i, $\bar{y}_i$. Finally, transient poverty is calculated as the difference between the two. Jalan and Ravallion (1998) compute these measures for every household and then aggregate them into population averages, using the squared poverty gap function for p (Equation **??**).

In terms of empirical applications, the main difference with the evaluation framework is that Jalan and Ravallion (1998) work with poverty evaluations, whereas the methodology presented in Section 2.1 first derives variability adjusted measures of income with an evaluation function, and then computes poverty indices based on them (Section 4 below presents an example of this procedure).

Despite this difference, the transient-chronic decomposition represents a special case of the evaluation framework. The poverty evaluation function p can be interpreted as an evaluation function by setting $v = -p$, which reflects an assessment of i's well-being that gives zero weight to income above the poverty line. This is illustrated in Figure 3, which presents an example for $T = 2$, with no discounting ($\Delta(t) = 1/T$) and with y_1 and y_2 below the poverty line. In the Figure, the poverty evaluation p is mirrored by the evaluation function $v = -p$. This representation highlights the connection between the two methodologies: the money metric indi-

Figure 3: Transient, Chronic and Variability Adjusted Measures of Poverty



cator $\tilde{y}_{se}$ based on $v = -p$ represents the fixed level of income that would result in the same intertemporal poverty P as the observed stream $\mathbf{y}$.

A disadvantage of the Jalan and Ravallion (1998) approach is that the aversion to variability is implicitly built into the poverty evaluation function p, which amalgamates the poverty and time dimensions. This function, however, may not be appropriate for evaluating income over time. For instance, most of the transient-chronic applications are based on the squared poverty gap, which is akin to a quadratic utility function and thus implies the undesirable property of increasing relative risk aversion (Kurosaki, 2003).[7] On the contrary, the two-step procedure proposed here ensures that these two facets are accounted for by a separate set of principles. The stability equivalent is derived from a set of principles specific to the time dimension, summarised by v, and the measure of poverty is then obtained by applying a function p, specific to the income dimension, to this household aggregate.

Finally, the evaluation framework has two additional advantages. On the one hand, it allows to compute variability adjusted measures of income for the whole population, while the transient-chronic decomposition by definition applies only

[7]The properties of the quadratic utility function in terms of risk aversion are analysed by Deaton and Muellbauer (1980, page 400).

to the poor. On the other hand, the incorporation of a discount factor in Equation 3 accounts for the trajectory of income, whereas the measures in Equation 15 are invariant to changes in the ordering of incomes y_t in $\mathbf{y}$.

Some of the advantages of the evaluation framework over the transient-chronic decomposition are also present when compared with the vulnerability approach, analysed in the following pages.

3.2 Ex-ante measures: risk and vulnerability

The vulnerability approach, as defined by Ligon and Schechter (2003), attempts to capture the ex-ante risk faced by households.[8] They rely on a "welfare function" U_i^{LS} defined over household income y_i. The vulnerability of a household i, V_i^{LS}, is given by the difference between U_i^{LS} evaluated at the poverty line z and the expectation of $U_i^{LS}(y_i)$:

$$V_i^{LS} = U_i^{LS}(z) - E[U_i^{LS}(y_i)] \tag{16}$$

which is decomposed into "poverty" and "risk" components:

$$V_i^{LS} = \underbrace{\{U_i^{LS}(z) - U_i^{LS}(E[y_i])\}}_{Poverty} + \underbrace{\{U_i^{LS}(E[y_i]) - E[U_i^{LS}(y_i)]\}}_{Risk} \tag{17}$$

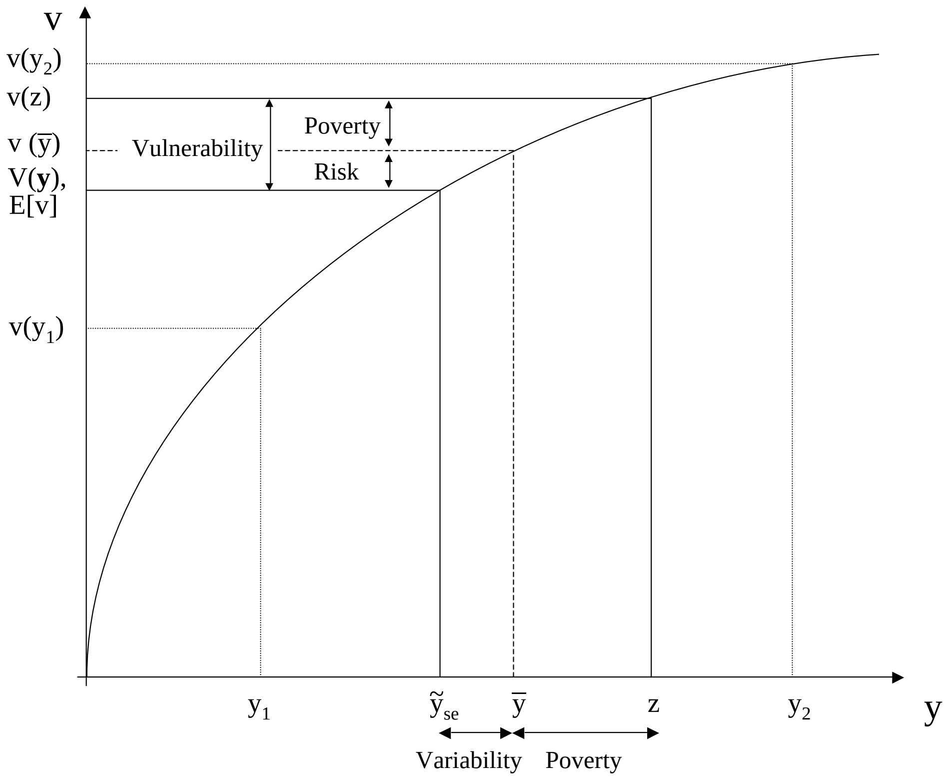
The expectation operator in Equations 16 and 17 refers to the distribution of future income: V_i^{LS} is meant to capture ex-ante risk and is thus "inherently forward-looking" (Ligon and Schechter, 2004). This is the main difference between the vulnerability approach and the evaluation framework: the former attempts to capture ex-ante income risk, while the latter evaluates ex-post fluctuations.

Since observed data is ex-post by definition, this approach requires an identifying assumption to use past realisations "to estimate the probability of possible future outcomes" (Ligon and Schechter, 2003). The assumption made by these authors is stationarity, which imposes the restriction that "the probability distribution of income in one period is identical to the probability distribution of income in any other period" (Ligon and Schechter, 2004). This implies that the last term in Equation 16, $E[U_i^{LS}(y_i)]$, becomes $(1/T)\sum_{t=0}^{T} U_i^{LS}(y_{it})$.

However, whether trying to capture past variability or future risk, from an applied point of view only realisations of income $\mathbf{y}$ are available to the researcher. The vulnerability approach and the evaluation framework methodologies differ conceptually, but the identifying assumption made by the former implies that the two result in similar empirical applications. This means that, as the transient-chronic decomposition, Ligon and Schechter's (2003) vulnerability measures can be inter-

[8] Thorbecke (2003) and Ligon and Schechter (2004) provide extensive overviews of the literature, including its relationship with Ravallion's (1988) concept of "expected poverty."

Figure 4: Poverty, Vulnerability and Income Fluctuations – Cardinal and Money Metric Measures



preted as a special case of the evaluation framework. This is illustrated in Figure 4 (based on Thorbecke, 2003), which presents an example with $T = 2$ and no discounting ($\Delta(t) = 1/T$). In this setting, the evaluation function in Equation 3 becomes $V(\mathbf{y}) = (1/T) \sum_{t=0}^{T} v(y_{it})$. The connection between the two methodologies emerges from setting the evaluation and welfare functions to coincide: assuming $U_i^{LS} = v$ results in $V(\mathbf{y}) = E[v(y_t)] = E[U_i^{LS}(y_i)]$, the last term in Equation 16. As can be appreciated in Figure 4, Ligon and Schechter's (2003) measure of vulnerability is equivalent, in the evaluation framework, to the difference between the evaluation of the poverty line, $v(z)$, and that of the observed income stream, $V(\mathbf{y})$.

The Figure also illustrates, in its vertical axis, the decomposition of vulnerability given by Equation 17. This example shows that the same exercise can be carried out within the evaluation framework: the Figure presents, along its horizontal axis, a monotone transformation of the "poverty" and "risk" components of Equation 17 in money metric terms, $z - \bar{y}$ and $\bar{y} - \tilde{y}_{se}$ respectively. The latter corresponds to the variability premium defined in Equation 6.[9]

A disadvantage of Ligon and Schechter's (2003) vulnerability measure, similar

[9]Moreover, the representation of V_i^{LS} in terms of income in the horizontal axis of Figure 4 reveals that this measure of vulnerability is a monotone transformation of the poverty gap ($\alpha = 1$ in Equation **??**) evaluated at $\tilde{y}_{se}$.

to that of the transient-chronic decomposition, is that the function U_i^{LS} determines not only the value of $U_i^{LS}(E[y_i]) - E[U_i^{LS}(y_i)]$, the "risk" component in Equation 17, but also the functional form of the "poverty" component, $U_i^{LS}(z) - U_i^{LS}(E[y_i])$. In the evaluation framework, however, the stability equivalent $\tilde{y}_{se}$ is derived from a function v, and the poverty measures are then based on $\tilde{y}_{se}$, which ensures that fluctuations and poverty are disentangled.

Moreover, V_i^{LS} in Equation 16 is derived in units of the cardinal welfare function U_i^{LS} ("utils" in Ligon and Schechter, 2003), which implies that measures of vulnerability based on two functions U_i^{LS} and $U_i^{LS'}$ are not directly comparable. As discussed in Section 2.1, a money metric indicator like $\tilde{y}_{se}$ ensures the comparability of results for different evaluation functions.

Finally, by attempting to capture the ex-ante risk faced by the households, the stationarity assumption means that the measure of vulnerability in Equation 16 does not take into account the dynamic dimension of the observed stream $\mathbf{y}$: V_i^{LS} is the same for the vectors $\mathbf{y} = [y_1, y_2]$ and $\mathbf{y}' = [y_2, y_1]$ with $y_1 \neq y_2$. While assuming stationarity is plausible in some contexts, the evaluation framework can account for the dynamic nature of $\mathbf{y}$ through the discounting function $\Delta(t)$. This is illustrated in the empirical applications presented in the following Section.

4 Poverty and Income Fluctuations in Turbulent Times: Argentina 1995-2002

4.1 Household Data and Measurement of Poverty in Argentina

The empirical analysis conducted in this paper is based on data from the Argentine Permanent Household Survey ("Encuesta Permanente de Hogares", EPH).[10] This is a labour market and living conditions survey that has been collected since 1975 in the Greater Buenos Aires region, which covers the country's capital and adjacent municipalities, and constitutes the country's largest urban centre. The region represents around 60 percent of the total population and 70 percent of the urban population of the country. The EPH is one of the longest serving household surveys in Latin America, and is considered to be of relatively high quality (World Bank, 2000). The data is collected by the national statistical agency, the Instituto Nacional de Estadísticas y Censos (INDEC).

During the 1995-2002 period, the survey was collected every year in two waves, in May and October (denoted waves 1 and 2 for each year), and all computations are based on the fifteen waves available between May 1995 and May 2002. The EPH is structured as a rotating sample, where 25 percent of households surveyed

[10]See Cruces (2005b, Chapter 2) and Cruces (2005a), a companion paper to this article, for details on the dataset employed and the construction of the income aggregate. The data, poverty measures and trends have been extensively covered in other articles (Cruces and Wodon 2003a; 2003b; 2003c).

are replaced in each wave (INDEC, 2002). INDEC provides household weights, which are used in all the estimates presented in this paper.

The rotating structure of the EPH's sample implies that households stay in the sample for four consecutive waves, a period of about a year and a half. The fifteen waves between May 1995 and May 2002 contain data for twelve "cohorts" of households observed in the same four consecutive waves. Only households observed four times and with complete information on income for every member of the household in the four waves are kept in the sample, which results in an average of 453 households observations per cohort – about 60 percent of the theoretical total for the GBA region.[11]

The EPH collects information on the income and labour market status of every member of a household, as well as some dwelling and individual characteristics. INDEC's methodology for aggregating household income recognises the differences in needs between household members, and accounts for the differential requirements by age and gender (INDEC, 2002). The total household equivalent monthly income is defined by the following expression:

$$y_i^e = \frac{\sum_{j=1}^{k_i} y_i^j}{\sum_{j=1}^{k_i} q_j} \tag{18}$$

where $\sum_{j=1}^{k_i} q_j$ is the number of equivalent adults for each household i with k_i members, q_j represents the adult equivalent coefficients determined by member j's age and gender, $\sum_{j=1}^{k_i} y_i^j$ is total household income and y_i^j represents each individual member's total monthly monetary income. Most individuals have only one source of income which consists of salaries for the active population and pensions for those who are retired.

This aggregate is attributed to every member of the household, which is why the text refers interchangeably to households and individuals. Since this paper deals with observations spanning the period 1995 to 2002, the main measure employed in this paper is the adult equivalent income normalised by the contemporaneous poverty line z_t. It is defined as:

$$y_{it} = \frac{y_{it}^e}{z_t} = \left[\frac{\sum_{j=1}^{k_i} y_{it}^j}{\sum_{j=1}^{k_i} q_j} \right] / z_t \tag{19}$$

This formulation is known as the "welfare ratio" in the literature and has a series

[11] Cruces and Wodon (2003c) argue that the attrition from the panel is compensated by the INDEC's weighting structure, and does not bias income and poverty measures in a significant way. Since the panels are relatively short, the problems identified by Cowell (1982) with respect to changes in family structure do not affect the results.

of advantages (Blackorby and Donaldson, 1987; Ravallion, 1998). Besides making equivalised incomes comparable over time, Equation 19 can be given an interpretation in terms of poverty measurement: $y_{it} < 1$ indicates that a household's income is below the poverty line, and thus its members can be classified as poor.

In terms of poverty, this paper relies on the FGT decomposable poverty measures proposed by Foster et al. (1984), which belong to the general class defined by Atkinson (1987). The FGT measures imply the following functional form for the poverty measures:

$$FGT\left(y^{e}, z, \alpha\right) = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{\max(z - y_i^e, 0)}{z}\right]^{\alpha} \tag{20}$$

where α is a sensitivity parameter ($\alpha \geq 0$) and N denotes the total number of households or individuals in the population.[12]

4.2 Variability Adjusted Poverty in Argentina

The following pages present alternatives for empirical analysis using the evaluation framework and the functional forms discussed in Section 2. The data corresponds to the Greater Buenos Aires dataset, a series of twelve panels with four observations each ($T = 4$), covering the 1995-2002 period. The evaluation functions and stability equivalents defined above are applied to the equivalised and normalised income of the households in each of these twelve cohorts, given by y_{it} in Equation 19.

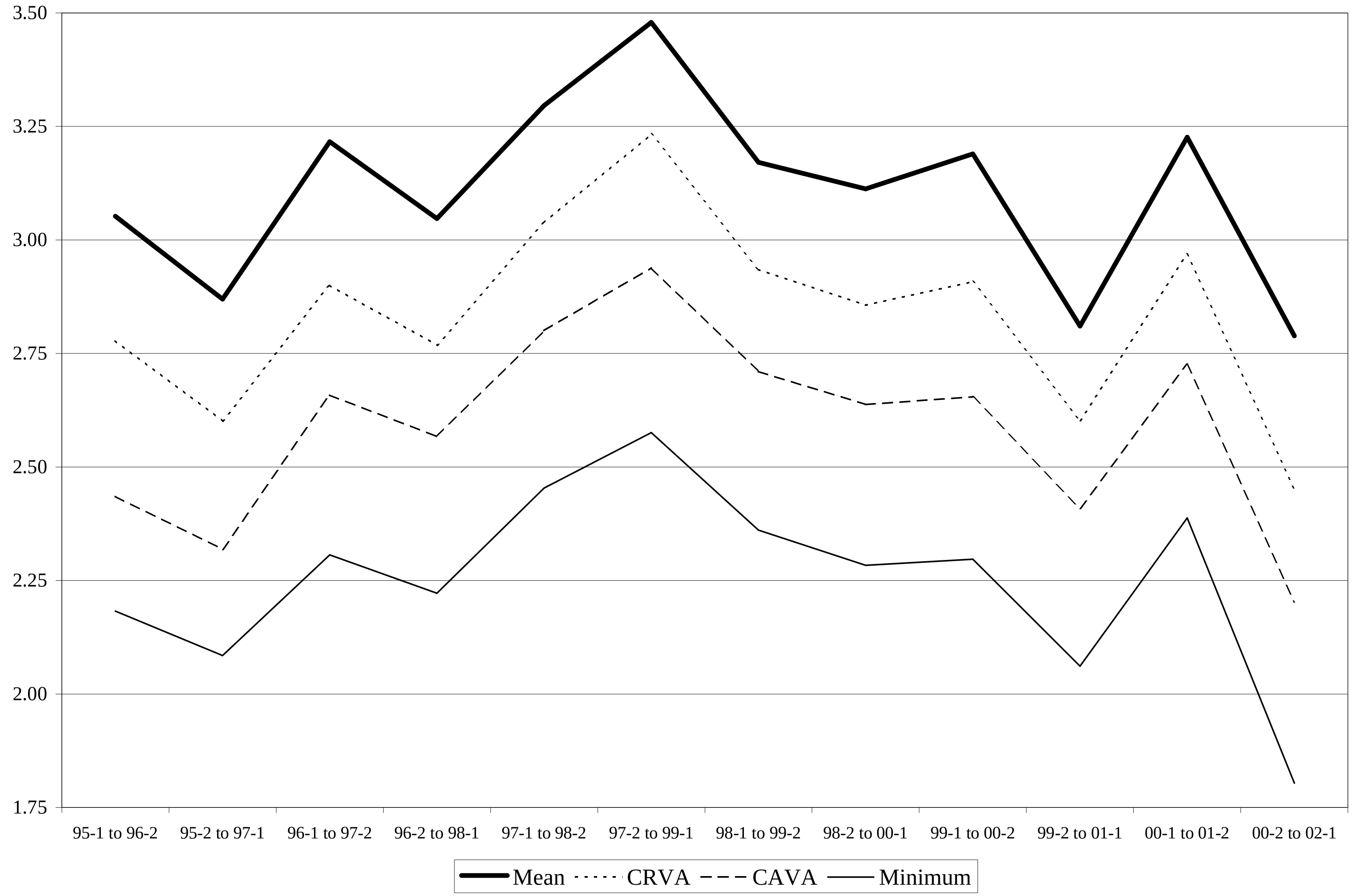
The simplest analysis can be carried out over the population average of $\tilde{y}_{se}$, depicted in Figure 5 for each of the twelve cohorts. The evaluation functions in this Figure are the CRVA (Equation 8), CAVA (Equation 10) and the extreme aversion (Equation 14), while the average of income over time (Equation 12) is used as the benchmark case. For the CRVA and CAVA formulations, the parameters ρ and η are set to 2, a value adopted for empirical analysis in Cruces and Wodon (2003b) and by Ligon and Schechter (2003), among others.[13] This example concentrates on different functional forms, and thus the parameter δ in Equation 4 is set to 1, resulting in $\Delta(t) = 1/T$.

Incomes are normalised by their contemporaneous poverty lines so their unit is the poverty line. The four variability adjusted measures and the average income in Figure 5 follow the basic trends in GDP (Cruces, 2005a), confirming the highly procyclical nature of household income. Notably, the difference between the average of income over the four periods in which households are observed (bold solid line) and its minimum (solid line) is quite sizeable at about three quarters of the poverty

[12]With the parameter set to $\alpha = 0$, Equation 20 represents the poverty headcount. With $\alpha = 1$ and $\alpha = 2$, the resulting measures are the poverty gap and the squared poverty gap, which take into account not only the number of poor (as the headcount does) but also the intensity of poverty.

[13]Cruces and Wodon (2003b) discuss the range of plausible values and the sensitivity of measures of this type with respect to ρ.

Figure 5: Variability Adjusted Measures of Income for Different Evaluation Functions, Greater Buenos Aires, 1995-2002



Source: Author's estimations based on EPH household survey data (INDEC).

Table 1: Relative Variability Premium by Quintile of Mean Income, Isoelastic Evaluation Function with Aversion Parameter=2, Greater Buenos Aires, 1995-2002

Cohort	Bottom Quintile	Second Quintile	Third Quintile	Fourth Quintile	Top Quintile	Overall
95-1 to 96-2	16.7%	11.3%	9.0%	10.4%	7.8%	11.0%
95-2 to 97-1	25.5%	9.4%	8.2%	11.2%	8.2%	12.4%
96-1 to 97-2	22.9%	14.3%	9.5%	10.0%	7.5%	12.7%
96-2 to 98-1	19.2%	11.9%	9.8%	9.4%	8.8%	11.8%
97-1 to 98-2	24.6%	8.6%	7.6%	6.9%	6.9%	11.0%
97-2 to 99-1	22.1%	10.4%	7.2%	7.4%	5.3%	10.4%
98-1 to 99-2	24.4%	11.0%	8.1%	7.9%	5.2%	11.2%
98-2 to 00-1	21.9%	12.8%	7.2%	5.6%	7.1%	10.9%
99-1 to 00-2	24.3%	10.1%	7.3%	5.2%	7.4%	10.8%
99-2 to 01-1	22.2%	10.0%	10.1%	7.5%	5.1%	10.9%
00-1 to 01-2	20.7%	15.2%	7.6%	5.8%	7.0%	11.2%
00-2 to 02-1	34.9%	19.7%	13.2%	12.2%	9.8%	17.9%
Overall	23.3%	12.1%	8.7%	8.3%	7.2%	11.8%

Source: Author's estimations based on EPH household survey data (INDEC).

line. This indicates the presence of strong within-panel fluctuations in household income.

This "minimum" stability equivalent can be interpreted as resulting from an extreme aversion evaluation function, while the average income represents no aversion and the CRVA and CAVA constitute intermediate cases (see the diagram in Figure 2). This implies that in Figure 5 the stability equivalents based on these two formulations fluctuate between the average and the minimum. On average, the difference between the stability equivalent given by the CRVA function with $\rho = 2$ and the average income is around a quarter of the poverty line, while the difference between the latter and $\tilde{y}_{se}$ based on the CAVA with $\eta = 2$ is about half of this unit. These differences represent the population averages of the absolute variability premium defined in Equation 6, and they are relatively large with respect to the average income, which fluctuates between 3 and 3.25 times the poverty line. Finally, while the four measures tend to move similarly, the CRVA is more sensitive to increases and decreases in the average income over time, magnifying its fluctuations.

Another type of empirical analysis based on the evaluation framework is presented in Table 1, which depicts the evolution of the relative variability premium Π (defined in Equation 7) by quintile of average income, based on a CRVA with $\rho = 2$

and no discounting. The advantage of this formulation is that the relative variability premium is constant with respect to proportional changes in the income vector $\mathbf{y}$ when $\delta = 1$, so that differences in its value at different points of the income distribution reflect the differential impact of income fluctuations as a proportion of total income. As can be appreciated from the Table, the poorest quintile bears the highest level of fluctuations in relative terms, with values of around 20 and 25 percent of the average income, with a peak of almost 35 percent in the period corresponding to the 2002 crisis (Cruces, 2005a). The second quintile also has a relatively higher level of the variability premium at around 12 percent, but for the three richest groups a pattern is not clearly discernible, standing between 7 and 9 percent on average.

Figure 6 presents the population squared poverty gap for the different evaluation functions considered above, with $\rho = 2$, $\eta = 2$ and $\delta = 1$. These poverty measures are based on the stability equivalent incomes presented in Figure 5: as expected, the order of the series is reversed with respect to that Figure, with higher poverty when using the minimum income over the period and the lowest when using the average over time. The difference between these two series is again sizeable, but the most notable fact from the Figure is the evolution of the CRVA series. While the averaging of incomes over time smooths income and poverty measures – a fact discussed at length in Cruces and Wodon (2003b)– the CRVA formulation is more sensitive than the CAVA to the variability of the underlying incomes. This can be appreciated in its higher curvature at the points where the poverty measure based on average income changes its trend.

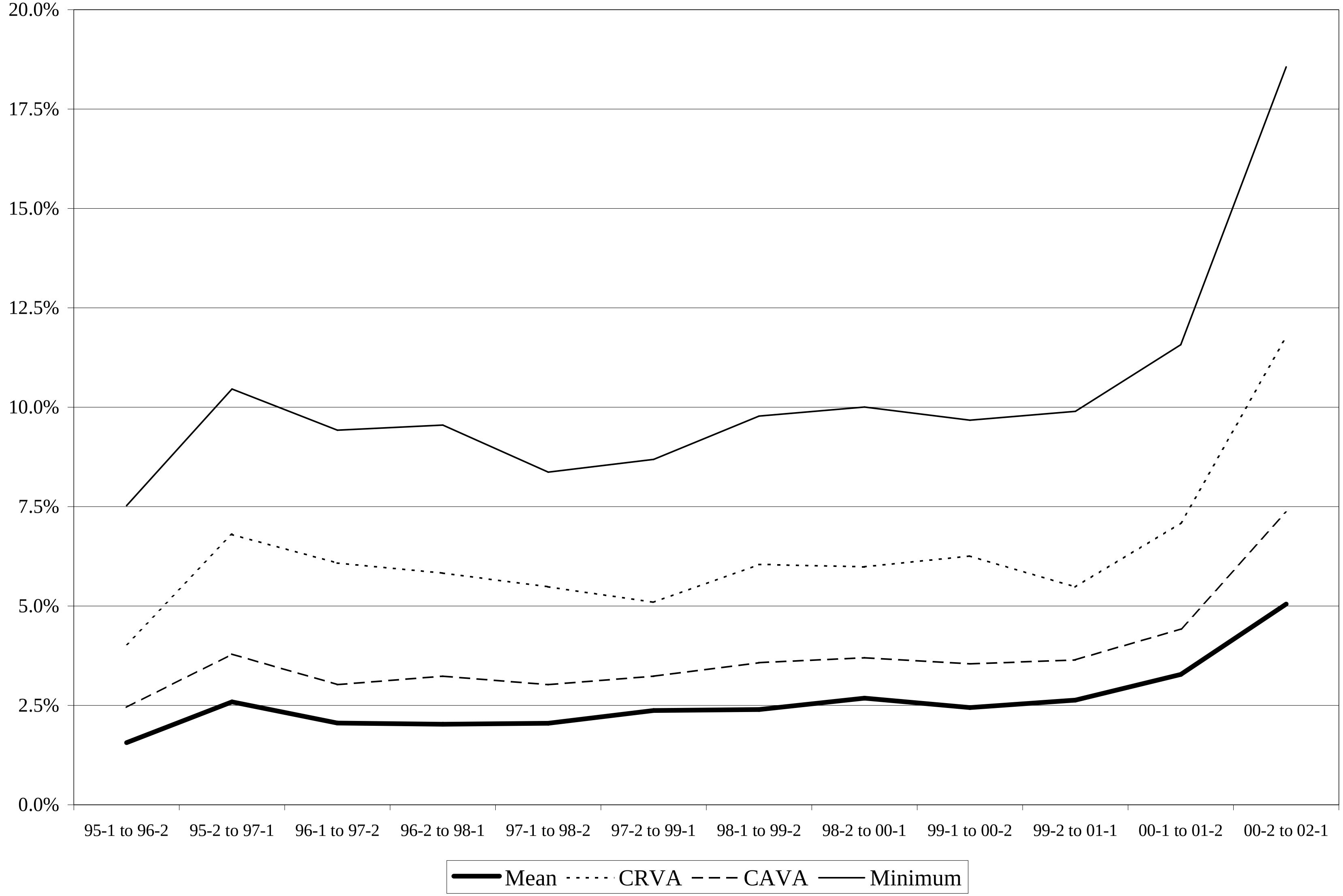
5 Conclusion

This paper explored the theoretical basis for the incorporation of income fluctuations in the measurement of poverty and well-being over time. A general framework and a series of related methodologies were illustrated with panel data on income for Argentina. This framework relies on an analogy with choice under uncertainty and the expected utility model to define a family of welfare-based indicators of well-being and variability over time. This is achieved by means of a two-step procedure, which involves aggregating vectors of observations over time for a household into a scalar and then studying the distribution of this aggregate.

The empirical findings of this paper imply that income fluctuations matter in at least two important dimensions. The first dimension refers to the relative importance of income fluctuations for household well-being. The framework developed in Section 2 provided a rationale, based on an analogy with the concept of risk aversion, for imputing a negative impact of fluctuations on welfare. However, the magnitude of this effect is an empirical question.

The evidence for Argentina demonstrated that income fluctuations had a substantial impact on household welfare under relatively mild assumptions. There

Figure 6: Variability Adjusted Squared Poverty Gap with Different Evaluation Functions, Greater Buenos Aires, 1995-2002



Source: Author's estimations based on EPH household survey data (INDEC).

is, however, a trade-off: when income observations over time are aggregated at the household level, welfare measures increase and poverty evaluations decrease when compared to indices based on punctual observations. This is because the averaging mitigates the impact of negative shocks. This smoothing effect, however, was more than offset once the disutility from income fluctuations was taken into account, assuming only moderate levels of risk aversion in line with most estimates of the uncertainty literature.

Most importantly, the sizeable effects of fluctuations on welfare and poverty were not limited to periods of crisis or downturns. The findings indicate that income fluctuations at the household level have substantial effects on well-being even during periods of aggregate growth, for instance during the 1996-1998 period in Argentina. This result reflects the finding that a substantial fraction of the population entered poverty even when aggregate rates were falling (Cruces, 2005a).

The second dimension refers to the effects of an economic crisis from a dynamic perspective. The empirical results in this paper indicate that major macroeconomic shocks, like the 2001-2002 crisis in Argentina, not only reduce income levels, but also increase income risk, which magnifies their overall negative impact on poverty and well-being.

While the importance of dealing with the effects of aggregate shocks has long been recognised, in terms of policy implications, the main conclusion from this paper is that safety nets and other social protection mechanisms, while vital during major crises, should also be implemented on a continuous basis, irrespective of the short term evolution of macroeconomic aggregates.

References

ARROW, K. J. (1970): *Essays in the Theory of Risk-Bearing*, North-Holland, Amsterdam.

ATKINSON, A. B. (1970): "On the Measurement of Inequality," *Journal of Economic Theory*, 2, pp. 244–263.

——— (1987): "On the Measurement of Poverty," *Econometrica*, 55(4), pp. 749–64.

BLACKORBY, C., AND D. DONALDSON (1987): "Welfare Ratios and Distributionally Sensitive Cost-Benefit Analysis," *Journal of Public Economics*, 34(1), pp. 265–290.

CALVO, C., AND S. DERCON (2003): "Vulnerability: an Axiomatic Approach," Unpublished, Oxford University.

COWELL, F. A. (1979): "The Definition of Lifetime Income," Institute for Research on Poverty Discussion paper 566-79, University of Wisconsin, Madison.

——— (1982): "Introduction," in *Panel Data on Incomes*, edited by A. B. ATKINSON AND F. A. COWELL, ICERD, LSE, London.

——— (1989): "On the Distribution of Lifetime Income in a Lognormal Model," in *Essays on Income Distribution, Economic Welfare and Taxation*, edited by R. HAGFORS AND P. VARTIA, ETLA, Helsinki.

——— (1995): *Measuring Inequality*, London School of Economics Handbooks in Economics, Harvester Wheatsheaf/Prentice Hall, London.

——— (2000): "Measurement of Inequality," in *Handbook of Income Distribution*, edited by A. B. ATKINSON AND F. BOURGUIGNON, p. 16, Elsevier Science, North-Holland.

CRUCES, G. (2005a): "Income Fluctuations, Poverty and Well-Being Over Time: Theory and Application to Argentina," Distributional Analysis Research Programme Working Paper 76.

——— (2005b): "Poverty, Income Fluctuations and Work: Argentina, 1991-2002," Ph.D. thesis, Economics Department, London School of Economics, University of London.

CRUCES, G., AND Q. WODON (2003a): "Argentina's Crises and the Poor, 1995-2002," *Económica*, 49(1-2).

——— (2003b): "Risk-Adjusted Poverty in Argentina: Measurement and Determinants," In World Bank (2003), *Argentina Crisis and Poverty 2003. A Poverty Assessment*, Volume 2. Also available as *Distributional Analysis Research Programme* Working Paper 72, STICERD, London.

——— (2003c): "Transient and Chronic Poverty in Turbulent Times: Argentina 1995-2002," *Economics Bulletin*, 9(3), pp. 1–12.

DEATON, A. S., AND J. MUELLBAUER (1980): *Economics and Consumer Behavior*, Cambridge University Press, Cambridge.

FOSTER, J., J. GREER, AND E. THORBECKE (1984): "A Class of Decomposable Poverty Measures," *Econometrica*, 52(3), pp. 761–66.

HAMMOND, P. J. (1975): "A Note on Extreme Inequality Aversion," *Journal of Economic Theory*, 11, pp. 465–467.

INDEC (2002): "Incidencia de la Pobreza y de la Indigencia en los Aglomerados Urbanos," Información de Prensa, Instituto Nacional de Estadísticas y Censos, Buenos Aires.

JALAN, J., AND M. RAVALLION (1998): "Transient Poverty in Postreform Rural China," *Journal of Comparative Economics*, 26, pp. 338–357.

——— (2000): "Is Transient Poverty Different? Evidence for Rural China," *Journal of Development Studies*, 36(6), pp. 82–99.

KUROSAKI, T. (2003): "Measurement of Chronic and Transient Poverty: Theory and Application to Pakistan," Unpublished, Institute of Economic Research, Hitotsubashi University, Japan.

LIGON, E., AND L. SCHECHTER (2003): "Measuring Vulnerability," *Economic Journal*, 113(486), pp. C95–110.

——— (2004): "Evaluating Different Approaches to Estimating Vulnerability," Unpublished, Department of Agricultural and Resource Economics, University of California, Berkeley.

O'DONOGHUE, E. D., AND M. RABIN (1999): "Doing It Now or Doing It Later," *American Economic Review*, 89, pp. 103–124.

PRATT, J. W. (1964): "Risk-Aversion in the Small and in the Large," *Econometrica*, 32(1-2), pp. 122–36.

RAVALLION, M. (1988): "Expected Poverty under Risk-Induced Welfare Variability," *Economic Journal*, 98(393), pp. 1171–82.

——— (1998): "Poverty Lines in Theory and Practice," Living Standards Measurement Study Working Paper 133, World Bank, Washington DC.

THORBECKE, E. (2003): "Conceptual and Measurement Issues in Poverty Analisys," Presented at the UNU / WIDER Conference on Inequality, Poverty and Human Well-being, 30-31 May 2003, Helsinki.

WORLD BANK (2000): "Argentina: Poor People in a Rich Country," Report 19992-AR, Poverty Reduction and Economic Management, Washington DC.