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On the Arbitrariness and Robustness of Multi-Dimensional Poverty Rankings

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Abstract It is often argued that multi-dimensional measures of well-being and poverty — such as those based on the capability approach and related views — are *ad hoc*. Rankings based on them are not, for this reason, robust to changes in the selection of weights used. In this paper, it is argued that the extent of potential arbitrariness and the range of issues relating to robustness have been underestimated in this context. Several issues relating to both the identification of the poor and the use of dimension-specific data are distinguished. For illustrative purposes, these distinct issues are discussed in the context of the inter-provincial ranking of poverty in South Africa in 1995–1996. It turns out that this ranking is fairly robust, and that an important policy-relevant result involving a comparison between KwaZulu-Natal and the Free State in 'income'/'expenditure' and 'human' poverty rankings is reinforced rather than undermined by checking for robustness. Even when the rankings are not robust, the discussion suggests that they may inform policy debates.

Key words: Poverty, Measurement, Capability, South Africa, Economics, Income poverty, Human poverty

Introduction

There is now a considerable and growing literature on multi-dimensional measures of poverty and well-being. The United Nations Development Programme's advocacy of the human development paradigm and the development of various measures in the *Human Development Reports* has contributed to the growth of this literature. The literature is both theoretical and empirical, and some of it is policy oriented. The policy relevance of multi-dimensionality relates, in part, to the genuine possibility that a uni-dimensional approach to the measurement of well-being and poverty — such as that involved in some of the income-focused or expenditure-focused poverty literature — is likely to underestimate the 'richness' or complexity of the nature of poverty, which needs to be addressed in any policy for

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poverty eradication. Furthermore, use of a multi-dimensional framework might actually alter the particular set of people who are identified as poor.

One response to arguments in favour of multi-dimensional approaches — such as those that follow Amartya Sen's capability approach as well as related views of well-being — claims that, while multi-dimensional measures can be useful, they are usually *ad hoc*. Multi-dimensional measures typically involve some sort of weighting scheme or exercise to capture the relative importance of the different dimensions of poverty. Any ranking of countries or provinces that is based on such measures must then be highly sensitive to the specific weighting scheme adopted. There are various ways of responding to this challenge. Nonetheless, this issue is also relevant in the context of some uni-dimensional measures — such as those income-based or expenditure-based metrics that use a basket of commodities, or a set of 'basic needs', to establish the income or expenditure poverty line. It is argued, in this paper, that there are numerous issues aside from the specific issue of weighting that are relevant to the robustness of rankings based on multi-dimensional measures. In particular, there are issues relating to the choice of dimensions that are relevant, and to the choice of the 'bottom line' in terms of each dimension, in the analysis of poverty. These need to be distinguished from issues relating to the weighting of dimensions if robustness is to be seriously examined in the multi-dimensional context.

I address some of the relevant issues in relation to two approaches to multi-dimensional poverty ranking: the Borda score and a family of measures developed by Sudhir Anand and Amartya Sen (the 'Anand–Sen family of measures', for short) in their work for the United Nations Development Programme (UNDP). The UNDP's human poverty index (HPI) is a member of this family of indices. In addressing these issues, I use South African data from 1995–1996. These data have been the focus of much of the recent literature on South Africa. Some of this literature has focused on the inter-provincial picture of poverty and the distribution of poverty eradication grants to the various provinces. In this paper, general points about arbitrariness and robustness are made. While these points are relevant to any country, they are illustrated in the case of South Africa. This case is of particular interest because a contrast between the pictures of poverty that emerge from the income-based or expenditure-based and multi-dimensional measures has emerged in previous work on South African data for 1995–1996. It is natural to ask whether this contrast remains when one addresses various issues about robustness and arbitrariness.

The paper is organized as follows: in the first section, the various distinct issues raised by multi-dimensionality are discussed and elucidated in various contexts. The following section introduces the Anand–Sen family of measures and alternative approaches to ranking are introduced. Arbitrariness and robustness with respect to the choice of dimensions and weighting are examined in the South African context in the third section, and in the fourth section issues relating to the choice of the 'bottom line' in each dimension are addressed. The following section relates the analysis to policy issues, and the final section concludes.

Issues raised by the multi-dimensionality of poverty and well-being

General issues

There are numerous distinct issues relating to arbitrariness and robustness that are raised in the context of multi-dimensional measures of well-being and poverty. One can distinguish between issues that are dimension specific and those that relate to the variety of dimensions. Many issues that are dimension specific — such as how to define a 'bottom line' in some dimension of poverty — are closely related to those that arise in the income-based or expenditure-based uni-dimensional context.[1] Nevertheless, problems that arise because of the variety of dimensions involve formal and substantive issues that — while they may have been discussed in the context of income or expenditure poverty — often need to be dealt with in a more explicit manner in the multi-dimensional context.

To see how these problems arise in the context of poverty analysis it is worth considering the context in which multi-dimensional measures are being used. I distinguish two distinct contexts: (a) those involving *identification problems* — problems that relate primarily to the identification of the poor; and (b) those that arise when a particular group has been identified as poor or disadvantaged in some dimension. In either context, issues of arbitrariness and robustness can include those relating to: the weight attached to different dimensions of poverty; the weight given to the intensity or 'depth' of poverty in each dimension versus that given to the range of dimensions of poverty — its 'width'; the selection of dimensions of poverty; the choice of indicators used to proxy dimensions in any particular application; and the cut-offs used in each dimension or in the terms of any index that aggregates across dimensions or indicators.

In the cases of both the cut-offs used and the dimensions selected, there may be further issues about arbitrariness and robustness that can arise in attempts to address the vagueness or imprecision involved in poverty analysis. In this context, vagueness or fuzziness about the 'bottom line' in each dimension — sometimes called 'vertical vagueness' — can be distinguished from vagueness about the dimensions of well-being that are relevant to the poverty evaluation exercise — 'horizontal vagueness' (Qizilbash, 2003). In most exercises, where vertical vagueness is allowed for, there is some level of well-being above which a person is *definitely* not poor, and another below which the person is *definitely* poor. It can be argued that the way in which these levels are fixed is arbitrary. Issues relating to this potential arbitrariness have been raised and discussed in the fuzzy set theoretic poverty literature (Cerioli and Zani, 1990; Chiappero Martinetti, 1994, 1996, 2000; Cheli and Lemmi, 1995; Lelli, 2001).

Aside from these issues, there are other specific issues that relate to multi-dimensionality where the issue of arbitrariness is relevant. These issues can arise in different ways depending on whether or not one is focusing on identification problems. They are often hard to separate out in specific

contexts. To illustrate the nature of these general issues, I now discuss a number of distinct ways in which these can arise in different contexts.

Identification problems

Perhaps the most difficult issue raised by the multi-dimensionality of poverty relates to how to define or identify someone as poor, taking account of all the different dimensions of poverty and the various critical levels that might be selected. A growing literature that looks at the properties of multi-dimensional measures and rankings has begun to take on some of these issues explicitly (Tsui, 1997; Bourguignon and Chakravarty, 2002, 2003; Atkinson, 2003; *inter alia*).[2] There are numerous approaches to dealing with this identification problem. Some take it that some individual (or household) is poor if he/she (or it) is poor in *any* dimension of poverty (Brandolini and d'Alessio, 2001; Bourguignon and Chakravarty, 2003; *inter alia*).[3] An alternative solution to this problem would identify an individual (or household) as poor if he/she (or it) is poor in terms of *all* the specified dimensions.

Yet another possibility is to classify people (households) as poor if they are poor in terms of some overall index or average of indices relating to poverty (for example, Klasen, 1997, 2000). In this last case, a further 'bottom line' is usually specified in terms of the average, or relevant overall index used. In Stephan Klasen's application of the capability approach — which sees poverty in terms of an inability to achieve certain crucially important functionings, or 'basic capability failure' (Sen, 1993, 1999) — to the South African context (Klasen, 2000), two such 'bottom lines' are specified. One uses the bottom quintile in terms of his deprivation measure, which involves an unweighted average of various indices — while the other uses the bottom 40% in terms of that measure. In Klasen's application there is also the standard problem of the choice of weights that are assigned to specific dimensions if an overall index or average is used. However, this problem is quite distinct from both those involved in defining the bottom line in terms of each dimension and in defining the bottom line in terms of the average of indices (weighted or non-weighted).

In most applications of multi-dimensional approaches to identification problems, some of the relevant issues relating to arbitrariness and robustness are discussed, while others are not. For example, in Klasen's work while the issue of the relative weight given to different dimensions is discussed, the relative weight given to 'width' as opposed to 'depth', which is relevant, is not addressed. Similarly, while most of the issues that are relevant to identification and weighting are clearly distinguished by Bourguignon and Chakravarty (2003), the issue of vagueness is not addressed. Furthermore, it is only rarely the case that *theoretical* arguments are presented in favour of the actual approach that is taken in response to issues raised by identification problems in the multi-dimensional context. So, for example, Klasen uses an average of deprivation indices without much justification for the use of an averaging approach.[4]

The selection of dimensions is also clearly relevant to identification

problems. In most applications of the capability or basic needs frameworks, some fairly uncontroversial dimensions of well-being are selected. So, for example, in his application of the capability approach, Klasen invokes aspects of the quality of life, such as health, education, and so on. He uses data on people's perceptions or evaluations to justify the choice of dimensions selected (Klasen, 2000, p. 39). In justifying a more restricted set of dimensions for his 'core deprivation index' he refers to Sen's work, which provides the methodological grounding for his study. In the absence of such data or such a methodological base it is often not clear whether, or how, the approach taken to the choice of dimensions can be justified. It is certainly plausible to claim, in many cases, that the approach actually taken is *ad hoc*. In fact, often the best defence of the actual indicators selected relates purely to the limits of data availability.

Other contexts

While issues relating to identification problems are perhaps the most challenging ones raised by the literature on multi-dimensional poverty measurement, there are many contexts in which researchers, or policy-makers, are not trying, specifically, to *identify* the poor using a multi-dimensional approach. Problems of the sort just discussed can, nonetheless, arise in the context of data relating to how deprived people or households are in terms of particular dimensions. It is one such context of application — involving inter-provincial rankings — that I shall be concerned with in much of this paper. In this context, some group (such as those who are illiterate) has usually already been identified as deprived or poor in the specific dimension involved (such as education or knowledge). Indeed, in this context, often the only available published data are dimension-specific.[5] The central issue is about how to arrive at a more general judgement or measure of poverty on the basis of such data. It is this problem that is involved in constructing some multi-dimensional poverty measures — such as the UNDP's HPI. In this case too, issues about the choice of dimensions and the weights attached to the selected dimensions, as well as issues relating to 'width' and 'depth', and to horizontal and vertical vagueness, are relevant. So the broad range of issues is similar in the context of both identification problems and measures that use dimension-specific information.

The Anand–Sen family of measures and other approaches to ranking

To investigate these issues further, I focus on the Anand–Sen family of measures and one alternative method of ranking — the Borda score ranking method. This family of measures is defined by Anand and Sen in their work on the HPI, even though it is not referred to as a family of measures.[6] Anand and Sen (United Nations Development Programme, 1997, p. 117) term each component index a 'shortfall', and each shortfall is indexed i so that S_i is the

shortfall in terms of component i, for n dimensions, so that $i = 1, 2, \ldots, n$. The weights attached to these components are written w_i. The Anand–Sen family of measures is a weighted average of power α of these shortfalls. It is written $S(\alpha)$, where:

$$S(\alpha) = \left\{ \left(\sum_{i=1}^{n} w_i S_i \right)^{\alpha} / \left(\sum_{i=1}^{n} w_i \right) \right\}^{1/\alpha} \quad (1)$$

The UNDP's HPI is a special case of this family of indices. In the HPI, $n = 3$, equal weights are used and weights sum to 1 — so that each dimension is given a weight of 1/3 — and the value of α is set above 1. The motivation for setting the value of α above 1 is to allow for the 'depth' of a shortfall in terms of each component index to be picked up. An increase in a component index at a higher level of deprivation in terms of that index will register more than at a lower level with $\alpha > 1$. The value of α is actually set at 3 for HPI. If it had been set at 1, equation (1) would reduce to an arithmetic average. Many of the issues about arbitrariness that have already been discussed emerge in the use of this family of measures. Some of them can be easily separated out by looking at equation (1). They include specific aspects of this family of measures, such as the value of α, the value of w_i for each dimension and the selection of relevant 'shortfalls' as well as the cut-offs used to define 'shortfalls' in each dimension.

One further worry that is sometimes expressed about measures like the Anand–Sen family of measures is that they involve 'cardinal information' — information (in the poverty context) about the *levels* of shortfall in each dimension of poverty.[7] If there are consistent biases in the data, such measures might be misleading (Dasgupta, 1993, p. 109). So there is a case for looking at whether rankings based on this family of measures remain unaffected when some alternative method of ranking that does not use cardinal information is used. One popular alternative approach is the rank order method developed by the French mathematician Jean-Charles de Borda. This approach involves simply assigning a rank order score to each group (province, nation, etc.) being compared in terms of each component index. Adding up the rank order scores gives the 'Borda score'. Ranking groups according to this score gives the 'Borda ranking'. Unlike the Anand–Sen family of measures, this method relies exclusively on 'ordinal information' — in the sense that it only uses rank order scores. As a consequence, consistent biases in the data on specific dimensions have no impact on the Borda score if they leave rank orders in those dimensions unchanged. Clearly there are weighting issues relating to, and criticisms of, the Borda ranking (Qizilbash, 1997). However, in this paper, the use of the Borda ranking is limited. The Borda method serves as an alternative approach to ranking that can be compared with that emerging from the Anand–Sen family of measures.

Given the problems posed by arbitrariness, as well as issues relating to weighing, one approach to addressing these issues is to rely only on judgements that are invariant to all the possible choices of critical levels, dimensions or weights, and so on, used. This is the 'intersection' or 'domin-

ance' approach — associated with Amartya Sen (1992, pp. 47–49) — which has been very influential. While it has had considerable influence on the academic literature, this approach has had less impact on policy debates where specific weights and poverty lines are generally used.

Inter-provincial comparisons in South Africa: dimensions and weights

In illustrating how issues relating to arbitrariness and robustness can be addressed, I focus on the inter-provincial ranking as regards poverty in South Africa in 1995–1996. Before embarking on the specific ranking exercises, it is worth mentioning some claims in the related literature. In an influential paper, Klasen (2000) has argued — using data for 1993 — that there were more households living in capability poverty in KwaZulu-Natal than would emerge from an examination of income or expenditures alone. Qizilbash (2002) echoes this result using dimension specific data from the 1996 Census publications on the basis of an inter-provincial ranking using Borda's method: the multi-dimensional ranking based on a selection of quality of life indices gives a quite different ordering of the provinces as compared with the standard expenditure measure quoted in the Census publications. In particular, KwaZulu-Natal is among the worst three, while the Free State is among the three best in terms of the multi-dimensional ranking based on direct indices of the quality of life that relate to 'human' (rather than income or expenditure) poverty. This result suggests a quite different ranking of the South African provinces as regards 'human poverty' to that based on 'expenditure poverty', since the Free State is usually among the worst provinces in terms of expenditure poverty measures. The result can be seen in Table 1, where performance across the various provinces is presented for a range of indices. The expenditure index that Qizilbash (2002) uses is taken from Hirschowitz *et al*. (2000). It relates to the proportion of households in the worst-off category as regards household expenditures (i.e. households whose expenditure is between 0 and 600 Rands). This index can be criticized on the grounds that expenditures are not adjusted for household size. However, the result about the respective positions of the Free State and Kwazulu-Natal also emerges when expenditures are adjusted for household size (Leibbrandt and Woolard, 1999) and when the unit of accounting is the individual rather than the household (Ngwane *et al*., 2001) in the 1995 data. So, while the data in Table 1 are not adjusted for household size, there is nonetheless a significant difference in the pictures that emerge from examining expenditures as opposed to direct indices relating to poverty in 1995–1996.[8] It might be argued that the result about the Free State is not robust to the choice of poverty line or the specific expenditure poverty measure used. It turns out that the relative position of the Free State and KwaZulu-Natal does indeed depend on the specific poverty line selected when using 1993 data (Leibbrandt and Woolard, 1999, p. 48). However, as regards the 1995 data, Murray Leibbrandt and Ingrid Woolard conclude that "KwaZulu-Natal has the third lowest incidence of poverty" for the Foster, Greer and Thorbecke class of

Table 1. Headcount indices of poverty in various dimensions in South Africa 1996

Indicator	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Mpumalanga	Northern Cape	Limpopo	North West	Western Cape	South Africa
X	33.50	39.10	6.30	13.30	13.40	22.00	15.80	20.00	5.20	16.60
E(1)	20.93	16.13	9.47	22.91	29.45	21.69	36.87	22.66	6.75	19.33
U	48.55	29.96	28.21	39.11	32.91	28.53	46.04	37.95	17.87	33.89
C	38.05	9.27	0.93	29.72	26.00	18.54	63.65	20.73	4.54	23.05
W(1)	41.02	0.89	0.11	24.65	5.73	3.23	11.35	1.84	0.58	12.54
R(1)	22.03	5.68	2.59	11.49	8.99	4.40	17.58	7.20	2.12	9.70
P(1)	45.25	11.59	3.97	19.97	14.59	12.22	30.67	19.36	2.99	18.39
D	52.75	36.83	25.07	43.96	34.21	19.10	37.29	29.65	17.85	34.81
L	28.54	34.94	17.02	40.23	31.74	20.93	37.56	48.27	5.78	28.75
H	45.14	14.09	2.56	36.51	31.07	31.50	64.96	29.54	8.83	27.88
T	29.14	8.83	2.48	15.21	8.69	10.69	21.21	6.41	5.39	12.41

Key: X, the proportion of households with expenditure of 0–600 Rands (%); E(1), the proportion of adults over the age of 20 years with no schooling (%); U, the unemployment rate (%); C, the proportion of households that use wood for cooking (%); W(1), the proportion of households that gain access to water from a river, dam, spring or stream (%); R(1), the proportion of households with no rubbish disposal (%); P(1), the proportion of households with no access to a telephone (%); D, the proportion of the population that is either living in informal dwellings, traditional dwellings, caravans, tents or homeless (%); L, the proportion of households that use candles for lighting (%); H, the proportion of households that use wood for heating (%); T, the proportion of households with no toilet (%).

Sources: Statistics South Africa (1998, 2000, p. 63). (All unspecified or unstated categories have been excluded.)

poverty indices (Leibbrandt and Woolard, 1999, p. 52) — with only the Western Cape and Gauteng having a lower incidence — and that this result does not depend on the specific poverty line or measure used. So one must conclude that in 1995 expenditure poverty was higher in the Free State than in KwaZulu-Natal, and that this result is robust. Qizilbash's result thus suggests that the expenditure and human poverty pictures are quite different. However, this result emerges from a specific choice of indices and one particular method of ranking — the Borda score method. How robust is this result about the relative position of the Free State and KwaZulu-Natal in human and expenditure poverty rankings?

To pursue this question, I focus on indices that are listed in the publications that emerged from the 1996 South African Census. They relate to some of the standard dimensions invoked in multi-dimensional poverty measures. If the selection of indices appears arbitrary, it is worth noting that the use of some of these indices can be justified on the grounds that they relate to dimensions that are either prioritized, or identified as, components of a minimally adequate life by South Africans themselves (Klasen, 2000; Clark, 2002; Clark and Qizilbash, 2002). Some of the indices can also be justified using Sen's capability approach and other accounts of well-being. Related indices were used in Stephan Klasen's attempt to apply the capability approach to the South African context. Inevitably, since the same data are being used, some of these indices were also used by Qizilbash (2002). We would thus expect the contrast between human and expenditure poverty to

emerge for some combination of these indices. Qizilbash's result can then be checked for robustness by changing the indices, weights, cut-offs and so on that are used. If it persists when we address all the various issues relating to arbitrariness, we can conclude that the result is robust.[9]

The initial set of selected dimensions is kept fairly broad to allow for sensitivity analysis. It includes employment, health, access to clean water, shelter, knowledge, energy use, and participation in the life of the community. Some of these (such as knowledge) relate primarily to what are thought of as the constitutive elements of well-being, while others (such as energy use) relate mostly to the requirements of a good life.[10] As regards the 'bottom line' in terms of these dimensions, I make fairly arbitrary judgements in this section, and allow for different bottom lines in the next section. Specific indices need to be selected to proxy for these dimensions. In each case the chosen index is an imperfect proxy for the relevant dimension. The choice of index is constrained, as always, by the available data. So in the case of employment, the relevant index used is the rate of unemployment. In the case of water access, it is the proportion of the households whose access to water is from a dam, river, stream or spring. In the case of knowledge, the component index is the proportion of individuals older than 20 years of age with no schooling at all. In the case of health, there was no useful index in the Census publications, and an index relating to sanitation is used. This relates to the nature of a household's refuse removal, or lack of such removal. The index used is the proportion of households without any refuse removal at all. In the case of shelter, the relevant index was the proportion of households living in traditional dwellings, informal housing (shacks, etc.), caravans and tents, as well as the homeless. An indicator relating to the energy used for cooking is also included: the proportion of households that use wood for cooking. Finally, an index relating to engagement in social existence is included: the proportion of households with no access to a telephone. This indicator might be justified in terms of considerations relating to 'social exclusion'. It is related to, and a proxy for, the inability to participate in the life of the community. Of course, some might doubt that this indicator relates to 'basic capabilities' at all. Our intuitions about it might well be 'fuzzy', so that there is 'horizontal vagueness' about whether it really is 'basic' or not.

Each of these indices can be criticized and alternatives might be suggested. For example, access to a telephone might be regarded as a weak indicator for the ability to participate in the life of the community. Equally in some cases, such as sanitation, it might be argued that the index chosen is less good than an alternative that is available. It might be argued, for example, that the nature or absence of toilet facilities is a better index than the nature or absence of rubbish disposal. To address these worries, I check whether the choice of these indices matters. In Table 1, values for these indices are presented for each of the South African provinces as well as for the whole of South Africa. It is worth noting that the selected indices are close, but not identical, to those used by Qizilbash (2002). In that study, a

Table 2. The Anand–Sen family of measures for South Africa 1996

Measure	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Mpumalanga	Northern Cape	Limpopo	North West	Western Cape	South Africa
S(1)7	38.37	15.76	10.05	27.40	21.70	15.39	34.78	19.91	7.53	21.67
S(2)7	40.07	19.88	14.98	29.30	24.27	17.61	38.35	22.96	10.12	23.46
S(3)7	41.43	22.86	17.75	30.95	25.98	19.09	41.30	24.96	11.91	25.02
S(1)5	37.06	17.89	13.09	28.42	22.26	15.39	29.83	23.64	9.03	22.05
S(2)5	39.36	22.57	17.63	30.46	25.43	18.32	32.58	24.03	11.72	24.43
S(3)5	41.22	25.33	19.84	32.60	27.34	20.08	34.56	26.47	13.27	23.53
S(1)6	35.97	12.25	7.55	24.64	19.61	14.77	34.36	18.28	5.81	19.48
S(2)6	37.54	15.34	12.53	26.06	22.18	17.35	38.52	21.64	8.15	20.99
S(3)6	38.82	17.76	15.74	27.34	23.98	19.09	41.90	23.98	10.08	22.40
S(1)7′	49.41	24.17	13.26	38.04	32.58	22.12	49.50	33.10	11.17	30.44
S(2)7′	49.81	27.10	16.94	38.92	35.31	24.47	52.91	36.01	13.53	31.47
S(3)7′	50.24	28.95	19.10	39.79	37.67	26.60	56.08	38.63	15.05	32.82

Key: S(1)7, the Anand–Sen measure for an alpha value of 1 and seven indicators (%), etc.; S(1)5, the Anand–Sen measure for an alpha value of 1 and five indicators (%), etc.; S(1)6, the Anand–Sen measure for an alpha value of 1 and six indicators (%), etc.; S(1)7′, the Anand–Sen measure for an alpha value of 1 and seven indicators with 'soft' borderlines (%), etc.

different index was used for housing (rooms per household) and access to a telephone was not included.[11]

In Table 2, the Anand–Sen family of measures is given for values equal to 1, 2 and 3. As with the HPI, equal weights are used, and set at $1/n$. In the case where $\alpha = 1$, we simply have an arithmetic average of the indices; in the case where $\alpha = 3$, we have a local variant of the HPI. In the case where $\alpha = 2$, 'depth' is given more importance than in the arithmetic average, but less importance than in the variant of the HPI. The measures are calculated for the full list of seven indices as well for as a subset of five indices — relating exclusively to education, employment, access to clean water, rubbish disposal and shelter. In the shorter list, the indices relating to telephone access and energy use have been removed to address possible issues relating to horizontal vagueness, and to check for sensitivity to the choice of dimensions. The remaining indices relate to what may be considered to be the less controversial dimensions: health, employment, clean water, education, and shelter.

In Table 3, the rankings of provinces in terms of the Anand–Sen family of measures are shown alongside the ranking according to household expenditures. The rankings are presented so that the province that is doing worst (second worst, etc.) has a rank order of nine (eight, etc.). The province that is doing best thus has a rank order of one. In the case of ties, if any two provinces are doing worse than three (four, etc.) provinces, they both get a rank order of four (five, etc.).

It is noticeable from looking at the rankings that KwaZulu-Natal does worse than the Free State in terms of the Anand–Sen family of measures, for all values of α, and both selections of dimensions. This is not surprising because it does worse in terms of each of the component indices used. An elementary implication of this fact is that KwaZulu-Natal must do worse than

Table 3. Rank orders according to expenditure and the Anand–Sen family of measures

Measure	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Mpuma-langa	Northern Cape	Limpopo	North West	Western Cape
X	8	9	2	3	4	7	5	6	1
S(1)7	9	4	2	7	6	3	8	5	1
S(2)7	9	4	2	7	6	3	8	5	1
S(3)7	9	4	2	7	6	3	8	5	1
S(1)5	9	4	2	7	5	3	8	6	1
S(2)5	9	4	2	7	6	3	8	5	1
S(3)5	9	4	2	7	6	3	8	5	1
S(1)6	9	3	2	7	6	4	8	5	1
S(2)6	8	3	2	7	6	4	9	5	1
S(3)6	8	3	2	7	5	4	9	5	1
S(1)7′	8	4	2	7	5	3	9	6	1
S(2)7′	8	4	2	7	5	3	9	6	1
S(3)7′	8	4	2	7	5	3	9	6	1

Key: X, rank order for expenditure poverty; S(1)7, rank order for the Anand-Sen measure for an alpha value of 1 and seven indicators, etc.; S(1)5, rank order for the Anand-Sen measure for an alpha value of 1 and five indicators, etc.; S(1)6, rank order for the Anand-Sen measure for an alpha value of 1 and six indicators, etc.; S(1)7′, rank order for the Anand-Sen measure for an alpha value of 1 and seven indicators with 'soft' borderlines, etc.

the Free State *whatever* the weights assigned to the different dimensions. In this case, then, Sen's 'intersection' approach is useful and we have a robust ranking of these provinces.

It might be argued that the contrast between the human and expenditure poverty performances of KwaZulu-Natal and the Free State may depend not so much on the *dimensions* selected, but rather on the particular indicators chosen for each dimension. While there are no obvious alternatives for some of the indicators used (such as unemployment), in the case of two of the seven indicators used there are plausible alternatives that might be used. In the case of energy use, it might be argued that energy used for lighting and for heating are alternatives to energy used for cooking. In this context, the proportion of households that use candles for lighting and the proportion using wood for heating are listed in the 1996 Census publications. In the case of sanitation, as has already been mentioned, it can be argued that the nature or absence of toilet facilities might be an alternative to the index relating to rubbish disposal. The proportion of households with no toilet is a plausible alternative to the proportion of the households without any rubbish disposal. These alternative indices are also presented in Table 1. Clearly, KwaZulu-Natal is doing worse than Free State in terms of all indices. Thus, using these indices does not affect the performance of the two provinces in terms of the Anand–Sen measures.[12]

What of the ranking of the remaining provinces? In all cases the worst three are: the Eastern Cape, Limpopo[13] and KwaZulu-Natal. While the Eastern Cape does worse than Limpopo irrespective of the dimensions used and for the various chosen levels of α, the ranking might easily switch if more weight is given to education, since Limpopo performs much worse than the Eastern

Cape in terms of this dimension. As regards the provinces that are doing best, the Western Cape, Gauteng, the Northern Cape and the Free State are invariably, respectively, first, second, third and fourth best. The position of the Free State is much better than in most expenditure-based rankings, although it is not third best (as in Qizilbash, 2002). The Northern Cape also clearly does better in the ranking according to the Anand–Sen measures (with a rank order of three) than it does in the expenditure ranking (where it has a rank order of seven). For many of the provinces in the 'middle' of the ranking — Mpumalanga, North West, Northern Cape and the Free State — the values of the Anand–Sen family of measures are relatively 'close', suggesting that relatively small changes in the weights attached to the different dimensions would change the orderings. So the rankings of these provinces are not particularly robust. It is easy to check this by assigning a considerably higher weight to one of the dimensions and comparing the resulting values of the indices for these provinces. As regards the difference between using five and seven indicators, the comparison between Mpumalanga and North West hinges on this, with North West doing worse when five indices are used and $\alpha = 1$.

How do these rankings compare with the Borda rankings based on the same indices? In applying Borda's method of ranking here, the province that is doing worst (second worst, etc.) in terms of a particular index is given a rank order score of nine (eight, etc.) except in the case of a tie. In the case of a tie, if any two provinces are doing worse than three (four, etc.) provinces, they both get a rank order of four (five, etc.). The sum of the rank order scores is the Borda score, and the ranking based on it is the Borda ranking. In the Borda ranking, the same method (i.e. that used for the particular indices) is used for assigning rank orders. The Borda score and the Borda ranking using all seven indices, as well as that based on just five indices, are presented in Table 4. The ranking of the provinces is much the same as that based on the Anand–Sen family of measures. The only difference between the Borda rankings using seven indices rather than the subset of five indices is that the Free State and the Northern Cape are tied in 'third best' place if we use the full set of indices, while the Northern Cape beats the Free State to third best when one looks only at the subset of five indices. So the overall ranking of the provinces in terms of human poverty is fairly robust. In particular, KwaZulu-Natal is third worst (and thus has a rank order of seven) in terms of *all* the ranking exercises just discussed. The contrast with Leibbrandt and Woolard's result that KwaZulu-Natal has the third lowest level of (expenditure or income) poverty in terms of the Foster, Greer and Thorbecke class of measures is striking.

Inter-provincial comparisons and the choice of 'bottom line'

Thus far, I have set to one side any worries about robustness to how one defines the 'bottom line.' Vagueness or imprecision about this 'bottom line' has been the focus of the fuzzy set theoretic poverty literature, as well as of the literature on uncertainty about the 'true' poverty line, when data is

Table 4. Rank orders for indicators, Borda score and Borda ranking for South Africa in 1996

Indicator	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Mpuma-langa	Northern Cape	Limpopo	North West	Western Cape
E(1)	4	3	2	7	8	5	9	6	1
U	9	4	2	7	5	3	8	6	1
C	8	3	1	7	6	4	9	5	2
W(1)	9	3	1	8	6	5	7	4	2
R(1)	9	4	2	7	6	3	8	5	1
P(1)	9	3	2	7	5	4	8	6	1
D	9	6	3	8	5	2	7	4	1
Borda score (7)	57	26	13	51	41	26	56	36	10
Borda rank (7)	9	3	2	7	6	3	8	5	1
Borda score (5)	40	20	10	37	30	18	39	25	7
Borda rank (5)	9	4	2	7	6	3	8	5	1
Borda score (6)	48	20	10	43	36	24	49	32	9
Borda rank (6)	8	3	2	7	6	4	9	5	1

Key: E(1), the proportion of adults over the age of 20 with no schooling; U, the unemployment rate; C, the proportion of households that use wood for cooking; W(1), the proportion of households that gain access to water from a river, dam, spring or stream; R(1), the proportion of households with no rubbish disposal; P(1), the proportion of households with no access to a telephone; D, the proportion of the population living in informal dwellings, traditional dwellings, caravans, tents or homeless; Borda score (7), E(1) + U + C + W(1) + R(1) + P(1) + D; Borda score (5), E(1) + U + W(1) + R(1) + D; Borda score (6), E(1) + U + C + W(1) + R(1) + P(1); Borda rank (7), rank order according to Borda score (7); Borda rank (5), rank order according to Borda score (5); Borda rank (6), rank order according to Borda score (6).

'noisy' (Ravallion, 1994). In related work, Qizilbash (2002) used an approach due to Cheli and Lemmi (1995) to define the boundaries of the zone of vagueness or 'fuzziness' in combination with data from the 1996 South African Census to rank the provinces of South Africa in terms of 'definite poverty'. The Cheli and Lemmi approach attempts to respond to worries about arbitrariness in the context of vertical vagueness — particularly those associated with a measure developed by Cerioli and Zani (1990) — by only treating the worst-off category for each dimension in the sample as definitely poor, and treating the best-off group in the sample as definitely not poor. If one were to use this methodology and focus exclusively on those who are definitely poor, one would have to amend at least one of the cut-offs that was used earlier: that relating to the shelter indicator. Indeed, only those who are in the worst-off category in this dimension (i.e. the homeless) would count as definitely poor in this dimension on the Cheli and Lemmi methodology. In related work, Clark and Qizilbash (2002) also argue, on the basis of a recent survey on 'The Essentials of Life', that a not insignificant proportion of people interviewed in three locations in South Africa thought that someone could get by with just about any sort of dwelling or access to water.[14] They conclude that if we are to define 'bottom lines' in terms of the views of ordinary South Africans, and to allow cut-offs as acceptable or 'admissible' if they are endorsed by a not insignificant proportion of South Africans, only those who have no access to water *at all* — even from a dam, stream, etc.— are definitely poor in the dimension of water access. Similarly,

they conclude that only those with no dwelling (the homeless) are definitely poor in terms of shelter. In this case, their methodology echoes the Cheli and Lemmi methodology. The remaining cut-offs used in the previous section are consistent with both the Cheli and Lemmi methodology and the results reported by Clark and Qizilbash (2002).[15]

If we follow these suggestions and 'toughen' the 'bottom lines' used in conjunction with the indices from the 1996 Census, then only a tiny proportion (either zero or very close to zero) are definitely poor in the dimensions of shelter and access to water. On this basis, we might exclude indices relating to these dimensions in ranking the provinces in terms of poverty. In the case of shelter, the only people who would count as poor would be the homeless. Since the percentage of the population that is homeless rounds to zero for each province, there is a case for excluding this variable in comparisons between the provinces. As regards water, however, only defining those who have no access to water as poor involves effectively saying that anyone with *any* access to water is non-poor in this dimension in the present context. This is not implied in Clark and Qizilbash's work because they allow for vagueness about the borderline between the poor and the non-poor. In the context of this paper, it seems implausible to treat those with *any* access to water as non-poor in this dimension. So I stick to the original cut-off used in this case. The effect of 'toughening' the borderlines is thus only to remove the shelter variable.

The values for the Anand–Sen family of measures for the remaining six indices is presented in Table 2, and the ranking based on these measures is presented in Table 3. The Borda scores and ranking based on these six indices are presented in Table 4. While the ranking based on the Anand–Sen family of measures is not very different, it is noticeable that Limpopo takes over from the Eastern Cape as the worst province if enough weight is given to 'depth'. KwaZulu-Natal remains third worst, and is consistently worse than the Free State. The Free State does better than the Northern Cape for all values of α, while Mpumalanga and the North West are equally bad if enough weight is given to 'depth' (with Mpumaplanga doing worse otherwise). The results about the relative positions of Limpopo, the Eastern Cape and KwaZulu-Natal are echoed in the Borda ranking that only looks at the six indicators. In the Borda ranking, the Free State is third best (echoing the result in Qizilbash, 2002).

It is also worth noting some implications of 'softening' the bottom lines used. So, in Table 5, headcount indices relating to all seven dimensions are included. In a number of cases, the 'cut-off' has been set less stringently than before. In the case of education those who have begun, but not completed, primary education are included. As regards energy used for cooking, all those who use dung for cooking are now included. In the case of water, those with access from a well, rainwater tank or borehole are also included. As regards access to a telephone, those who only have access to a phone at some distance are now included. In the case of rubbish disposal, those who have their own refuse dump are now included. In the remaining

Table 5. Headcount poverty indices using 'soft borderlines' in various dimensions in South Africa 1996

Indicator	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Mpumalanga	Northern Cape	Limpopo	North West	Western Cape	South Africa
E(2)	42.46	38.55	21.15	40.80	44.60	42.68	48.92	43.14	22.40	36.03
U	48.55	29.96	28.21	39.11	32.91	28.53	46.04	37.95	17.97	33.89
C(2)	43.44	10.82	0.94	30.36	26.48	18.60	64.17	21.59	4.54	24.22
W(2)	44.89	4.21	1.79	31.43	12.41	7.30	21.29	12.94	1.42	17.50
R(2)	62.12	30.49	9.97	52.91	56.48	24.09	84.73	59.53	9.91	42.35
P(2)	51.64	18.34	5.71	27.72	20.98	14.52	44.08	27.26	4.13	24.27
D	52.75	36.83	25.07	43.96	34.21	19.10	37.29	29.29	17.85	34.81

Key: E(2), the proportion of adults over the age of 20 years with either schooling or that have not completed primary education (%); U, the unemployment rate (%); C(2), the proportion of households that use wood or dung for cooking (%); W(2), the proportion of households that gain access to water from a river, dam, spring, stream, well, rainwater tank or borehole (%); R(2), the proportion of households with no rubbish disposal or own rubbish dump (%); P(2), the proportion of households with either no access to a telephone or access to a telephone at some distance (%); D, the proportion of the population living in informal dwellings, traditional dwellings, caravans, tents or homeless (%).

Source: Statistics South Africa (1998). (All unspecified or unstated categories have been excluded.)

two cases (shelter and employment), the cut-offs used in the previous section are adopted.

Values of the Anand–Sen family of measures with $\alpha = 1$, 2 and 3 for these indicators are presented in Table 2 and the rankings of provinces are presented in Table 3. It is noticeable that Limpopo is worse than the Eastern Cape for all choices of α. Similarly, the Free State is doing worse than the Northern Cape. Since the values of the Anand–Sen family of measures are relatively 'close' for all values of α in both comparisons, the use of different weights for specific dimensions might reverse these results. The positions of the various provinces is, nonetheless, not affected by the weight given to 'depth'. Again, as in all the previous rankings, KwaZulu-Natal is third worst. The Borda ranking based on these indicators is presented in Table 6. In the Borda ranking the Free State is fourth best. However, the Eastern Cape is now doing worse than Limpopo, while the North West is doing worse than Mpumalanga. Otherwise, the ranking is much the same as that based on the Anand–Sen family of measures. In particular, KwaZulu-Natal remains third worst. Finally, it is worth noting that while I have mentioned various rank order changes, the overall picture of the rankings of the provinces based on the Anand–Sen measures presented in Table 3 is fairly stable. The striking contrast is not between rankings based on these measures for different cut-off and selections of indices: it is between the ranking based on household expenditures and those based on the multi-dimensional human poverty rankings. This observation clearly supports the earlier results in Klasen (2000) and Qizilbash (2002).

Policy relevance

Issues relating to robustness and arbitrariness are relevant to policy at a number of levels. On the one hand, composite multi-dimensional indices —

Table 6. Rank orders for indicators, Borda score and Borda ranking using 'soft borderlines' for South Africa in 1996

Indicator	Eastern Cape	Free State	Gauteng	KwaZulu-Natal	Mpumalanga	Northern Cape	Limpopo	North West	Western Cape
E(2)	5	3	1	4	8	6	9	7	2
U	9	4	2	7	5	3	8	6	1
C(2)	8	3	1	7	6	4	9	5	2
W(2)	9	3	2	8	5	4	7	6	1
R(2)	8	4	2	5	6	3	9	7	1
P(2)	9	4	2	7	5	3	8	6	1
D	9	6	3	8	5	2	7	4	1
Borda score	57	27	13	46	40	25	57	41	9
Borda rank	8	4	2	7	5	3	8	6	1

Key: E(1), the proportion of adults over the age of 20 years with either no schooling or with some but not complete primary education; U, the unemployment rate; C(2), the proportion of households that use wood or dung for cooking; W(2), the proportion of households that gain access to water from a river, dam, spring, stream, well, rainwater tank or borehole; R(2), the proportion of households with no rubbish disposal or own rubbish dump; P(2), the proportion of households with either no access to a telephone or access to a telephone at some distance; D, the proportion of the population living in informal dwellings, traditional dwellings, caravans, tents or homeless; Borda score, E(2) + U + C(2) + W(2) + R(2) + P(2) + D; Borda rank, rank order according to the Borda score.

like the human development index and the Anand–Sen family of measures — are attractive for policy-makers, because they summarize information in one number. On the other hand, these indices can be criticized on the grounds that specific underlying evaluative judgements about weights and components indices are made. There is then a question about whether such indices can still be useful for practical purposes when one addresses concerns relating to weights and other issues involving arbitrariness.

The contrast between income and human poverty is also highly relevant to policy. In the South African context, Qizilbash (2002, pp. 768–770) argues that this contrast is relevant to the distribution of poverty reduction grants. This argument is made in the context of a discussion of Hirschowitz *et al.*, who wrote that:

> [t]he department of Constitutional Development makes 'equitable share allocations' to the local authorities. These include among other funds to be phased in over time, a basic services (S), and an institution building (I) grant. The S grant supports the ability of municipalities to supply services to the poor. The approach is to estimate the number of poor households, defined as those earning less than R800 (1998 Rand values) a month, and to allocate a subsidy to each municipality for each household (in 1998 the amount per poor household was R86 per month). (2000, p. 81)

Qizilbash (2002) suggests that, in the light of the result about the difference between the income and human poverty pictures across the provinces, a policy based on looking at household expenditures alone could have very

different implications to one that focused on human poverty. In particular, KwaZulu-Natal would do better than the Free State as regards the distribution of poverty alleviation grants if the policy were based on a multi-dimensional human poverty measures rather than expenditure-based measures. It is significant, at the policy level, that this claim is based on a contrast between the human and expenditure poverty pictures that is robust.

There may, nonetheless, be worries about making policy judgements when the ranking is not robust. Should worries about lack of robustness to lead us to restrict the use of multi-dimensional measures and rankings at the policy level? It is not obvious that they should. Again to make the case, I shall illustrate the argument in the South African context. It might be argued, for example, that when the values of the Anand–Sen measures are 'close' on virtually all alternative choices of cut-offs, dimensions and weights, it may be perfectly sensible to give the relevant provinces the same level of funding per household. This would be true in the case of the Free State and the Northern Cape and that of Mpumalanga and the North West. Alternatively, in cases where the ranking is not robust, one might suppose that in such cases the larger share of funds per household might be allocated to the province with the most 'definite poverty'. This could be the province that has the highest level of poverty using the narrowest range of dimensions or the one with the highest level of poverty when the 'toughest' cut-offs are used. In the first case, the policy would favour the Eastern Cape, while in the latter it would favour Limpopo if enough weight were given to 'depth'. However, it is not obvious whether a 'tough stance' ought to favour restricting the dimensions used, or tightening the borderlines for particular indices, or *both*. Being 'tough' about both the selected dimensions and the borderlines used may lead to a more determinate conclusion as regards policy. Furthermore, policy-makers who take a 'tough stance' may take some view of the relative importance to be given to width as compared with depth. Which approach is taken will thus depend on the judgements of policy-makers. The key point is that addressing issues relating to robustness discussed earlier can lead to specific kinds of policies being adopted. They can thus inform policy, rather than merely posing a difficulty for policy-makers.

There are other well-known arguments about the implications of multi-dimensional human poverty approaches for policy. They relate (among other things) to the identification of the poor and the nature of programs that aim to eradicate poverty. For example, it is sometimes argued that looking at performance across the dimensions of poverty might help to pinpoint the sort of intervention that might be most suitable. Focusing on income or expenditures alone may not be very informative in this context. There may, however, be more specific implications of the contrast between the income and human poverty pictures. In the South African case, for example, it is not obvious from looking at the rankings why the remarkably robust result about KwaZulu-Natal and the Free State emerges. One might conjecture that the underlying reason for the result is that public services in the Free State are superior to those in KwaZulu-Natal. The policy implication would be that

public services in KwaZulu-Natal need to be improved. While this argument is based on a conjecture, it illustrates the policy relevance of the sorts of ranking exercises carried out in this paper.

Conclusions

There are several distinct issues that relate to arbitrariness and robustness involved in any framework for multi-dimensional poverty measurement and ranking. In this paper, while identification problems are discussed, the focus has not been on such problems. Instead, it has been on the use of measures and rankings based on dimension-specific data using the Anand–Sen family of measures and the Borda score. It is often argued that such measures and rankings are arbitrary because of the specific weights given to different dimensions and indicators. In this paper, this issue is distinguished from other issues that relate to arbitrariness and robustness. To illustrate the distinct issues, the inter-provincial ranking of South African provinces in 1995–1996 has been examined. It turns out that the inter-provincial poverty rankings based on the Anand–Sen family of measures and the Borda score are fairly robust. In particular, the results confirm a claim in the related literature about the positions of the Free State and KwaZulu-Natal in inter-provincial rankings in expenditure and human poverty rankings. This claim is robust to the choice of dimensions, the selection of 'bottom lines' and various alternative weights (involving both the different components of the measures and the relative importance given to 'depth' and 'width'). Even when rankings are not robust, furthermore, the discussion suggests ways in which multi-dimensional rankings can be informative for policy purposes. While the arguments in this paper have been illustrated in the South African context, they are equally relevant to inter-provincial poverty rankings in other countries, as well as to international poverty comparisons, since much the same issues about robustness and arbitrariness emerge in those contexts.

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Notes

1 Issues about the selection of poverty line and imprecision that have arisen in the context of income and expenditure measures are discussed by Atkinson (1987), Foster and Shorrocks (1988) and Ravallion (1994), *inter alia*.

2 There is a related literature about the measurement of multidimensional inequality, which includes Maasoumi (1986) and Atkinson and Bourguignon (1987).
3 Clark and Qizilbash (2002) use a similar methodology, except that they allow a person (household) to be 'core poor' if she (it) is poor on a 'core dimension', a dimension that is part of any way of specifying the notion of poverty. This methodology allows for horizontal vagueness.
4 Klasen does, nonetheless, test for sensitivity of the weighting scheme adopted and argues that his results — which focus on an unweighted average of indices — are robust to the choice of an alternative averaging scheme, which uses principal-component analysis. So Klasen does test for robustness at that level.
5 Dutta *et al*. (2003) discuss the relation between measures that use, and combine, dimension-specific 'aggregate' data and measures that begin with observations on individuals and households, and aggregate that information. They argue that measures that begin with aggregate data will very rarely lead to the same picture of poverty as those that begin with individual or household data.
6 It is important to clarify here that while the HPI is now thought of in terms of the specific indices that the UNDP have developed (HPI-1 for developing countries and HPI-2 for developed countries), in the relevant technical note in the UNDP's *Human Development Report 1997* Anand and Sen describe the equation that (in this paper) defines the Anand–Sen family of measures as "a more general definition of the human poverty index ... than that used in this Report" (UNDP, 1997, p. 117).
7 Of course, there are other potential problems with such measures. Majumdar and Subramanian (2001) develop a measure that adjusts for inequality and apply their approach in the context of the interprovincial picture of poverty in India.
8 KwaZulu-Natal, nonetheless, has one of the highest *shares* of expenditure poverty, given its population size.
9 It might be argued that this paper does not consider every possible combination of weights, measures, etc. in checking for the robustness of a comparison or ranking. In the end, this is a matter of judgement. If a result survives in a wide range of plausible combinations — such as those that have been examined in this paper — my suggestion is that it can be judged to be robust.
10 This is not to say that any one of the dimensions relates *exclusively* to ends that are constitutive of a good life or means to achieving that life. Knowledge can, for example, be both a means and an end.
11 The figures used for unemployment in that paper are also different. In this paper, the standard figures for unemployment are used.
12 It is also easy to check that the use of these indicators does not affect the position of the two provinces when one uses the Borda score. As regards the results in the fourth section, in the case of sanitation — where there may be a case for preferring an index relating to toilet facilities — it can be easily checked that this result remains robust even if the 'bottom line' is 'softened' to allow those who use a bucket latrine as well as those who have no toilet as poor. This is so for values of $\alpha = 1$, 2 and 3 for the Anand–Sen family of measures as well as for the Borda score.
13 Throughout the paper I use 'Limpopo', which is the current name for the province previously known as the Northern Province.
14 Clark and Qizilbash (2002) use "at least 5%" as the crucial cut-off for a "not insignificant" proportion of the sample they are concerned with.
15 In Clark and Qizilbash's approach to dealing with 'horizontal vagueness', certain dimensions of poverty are classified as *core*. These are thought of as dimensions that are components of poverty, however the notion of poverty is specified. In their work neither energy use nor participation in the life of the community emerge as core. The exclusion of these two dimensions in the previous section to allow for concerns relating to horizontal vagueness is thus consistent with the results in that paper.

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