



On testing the scale sensitivity of poverty measures



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HIGHLIGHTS

- Scale sensitivity tests for poverty measures are sensitive to the choice of reference demographics.
- The single adult as the reference is questionable, as this is an untypical household.
- Better to anchor scales to reference demographics typical of the circumstances of poor people.

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ABSTRACT

Past tests of the sensitivity of aggregate poverty measures to changes in equivalence scales can be very sensitive to the arbitrary choice of the pivotal reference demographics. It is recommended that future tests should use demographics typical of people living near the poverty line as their reference.

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1. Introduction

There are long-standing issues in calibrating equivalence scales for making inter-household welfare comparisons, including when measuring poverty.¹ Thus there is interest in testing the sensitivity of poverty measures to changes in the scales used. There are many examples of such tests in the literature, including (amongst others) Buhmann et al. (1988), Coulter et al. (1992), Lanjouw and Ravallion (1995), Citro and Michael (1995), Duclos and Mercader-Prats (1999) and Batana et al. (2013). The latter paper provides estimates of aggregate poverty rates for the developing world allowing for scale economies in consumption and differences in expenditure needs between adults and children. They compare their measures to those of Chen and Ravallion (2010) based on a “per-capita” scale. Batana et al. conclude that “...the figures calculated by Chen and Ravallion are substantially overestimated”. The differences are indeed substantial. For the developing world as

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¹ There is an extensive literature on scales; the classic treatment is Deaton and Muellbauer (1980). On the conceptual problems in identifying scales from demand behavior see Pollak and Wales (1979) and Fisher (1987).

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a whole, their estimate of the poverty rate in 2000 falls from 31% to 3%–13% depending on the scale used.

This paper argues that such tests are very sensitive to arbitrary (and often implicit) choices made about welfare scaling—so much so that it is unclear what lessons can be drawn. A solution is proposed based on the principle that the poverty comparisons should be anchored to the typical circumstances of households living near the poverty line.

2. Sensitive tests of the scale sensitivity of poverty measures

Let $m(\underline{n}_i, \pi)$ denote the equivalence scale, giving the number of equivalent adults (EA) deemed to be living in household i with demographic characteristics represented by a vector \underline{n}_i . (The demographics vector is denoted \underline{n} with an underscore, while household size is simply n .) The vector of scale parameters π is fixed across all i . The scale is taken to be normalized such that $m(\underline{1}, \pi) = 1$, where $\underline{1}$ is the demographic vector for a household of a single adult, although other normalizations have been used in practice such as two adults.² An example is $m(\underline{n}_i, \pi) = (n_{ai} + \alpha n_{ci})^\theta$ where n_{ai} and n_{ci} are the numbers of adults and children

² See, for example, Whiteford (1985).

respectively in household i ($\underline{n}_i = (n_{ai}, n_{ci})$) and $\pi = (\alpha, \theta)$ both of which are bounded below by 0 and above by 1. Here θ represents the economies of scale in consumption. A popular special case is to set $\alpha = 1$ and $\theta = 0.5$ giving the “square-root scale”.³ The monetary metric of welfare is consumption per EA, $y_i/m(\underline{n}_i, \pi)$, where y_i is total household consumption.

Given this set-up, how should the poverty line be adjusted when one compares different scales? The answer is far from obvious since one is essentially trying to make welfare comparisons across different utility functions. Batana et al. (2013) keep the line constant. Deaton and Zaidi (2002, pp.59) raise the objection that doing so would mechanically lower the poverty rate for all except single-person households.

One can propose the following axiom for making comparisons across different scales:

The pivot axiom: *There exists some reference demographic vector, denoted \underline{n}^r , such that assessed welfare is consumption per person whatever scale is used.*

This requires re-scaling consumption per EA by a multiplicative constant as:

$$y_i^e \equiv \frac{y_i}{m(\underline{n}_i, \pi)} \cdot \frac{m(\underline{n}^r, \pi)}{n^r} \quad (1)$$

where \underline{n}^r is a fixed reference vector of demographic characteristics, and n^r is the corresponding reference household size. The poverty line is then fixed in the space of y_i^e when comparing scales or (equivalently) the line is adjusted in the space of consumption per EA to assure consistency. Suppose that we are given a poverty line z_1 for the per-capita scale, $m(\underline{n}_i, \pi) = n_i$. In the space of consumption per EA one then sets the poverty line at $z(\pi) \equiv z_1 n^r / m(\underline{n}^r, \pi)$ for any distribution based on an alternative scale $m(\underline{n}_i, \pi) \neq n_i$.

This formulation encompasses the main methods found in the literature on testing the scale sensitivity of absolute poverty measures, all of which (implicitly or explicitly) assume that the pivot axiom holds. The question remains as to what should be chosen for the reference demographics. Here practice has varied greatly and often with little or no discussion of the choices made. Deaton and Zaidi (2002) recommend sample modal demographics. An example of that method can be found in Citro and Michael (1995) using US data. Lanjouw and Ravallion (1995) use instead the mean demographics in their data for Pakistan in 1994, implying a reference household size of 7.4. Others have instead used a single (male) adult as the reference, setting $\underline{n}^r = \underline{1}$; examples are found in Coulter et al. (1992), Duclos and Mercader-Prats (1999) and Batana et al. (2013). These are all special cases of the pivot axiom.

One source of confusion in the literature should be noted. The choice of the pivot is a conceptually distinct issue to the scale normalization. While setting $m(\underline{1}, \pi) = 1$ is a common (though not universal) practice for scale normalization, that does not make $\underline{n}^r = \underline{1}$ any more or less compelling as an option for the pivot. For example, the \$1.25 a day line proposed by Ravallion et al. (2009) is a per capita line (z_1 above). Naturally, it is also the line for a single adult given the normalization. But that does not mean that the single adult should be the reference in sensitivity tests, as assumed by Batana et al. (2013). The national poverty lines in low-income countries used to derive the \$1.25 line were certainly not calibrated to single adults living alone, but were derived for more typical poor households in each country.

Does the choice of pivot make much difference? Two examples will illustrate how much the choice can matter. First, suppose that

there are three households with incomes per capita per day, \$1, \$2 and \$3, and household sizes 5, 4 and 3 (respectively). The per-capita poverty line is \$2, giving a (population-weighted) poverty rate of 75%. Suppose now that one switches to the square-root scale giving the distribution: \$2.24, \$4 and \$5.20. If one follows Batana et al. in keeping the poverty line at \$2 (implicitly using a single adult as the reference), then one finds that poverty has vanished. However, suppose instead that one sets the reference as a household with four people—the size for the family living at the per-capita line. For the reference household to have the same level of welfare in both scales, the equivalent poverty line to \$2 in the space of income per person is then \$4 in the space of $y_i n_i^{-0.5}$. Then the poverty rate would return to 75%. That is also the case for references of 5 or 6. If the reference is set at 7 or more, then everyone is deemed poor. So we can get anything from zero poverty to 100% in switching to this scale depending on the arbitrary choice of reference for establishing the equivalence in poverty lines between the different scales.

Second, consider the result reported by Batana et al. (2013) that the global poverty rate falls from 31% to 3% when one switches from the per capita scale to a square-root scale while fixing the poverty line at \$1.25 a day, based on Ravallion et al. (2009). Arguably it would be more consistent with how the \$1.25 line was set to interpret it as the per capita line for a household with the demographics typical of people living in a neighborhood of the poverty line. Suppose that Batana et al. had set the reference at 5—a seemingly reasonable guess for average household size around the per capita poverty line. Then they would have had to apply a poverty line of \$2.80 to their distributions of income using the square root scale, rather than \$1.25. Such a large difference in poverty lines would have greatly attenuated their claimed sensitivity to the change in scales. Indeed, without differences in household size the gap would vanish.

This degree of sensitivity of past scale sensitivity tests to the choice of pivot does not appear to have been noted before and clearly warns for caution. The essential problem is that these tests are missing a conceptual basis for making welfare comparisons across different scale parameters, which matter greatly to the results.

How then should the reference be chosen? As a guiding principle in testing scale sensitivity one would want to avoid pivoting the comparisons around either extreme in the range of household sizes. For one thing, the extremes tend to be unusual; a household of just one (male) adult is untypical, not least in developing countries, where average household size is around 5. For another, when an allowance is made for scale economies and lower child costs, larger households will tend to have lower scales and higher imputed equivalent incomes. Setting the reference at either extreme will mechanically exaggerate sensitivity, giving a larger reduction in poverty relative to the per capita scale when the single adult is the reference and a larger increase when the largest household is chosen.

One possibility is to fix the reference at the average demographics of those living in a neighborhood of, the poverty line in the per capita space. This can be motivated by the longstanding argument in measuring poverty that the parameters (such as those of the price index and allowances for non-food goods) should accord reasonably well with the circumstances of poor people—that one should not use atypical parameters in assessing their welfare. That is a value judgment, but a seemingly acceptable one. The single adult reference is unlikely to qualify.

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³ See Coulter et al. (1992), Lanjouw and Ravallion (1995) and Buhmann et al. (1988).

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