Poor, multidimensionally speaking: Evidence from South Africa

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Abstract

There is an expanding literature on multidimensional poverty measurement. Even though the theoretical foundations of the field are well-developed, there are only a few empirical papers on developing countries, especially on the comparison of different measures. This paper applies a decomposable multidimensional measure developed by Alkire and Foster (2007) to a cross-sectional dataset on South Africa. This measure allows for decomposition of final outcome into the dimensions used. Furthermore, South Africa provides an interesting case study as the country is renowned for its high income-inequality rate. The contribution of the paper is to draw significant policy implications when a decomposable multidimensional measure is used as opposed to measures that are either multidimensional but not dimensionally decomposable or unidimensional. Specifically, it evaluates the current policy-making mechanism in South Africa at the provincial level and suggests further improvements by using the Alkire-Foster measure.

JEL Classification: I3, I32. O1

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1 Introduction

Even if attempts to quantify poverty date back to the beginning of the last century (Rowntree, 1901), it is relatively new to investigate deprivation as a multidimensional phenomenon rather than a unidimensional one based on income (and later, expenditure) data. As pioneers such as Amartya Sen stresses in his work (Sen 1976, 1982, 1985, 1992), the well-being of an individual cannot merely be explained by the income of that individual. The assumptions such as specification of cardinal utility functions, complete markets (Bourguignon and Chakravarty, 2003), no externalities or public goods and no increasing returns to scale should all hold for income to be a robust indicator of individual welfare (Klasen, 2000). Furthermore, the policy implications of unidimensional measures are limited as they provide limited information about the standard of living in a particular context.

This paper has two main contributions: investigating the provincial deprivation rankings obtained by using three families of poverty measures and developing a revenue allocation framework that suggest precise revenue allocations for each of the ten well-being dimensions considered in the South African context. Alkire and Foster (2007) (AF measure, henceforth) have developed a family of decomposable multidimensional measures analogous to the Foster, Greer and Thorbecke (1984) family (FGT measure, henceforth). In addition to these two families, this paper investigates the Anand-Sen (AS measure, henceforth) family of measures (of which Human Poverty Index [HPI] is a special case) to rank the nine provinces of South Africa based on their deprivation levels. A number of previous studies on poverty and inequality decomposition in South African context proved to be useful for policy-making purposes (see, for example, Liebbrandt *et al.* [2000] and Alderman *et al.* [2003]) and this paper applies another decomposition method with direct policy implications. Each measure suggests different, albeit similar, rankings where the difference is less significant between the two multidimensional measures.

Furthermore, a framework based on the AF measure has been developed in order to allocate provincial revenues. Revenue allocations across South Africa in line with the Provincial Equitable Shares (PES) scheme have been compared with the allocations suggested by a framework developed here based on the AF measure. Finally, policy-implications of the scheme based on the AF measure have been further evaluated at the provincial-governance level. This exercise allows us to check the value-added of a decomposable

multidimensional measure. The ability to decompose the results according to the well-being dimensions, provinces and population groups was a significant feature of the AF measure that allowed us to derive precise policy implications and revenue allocation schemes.

Streeten (1981) pioneered the Basic Needs Approach (BNA) where he suggests five dimensions of development. These dimensions make up the entire list of "core" dimensions and half of the list of "extended" dimensions used in this paper. Amartya Sen's Capability Approach (Sen, 1999) stresses the fact that there is more to poverty than lack of income and has often been used in the literature as the underlying framework of multidimensional poverty analysis (see, for example, Klasen [2000]). I have benefited from both[1] of these schools of thought in selecting dimensions and indicators. I have also employed the Principal Component Analysis (PCA) to assign dimension weights based on the empirical relationship between dimensions and the deprivation measure. The principal component is the background variable contained in all dimensions that accounts for the largest variance in all ten dimensions used here.

The Millennium Development Goals (MDGs) provide a framework used to stimulate attention and guidance for the poverty reduction process all over the world. There are eight main goals which can be divided into numerous targets and indicators, all aiming to halve the different aspects of poverty by the year 2015 (The United Nations Development Report 2008). This framework has also influenced the selection of a number of cutoffs in this paper, with a view to increasing the comparability of this study with other empirical work (see, for example, Klasen [2008]).

[1] "Human development, initiated by the UNDP in its 1 990 Human Development Report, brought together ideas from the BNA and from capabilities and people previously involved in each worked on the first report - Amartya Sen representing the capabilities approach; and Mahbub ul-Haq, Gustav Ranis, Frances Stewart and Paul Streeten the BNA. The human development approach has the virtues of both - the immediacy and pragmaticism of BNA and the elegance of the capabilities appraoch. It is noteworthy, however, that the human development alone did not seem to impart the urgency needed, and so the Social Summit endorsed a set of objectives, which became the Millenium Development Goals, bringing a BN type of approach to the fore again." Frances Stewart, Elgar Companion to Development Studies, pp. 18.

2 Families of Poverty Measures

2.1 Foster,Greer and Thorbecke (1984) Family

Motivated by the importance of decomposability for policy-makers, the FGT measure uses the deprivation gap of each individual as her shortfall weight and can be generalised as:

$$P_\alpha(y;f) = \frac{1}{N}\sum_{i=1}^{q}(\frac{f-y_i}{f})^\alpha \qquad (1)$$

where P_α is the generalised FGT measure,α is the power of the FGT measure used, Y is the $q \times 1$ achievement vector where y_i is the achievement (expenditure) of household i ($i = 1, ..., q$), f is the predetermined poverty line (cut-off level), $q = q(y; f)$ is the number of poor households, and $N = N(y)$ is the total number of households (where $q \leq N$). y can be broken down into subgroup income vectors $y^{(1)}, ..., y^{(m)}$,

$$P_\alpha(y;f) = \sum_{j=1}^{m}\frac{N_j}{N}P_\alpha(y^{(j)};f) \qquad (2)$$

The quantity $\frac{N_j}{N}P_\alpha(y^{(j)};f)$ can be interpreted as the total contribution of subgroup j to overall poverty. Depending on the non-negative value that α takes, the FGT measures take different names and satisfy different axioms. If $\alpha = 0$, the headcount ratio (H), which shows the share of poor individuals in the total population, can be obtained. When $\alpha = 1$, equation (1) reduces to the normalised poverty gap (G), which sums up the individual deprivations and divides the result by the product of total population and the poverty line. If $\alpha = 2$ is chosen, the average of squared normalised shortfalls, P_2, is the result.

All FGT measures satisfy core axioms (such as decomposability, symmetry, replication invariance and subgroup inconsistency). In this paper, expenditure of households on transport, housing, clothing, food, personal appearance and "other" items (for the month before the survey was held) have been summed up as an overall cardinal 'expenditure' variable to which three traditional FGT measures have been applied for comparison purposes.

2.2 Anand and Sen (2003) Family

The second measure of interest is the Anand-Sen family of measures, which allows for multidimensionality but is not decomposable. Following the technical notes of *Human Development Report 1997* which have been further exploited by Anand and Sen (2003)[2], the AS measure (see Qizilbash 2004) can be written as follows :

$$AS(\theta) = \left(\frac{\sum_{d=1}^{D} (w_d P_d^{\theta})}{\sum_{d=1}^{D} w_d} \right)^{\frac{1}{\theta}} \qquad (3)$$

where P_d is the headcount ratio of dimension d ($d = 1, ..., D$), w_d is the weight assigned to dimension d and θ is the power of the AS measure. The Human Poverty Index is the power mean of order three of the AS measure.

2.3 Alkire and Foster (2007) Family

Before moving on to the next family of measures, it may be useful to summarise the identification procedure in a multidimensional setting. There are three approaches associated with the identification of poor households in the presence of multidimensionality. These are the union, intersection and counting approaches[3]. Let k be the 'across-dimension cut-off' (where $k = 1, ..., D$). That is, k shows the total number of dimensions a household should be deprived in, in order to be considered multidimensionally poor. The union approach is when $k = 1$. This approach is seen as over-inclusive[4] by Alkire

[2]Anand and Sen (2003) draw on the notion that a measure should focus merely on the poor for a better accounting of the development process, so that "lack of progress in reducing the disadvantages of the deprived cannot be 'washed away' by large advances – no matter how large – by the better-off people". In addition, as the income dimension by itself is not capable of representing the vital aspects that have a crucial impact on the living standard of the individuals, multidimensionality was a need rather than a luxury. This deprivation-based approach has led to HPI, which is criticised for its arbitrariness (Krishnaji 1997, Bibi 2002). Along the same lines, Sen himself accepts the "vulgarity" of the Human Development Index but claims that the reason for that vulgarity, its simplicity, is also its main attraction (Qizilbash 2006, pp.248).

[3]HPI is an example (implicitly) of the union approach, in terms of the identification criterion, where an unit of observation is considered as poor if it is deprived in at least one dimension.

[4]Furthermore, in general, not all dimensions are equally crucial for the overall poverty aggregation, especially as the number of dimensions increases.

and Foster (2007) since an individual may be deprived in a certain dimension due to personal reasons (norms, beliefs etc.) rather than lack of opportunity (Alkire and Foster, 2007). On the other hand, the intersection approach is when an household is considered as poor if the household is deprived in all the dimensions that are considered (i.e. $k = D$). Analogously, this approach is seen as under-inclusive by Alkire and Foster (2007), as deprivation in certain dimensions may be enough to have a standard of life that is unacceptable. Finally, the Alkire-Foster (AF) measure offers us the option to pick an intermediate across-dimension cut-off ($1 \leq k \leq D$) which is called the counting approach.

Following the standard notation in the literature (see Alkire and Foster, 2007), the set up consists of an $N \times D$ achievement matrix X where a typical element of this achievement matrix[5], x_{id}, indicates the achievement of household i ($i = 1, ..., N$) in dimension d ($d = 1, ..., D$), given $D \geq 2$. The cut-off vector Z is a $1 \times D$ vector where z_d is the 'within-dimension cut-off level' for dimension d, which separates poor households (with $x_{id} < z_d$) from non-poor ones (with $x_{id} \geq z_d$). A dictomised deprivation matrix g^0 can be obtained by using binary values 0 (if $x_{id} \geq z_d$) and 1(if $x_{id} < z_d$).

Many poverty measures require cardinal data, which leads to a cardinalisation of ordinal data that does not have an absolute zero. However, the AF measure uses a dictomisation[6] technique for a robust treatment of ordinal data[7]. Consequently, a separate $N \times 1$ column vector C is used to accumulate the information on individual deprivations across dimensions. A typical element of this vector, c_i, indicates the total number of deprivations

[5]The row vector $x_{i:}$ corresponds to the achievements of household i in each dimension whereas the column vector $x_{:d}$ shows each individual achievement in a particular dimension d.

[6]This comes at a cost, as the poverty gap information (distance between the individual achievement level and the cut-off) is forgone. For example, in this paper, a household with a house made of mud and cement has received the same treatment with a household which has a house made of mud only – they are both poor. Likewise, a household with a house made of bricks has been treated as non-poor just as one living in a house made of zinc.

[7]If cardinal data is thought to be appropriate for this analysis and is available, a normalised gap matrix, g^1, would be more appropriate to save the additional information that would have been lost in g^0. In this case, deprivation-matrix elements of the poor would take values such as $(z_d - x_{id})/z_d$ if $(x_{id} < z_d)$ and zero otherwise as before, therefore $0 \leq x_{id} \leq 1$. This and higher powers ($\delta > 0$) of the matrix (g^δ) can be labelled as the normalised gap matrices.

experienced by the i_{th} household and can be written as follows:

$$c_i = \sum_{d=1}^{D} g_{id}^0 \qquad (4)$$

where g_{id}^0 is a typical element of the g^0 matrix. As x_{id} should be smaller than z_d for a household to be considered as deprived in a given dimension, c_i should be equal or larger than k to conclude that a household is poor multidimensionally. Accordingly, the g^0 matrix can be censored by replacing the non-poor nth household's $1 \times D$ vector with a vector of zeros[8]. As the goal is to focus on the poor households only, these censored deprivation matrices[9] are essential in developing the AF measure.

The seminal paper by Sen (1976) criticises the headcount ratio for not satisfying core axioms such as monotonicity and transfer. In a multidimensional setting, the concern about the monotonicity axiom (defined by Sen as "given other things, a reduction in income of a person below the poverty line must increase the poverty measure") is extended to dimensional monotonicity. Briefly, this is the requirement that, for a poor person, a new deprivation in a previously non-deprived dimension should increase the overall poverty level.

Let q_k be the number of multidimensionally poor households. Therefore, the headcount ratio $H = q_k/N$ is defined by a dual cut-off identification approach as shown previously. H shows the incidence but it does not satisfy monotonicity or dimensional monotonicity axioms. To overcome the violation of dimensional monotonicity, the vector of deprivation counts C needs to be censored in order to focus on the poor[10]. As $0 \leq c_i \leq D$, $c_i(k)/D$ is the individual deprivation share of each household whereas the deprivation average among the poor (A) is:

$$A = \frac{1}{q_k D} \sum_{i=1}^{N} (c_i(k)) \qquad (5)$$

Therefore, the 'power zero' of the AF measure used here, which is called the dimension-adjusted headcount ratio, or M_0, is:

[8] Whereas for higher powers ($\delta > 0$) of g, in addition to this non-poor restriction, the entries of the poor ($c_i \geq k$) is given by $g_{id}^{\delta}(k) = g_{id}^{\delta}$.

[9] Generalised representation would be $(g^{\delta}(k))$.

[10] Hence, $c_i(k) = c_i$ if $c_i \geq k$, or else, $c_i(k) = 0$.

$$M_0 = HA = \frac{1}{ND}\sum_{i=1}^{N} c_i(k) = \frac{1}{ND}\sum_{i=1}^{N}\sum_{d=1}^{D} g_{id}^0 \qquad (6)$$

A shows the total number of deprivations out of all the possible deprivations a household may experience. Therefore, its product with H, M_0, takes into account the changes in the number of deprivations the poor households experience, unlike its unidimensional counterpart. Hence, it can be used with ordinal data and overcomes the problem of dimensional monotonicity[11]. As M_0 is the only robust measure in the Alkire-Foster family that satisfies a number of the important axioms while producing consistent results with ordinal data, we employed this measure in our analysis. For the argument of this paper, the crucial axiom it satisfies is the decomposability axiom (see the definition in the Appendix section 9.2).

Dimensional weighting is a significant aspect of multidimensional analysis since depending on the context of the study, unequal weights might be more appropriate than equal (unitary) weights for each dimension. The AF measure can easily be adjusted for unequal weighting through elements of the generalised gap matrix:

$$g_{id}^{\delta} = w_d[(\tfrac{z_d - x_{id}}{z_d})]^{\delta} \text{ if } (x_{id} < z_d) \text{ and zero otherwise} \qquad (7)$$

$$\text{where } \sum_{d=1}^{D} w_d = D. \qquad (8)$$

Therefore, if certain dimensions are thought to be more important than others in a particular setting, this can easily be applied to the AF measure being used as shown above.

3 Data

This paper uses the General Household Survey (GHS) 2007 data, obtained from Statistics South Africa (SSA) website (http://statssa.gov.za/). The GHS is an annual and nationally representative survey, and the observations are selected based on a probability survey. The GHS 2007 survey mainly focuses on education, health, work and unemployment, housing, and access

[11] For the higher-powered AF measures that satisfy various other axioms when cardinal data is available, please see Alkire and Seth (2008) pp. 10-12 or Batana (2008) pp. 7.

to services and facilities by conducting interviews with 29,280 households[12] from all nine provinces of South Africa.

A multi-stage stratified area probability sample design was used. Stratification was done per province (nine provinces) and according to district council (DC) (53 DCs) within provinces. These stratification variables were mainly chosen to ensure better geographical coverage, and to enable analysts to disaggregate the data at DC level.

The design included two stages of sampling. Firstly PSUs were systematically selected using Probability Proportional to Size (PPS) sampling techniques. During the second stage of sampling, Dwelling Units (DUs) were systematically selected as Secondary Sampling Units (SSUs). A PPS sample of PSUs was drawn in each stratum, with the measure of size being the number of households in the PSU. Altogether approximately 3 000 PSUs were selected. In each selected PSU a systematic sample of ten dwelling units was drawn, thus, resulting in approximately 30 000 dwelling units. All households in the sampled dwelling units were enumerated.

Out of these 29,280 available observations, I have eliminated another 21 as they were not informative on the dimensions considered here; hence, 29,259 observations have been used for poverty measurement in total. By using the given population weights, these observations represent around 13,246,000 households. Due to the nature of the matrix calculations and data availability, the AF measure underestimates poverty but this bias is no higher than half a percentage point in any case. Analogously, for the FGT measures, I have eliminated the households who have not indicated a value for at least one of the five consumption dimensions.

The population weights have been assigned based on the inclusion probability of the PSU and the household-inclusion probability per PSU. The intention is to represent the total population in South Africa. These assigned weights have been used in the analysis following the General Household Survey report. Applying unitary weights gives similar results as the sample size is large. The descriptive statistics of the data have been reported in Table 1.

[12] According to the General Household Survey (2007) Technical Notes (pp. 57), a household is defined as "a person, or group of persons, who occupy a common dwelling unit (or part of it) for at least four nights in a week on average during the past four weeks prior to the survey interview."

Table 1 .Dimensions, Weights and Indicator Cut-offs

Dimensions	***Indicators***	***Mean***	***Standard Deviation***	***PCA* Weights***	***BNA** Weights***	***The household is considered as deprived if***
1. Shelter	Housing	0.84	0.37	1.07	3/2	The main material used for the walls of the house is cardboard, mixture of mud and cement, wattle and daub, tile, mud, thatching, asbestos or other (and NOT bricks, cement block/concrete, corrugated iron/zinc, wood or plastic).
2. Water	Drinking Water	0.88	0.33	0.86	3/2	The household's main source of drinking water is a water carrier/tanker, borehole off site/communal, flowing water/stream/river, stagnant water/dam/pool, well, spring or other (and NOT piped (tap) water in dwelling, piped (tap) water on site or in yard, borehole in site, rain-water tank on site, neighbour's tap or public/communal tap).
3.Sanitation	Sanitation	0.87	0.34	0.73	1/2	The type of toilet facility available for the household is (off-site) a chemical toilet, (off-site) pit latrine with ventilation, (off-site) pit latrine without ventilation, (off-site) bucket toilet or none (and NOT a flush toilet with offsite disposal, a flush toilet with on site disposal (septic tank), (on-site) a chemical toilet, (on-site) pit latrine with ventilation or (on-site) pit latrine without ventilation).
4.Social Participation	Home/Cell Phone	0.72	0.45	1.12	1/2	Neither a functional/working landline telephone nor a cellular telephone is available for the household for regular use (and NOT if either one of the above is available).
5. Education	Years of Education	0.66	0.47	1.44	3/2	The members of the household who are at least 16 years old have, on average, failed to completed their primary school education at least up to Grade 7/Standard 5, (and NOT if they have completed their primary school education as a household, based on simple average of years of schooling of the individual members who are at least 16 years old).
6.Nutrition	Hunger	0.89	0.32	0.61	3/2	In the last 12 months, any adult (18 years and above) in this household sometimes, often or always went hungry because there wasn't enough food (and NOT in the last 12 months, any adult (18 years and above) in this household never or seldom went hungry because there wasn't enough food).
7.Financial Wealth	Expenditure	0.36	0.48	1.50	1/2	The total household expenditure in the last month (include everything that the household and its members spent money on, including food, clothing, transport, rent and rates, alcohol and tobacco, school fees,

						entertainment and any other expenses) was R 1200 or below (and NOT the total household expenditure in the last month was above R1200).
8.Safety	Harassment	0.94	0.23	0.15	1/2	During the past 12 months, any member of this household has been harassed or threatened by a household member, been harassed or threatened by someone outside the household, been sexually molested by a household member, been sexually molested by someone outside the household, been beaten up or hurt by a household member, been beaten up or hurt by someone outside the household, been murdered by a household member, been murdered by someone outside the household (and NOT if NONE of the above has happened in the past 12 months to any member of this household).
9. Health	Health Proximity	0.66	0.47	1.23	3/2	The household does not have access (within 30 minutes by usual means of transport) to a clinic or a hospital (and NOT if the household has access to a clinic or a hospital within 30 minutes by usual means of transport).
10. Employment	Employment Ratio	0.50	0.50	1.29	1/2	On average, at least half of the members of the household who are aged between 15-64 did not do any work for a wage, salary, commission or payment in kind (including domestic work) in the last seven days AND they do not have a job, business or other economic activity or farming activity that they will definitely return to (and NOT if, on average, at least half of the members of the household who are aged between 15-64 did some work for a wage, salary, commission or payment in kind in the last seven days OR even if they did not, they have a job, business or other economic activity or farming activity that they will definitely return to)

Data Source: GHS (2007)

* Principal Component Analysis

**Basic Needs Approach

Note 1: For each dimension listed, the minimum is zero and the maximum is one.

Note 2: The weights shown in this table are valid for the extended list used in this paper. For the core list, equal weights have been assigned to each dimension.

4 Dimensions, Weights and Cut-offs

Table 1 reports the descriptive statistics, dimension cut-offs and alternative weighting schemes used in this paper. The following part (in combination with Table 1) briefly explains the specific adjustments made to particular indicators considered in this paper. As far as possible, within-dimension cut-offs of these dimensions have been assigned based on Klasen's paper on multidimensional poverty in South Africa for comparability (Klasen 2000, pp.40).

The quality of walls is an imperfect indicator of the shelter dimension, the source of drinking water for the water dimension, the type of toilet for the sanitation dimension, phone availability for the social participation dimension, the proximity of the nearest clinic or hospital for the health dimension and the ratio of working-age adults for the employment dimension. These are well-accepted indicators that are frequently used in the related literature on South Africa (see, for example, Klasen [2000], Qizilbash [2004] and Alkire [2007]). These indicators are selected primarily on the basis of data availability.

Years of education is one of the most widely used indicators of the education dimension in the multidimensional poverty measurement as it has intrinsic and instrumental value and may not be reflected accurately by the income level of the household. This indicator has been formed by taking the average of the years of education of the household members over age 16 with a cut-off of Grade 7/Standard 5, indicating the completion of primary school. As an indicator, years of education is vulnerable to cases where a student repeats a year of primary education. In order to alleviate this problem, I have considered household members over 16 rather than 13, which is the usual completion age of primary education.

Total expenditure is an indicator of the financial wealth dimension that may not be captured fully by including other dimensions. It has an instrumental value as well as an intrinsic value as a (albeit controversial) social-status indicator. Different municipalities use different poverty lines (for PPP-adjusted values of 800 Rands, 1600 Rands and 2400 Rands, see Woolard and Leibbrandt [2006]) and therefore, the expenditure level of R1200 I have used in this paper falls between the lowest and middle poverty lines. Adjusted "$1-a-day" and "$2-a-day" poverty lines can be found in the Appendix to see where the poverty line used in this paper stands in comparison to them (for a similar approach, see Ozler [2007]).

The hunger indicator is an imperfect proxy for the nutrition dimension and captures the availability of food for adults (above 18) within the household. In this case, data on children (below 17) are not used as it had a low response rate. As traditional measures such as body mass index (BMI)[13] were not provided, we relied on the respondent's answer to a specific question about this vital dimension. The household is considered as deprived in the nutrition dimension if "in the last 12 months, any adult (18 years and above) in this household sometimes, often or always went hungry because there wasn't enough food (and non-deprived if, in the last 12 months, any adult (18 years and above) in this household never or seldom went hungry because there wasn't enough food)". It is problematic in the sense that the definition of hunger is subjective. However, the only alternative we had was expenditure data on food which seemed more problematic as different people have different dietary needs and the type of food bought with this expenditure amount is not known. Use of the hunger indicator is quite wide-spread[14].

A physical harassment indicator is an imperfect indicator of the safety dimension. It is based on data indicating if any member of the household has been exposed to a list of different harassment types over the past 12 months. Nussbaum (2003) has defined a list of capabilities where the "bodily integrity" element could be associated with the indicator I used here. Nussbaum (2005) stresses the importance of this dimension further by providing real-life examples and elaborates how such an important dimension is under-reported and under-exposed in related work. In his study on poverty in South Africa, Klasen (2000, pp.40) uses "perception of safety inside and outside of the house, compared to 5 years ago" as his safety indicator due to a lack of alternatives. Streeten (1981, pp.61) suspects that people would highly prioritise personal safety, which is not included in the five core dimensions on his list. Due to data limitations, I conclude that the physical harassment indicator used here was the most appropriate choice for the safety dimension in this paper. The harassment indicator is used as a proxy for the safety dimension in a number of studies[15].

In order to address the normative aspect of the dimension selection as well as for sensitivity analysis, we develop two lists of dimensions; one that covers

[13] BMI has been used widely in similar empirical studies, however, it is far from perfect as well. For a recent note on this, please see Green (2009).

[14] See Bickel et al. (2000) and Rainville and Brink (2001) and Asian Development Bank (2005), among others.

[15] See OECD (1976), Braybrooke (1987) and Cummins (1996), among others.

five 'core' dimensions relating to basic needs following Streeten (1981) and another 'extended' list that covers an additional five dimensions that have been previously cited[16] in the literature. The BNA employed in Streeten's work emphasises five core dimensions, namely shelter, water and sanitation[17], education, nutrition and health (Streeten 1981, pp. 61). Streeten argues that these dimensions are the starting point to improve the living conditions of the poor so that they can live a "full life". He argues that it is hard to imagine a society that does not list these five dimensions as basic, even if each person would not provide an identical list of basic needs when asked. Qizilbash (1996 pp. 1212) claims that there is a considerable agreement on this list.

The Capability Approach of Amartya Sen has a similar broader definition of poverty where income does not, on its own, provide adequate information on the standards of living (see, for example, Sen 1999, pp. 87-88). There is no fixed (or generally-accepted) list of capabilities and therefore core capabilities have not been identified explicitly by Sen. However, these five dimensions have been listed as five core capabilities in the literature. Klasen (2000) lists them as five of seven core dimensions of well-being used in applying the Capability Approach in the South African context. The extended list used here consists of the five core dimensions as well as sanitation, social participation, financial wealth, safety and employment dimensions.

Table 2a provides the correlation matrix for the dimensions listed in Table 1. Considering the significant normative component in multidimensional poverty measurement, robustness analysis is vital to ensure that results are as insensitive as possible to changes in cut-off and dimension selection. The Pearson correlation coefficient, which computes linear correlation among the dimensions, reveals that only one coefficient is above the 0.3-level (out of 45). This is a good sign as it indicates that different well-being indicators do not overlap, or replicate information. A particularly striking example is the sexual/physical harassment indicator, which proxies for the safety dimension, with a maximum correlation coefficient of 0.06 (with hunger) and virtually zero with six other dimensions.

Table 2b provides the correlation matrix for alternative choices of k. The

[16] Please see Klasen (2000), Qizilbash (2004), Asian Development Bank (2005), Alkire (2007), Thorbecke (2008).

[17] Drinking water is used as an indicator to represent the water and sanitation dimension in the core list whereas sanitation dimension has a seperate indicator in the extended list here.

Table 2a: Correlation Matrix for dimensions used

	1. Housing	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7. Expenditure*	*8.Harassment*	*9. Health Proxy*	*10. Employment*
1. Housing	1.00									
2.Drinking Water	0.43	1.00								
3.Sanitation	0.21	0.21	1.00							
4.Home/Cell phone	0.15	0.11	0.13	1.00						
5.Years of Education	0.23	0.20	0.16	0.27	1.00					
6.Hunger	0.14	0.10	0.11	0.11	0.13	1.00				
7. Expenditure	0.21	0.17	0.17	0.28	0.30	0.17	1.00			
8.Harassment	0.00	0.00	0.02	0.00	0.00	0.06	0.00	1.00		
9. Health Proxy	0.26	0.27	0.15	0.09	0.18	0.09	0.17	0.01	1.00	
10. Employment	0.19	0.16	0.06	0.08	0.20	0.15	0.25	0.00	0.12	1.00

Author's calculations using GHS (2007) dataset.

Table 2b: Correlation Matrix for rankings obtained due to the alternative choices of k (across dimension cut-off level)

	k=1	*k=2*	*k=3*	*k=4*	*k=5*	*k=6*	*k=7*	*k=8*
k=1	1.00							
k=2	1.00	1.00						
k=3	0.98	0.98	1.00					
k=4	0.97	0.97	0.98	1.00				
k=5	0.97	0.97	0.95	0.97	1.00			
k=6	0.93	0.93	0.95	0.97	0.97	1.00		
k=7	0.93	0.93	0.95	0.98	0.93	0.93	1.00	
k=8	0.88	0.88	0.87	0.92	0.92	0.92	0.95	1.00

Author's calculations using GHS (2007) dataset.

Note: Higher k choices has not been reported here as a number of provinces did not have any citizens deprived in nine or ten dimensions, hence causing ambiguity in rankings.

choice of the across-dimension cut-off k can be crucial and there is not a generally-agreed method for identifying the optimal k. A similar correlation matrix to the one above reveals the fact that different choices of k lead to highly correlated results in provincial rankings (the lowest correlation coefficient was 0.87 between $k = 3$ and $k = 8$). Here, $k = 1$ is used for the core list as each one of these dimensions are essential to have an adequate standard of living and $k = 3$ has been used for the extended list, which leads to a multidimensional headcount ratio of around 42%. However, as shown in Table 2b, the choice of k is not extremely significant here as it hardly affects the overall rankings in the South African context.

Assigning weights to dimensions is another essential part of poverty measurement and is often done arbitrarily. As discussed in the literature, the main justification for the use of the equal-weights assumption is the lack of any obvious alternative (see, for example, UNDP 2008, pp. 3). The dimension weights in the application of the core list were equal as these five dimensions are all very important and their importance is about the same[18]. However, in the application of the extended list, as D is relatively high, equal weights would put equal importance on each dimension, which is not necessarily sensible. Therefore, I have employed three ways of assigning dimension weights for the full extended list of ten dimensions.

One was to derive the weights by Principal Component Analysis (PCA) (see Klasen, 2000). To equalise the sum of weights with the total number of dimensions, I have multiplied each weight by a fixed constant so that the proportional ratios of PCA weights remain unaffected. The following weights were derived for each indicator: housing (1.07), drinking water (0.86), sanitation (0.73), home/cell phone (1.12), education (1.44), hunger (0.61), household expenditure (1.50), physical/sexual harassment (0.15), health (1.23) and employment (1.29), as shown before in Table 1. As Klasen (2000, pp. 39) indicates, the low coefficient driven by PCA for physical/sexual harassment indicator, which proxies for the safety dimension, should not suggest that safety is relatively less important than the other dimensions.

In a second exercise, I have assigned higher weights for the five core dimensions suggested by Streeten (1981), namely shelter, water, education, nutrition and health, and divided the rest among the other five dimensions equally. As the sum of weights should be equal to the number of total dimen-

[18] The reasoning here is analogous to equal weights given to education, life expectancy and income in the HDI weighting (see Sen 2006, pp. 258).

sions, the weights given to each of these core dimensions were about three times each of the other five dimensions (a weight of 1.5 has been given each of the five core dimensions and [10-(1.5*5)] / 5 = 0.5 is given to each of the other five dimensions). As $k = 3$ is used for the extended list of dimensions throughout the paper, this weighting scheme indicates that deprivation in two basic needs is required to consider a household as poor (rather than one as in the core list, as more deprivation possibilities have been considered in the extended list). Also, if a household is not deprived in any of the five core dimensions, it cannot be considered as poor even if it is deprived in all the remaining dimensions.

Finally, for completeness, results obtained using equal dimension weights have been reported as well. The provincial ranking obtained by PCA weights is identical with equal-weight ranking and the ranking obtained by BNA weights are identical with core-list ranking, the only difference between these two groups of rankings being the order of Limpopo and KwaZulu-Natal provinces. Therefore, weights hardly affect the overall picture in this paper.

5 Empirical Results

This section elaborates on the empirical results obtained by using the FGT measure and compares the provincial rankings based on the three family of measures employed in this paper. Table 3a shows the result of the poverty measurement using the FGT measure, using the poverty lines suggested by Woolard and Leibbrandt (2006), as South Africa does not have an official national poverty line. These are the PPP-adjusted values of $PL_1 = 800$ Rands, $PL_2 = 1600$ Rands and $PL_3 = 2400$ Rands (Technical notes on the adjustment process can be found in the Appendix, section 9.1). There are a small number of variations in the rankings, given in Table 3b, when different poverty lines have been used. In the rankings, "1" is given to the least-deprived province ("2" is given to second least-deprived) whereas "9" is assigned to the most-deprived province ("8" is assigned to second most-deprived). For every poverty line, Western Cape is the province with lowest number of poor households, lowest level of average poverty gap and the lowest level of average squared poverty gap, followed by Gauteng whereas Limpopo and the Eastern Cape are on the other end of the spectrum.

Most of the ranking variations in terms of the measures can be observed

Table 3a: Income-based population-weighted FGT measures by province (%)

Provinces	Poverty Line$_1$=827			Poverty Line$_2$=1656			Poverty Line$_3$=2483		
	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2
Western Cape	24.88	8.73	4.52	54.30	24.99	14.59	67.48	37.22	24.19
Eastern Cape	**58.00**	**24.56**	**13.71**	**80.73**	**48.46**	**32.91**	**87.57**	**60.51**	**45.44**
Northern Cape	42.69	17.92	10.25	69.26	38.27	25.11	80.06	50.66	36.35
Free State	**53.42**	**22.01**	**12.11**	**77.22**	**44.85**	**30.00**	**85.70**	**57.05**	**42.15**
Kwazulu-Natal	54.88	20.67	10.46	80.98	46.09	29.84	88.61	59.21	43.10
North West	**50.61**	**21.55**	**12.27**	**76.19**	**43.50**	**29.19**	**84.98**	**55.99**	**41.13**
Guateng	36.14	15.24	8.78	63.24	33.27	21.50	75.35	45.45	31.88
Mpumalanga	**50.93**	**20.06**	**10.50**	**78.34**	**44.10**	**28.63**	**85.91**	**56.84**	**41.33**
Limpopo	61.85	23.95	12.17	86.22	50.81	33.52	92.25	63.74	47.31
Country Total	**48.98**	**19.53**	**10.49**	**74.84**	**42.11**	**27.54**	**83.69**	**54.66**	**39.65**

Author's calculations using GHS (2007) dataset.

Table 3b: Income-based population-weighted FGT measures by province (rankings)

Provinces	Poverty Line$_1$=827			Poverty Line$_2$=1656			Poverty Line$_3$=2483		
	P_0	P_1	P_2	P_0	P_1	P_2	P_0	P_1	P_2
Western Cape	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Eastern Cape	8	8	9	8	8	8	8	8	8
Northern Cape	**3**	**4**	**5**	**3**	**3**	**3**	**3**	**3**	**3**
Free State	5	7	7	4	6	6	4	4	6
Kwazulu-Natal	**6**	**3**	**3**	**6**	**5**	**4**	**7**	**6**	**5**
North West	4	5	6	5	4	5	5	5	4
Gauteng	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Mpumalanga	7	6	4	7	7	7	6	7	7
Limpopo	**9**	**9**	**8**	**9**	**9**	**9**	**9**	**9**	**9**

Author's calculations using GHS (2007) dataset.

in the mid-ranking provinces. KwaZulu-Natal is an interesting example as, by using PL_1, it is sixth among nine provinces in terms of H (first being the least-deprived), however, it is only third in G and P_2. This implies that a large share of people in KwaZulu-Natal are under the lowest poverty line PL_1 but a good number of these poor people are just under the line. This is the case as KwaZulu-Natal's average gap and average squared gap are smaller than those of other provinces which have fewer poor people by using PL_1. A reverse case can be observed in the rankings of Free State, as the province is fifth in H but seventh in the other FGT measures under PL_1. Even though the observed patterns are similar, under higher poverty lines, the place of Free State improves in rankings. This implies that a large number of the expenditure-deprived inhabitants of this province are grouped at the very bottom of the expenditure scale. By using PL_1, female-led households are relatively better-off than male-led households in Northern Cape whereas the opposite is true for North West. Clearly, extremely close (as close as 0.13%, in some cases) H values are the key for these variations, which raises the question of robustness of the results obtained by the unidimensional FGT measures.

In general, unidimensional poverty measures help us to get a general feeling of who is more deprived financially and needs to be "saved" first, though the policy implications are very limited as we know little about their standard of living as financial superiority may not mean as much in a province where markets to exercise that financial power are not complete or do not exist at all. Likewise, superior local governmental bodies (such as municipalities) may help to compensate for the lack of finances up to a certain level by providing better services to the households living in that particular province. Therefore, in addition to financial wealth and income, the availability of public services is crucial as well.

Table 4a shows the percentage of poor by using the headcount ratio (H) for each dimension in each province. In addition, Table 4b shows the rankings obtained from Table 4a. There are some significant changes in the rankings among the provinces and variations in the rankings based on the gender of the household head do not always follow the overall ranking variations closely. Unexpected ranking results include the hunger (6th "best") and sexual/physical harassment (8th "best") rankings of Western Cape, which has the lowest deprivation levels in most of the other dimensions. Limpopo, a "rather" poor province, has the best hunger and sexual/physical harassment numbers, which is rather surprising. A possible explanation for these

Table 4a: The Headcount Ratio in Each Dimension (%)

Provinces	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7. Expenditure*	*8.Harassment*	*9. Health Proxy*	*10. Employment*
Western Cape	1.42	0.24	8.03	19.26	14.06	11.24	34.83	7.59	10.46	31.87
Eastern Cape	**35.06**	**22.70**	**28.58**	**32.04**	**36.70**	**16.64**	**71.59**	**6.12**	**40.73**	**54.62**
Northern Cape	2.41	2.82	13.34	29.23	32.19	8.90	55.89	6.85	23.92	40.31
Free State	**4.55**	**1.71**	**16.35**	**24.62**	**26.05**	**9.08**	**63.78**	**8.79**	**20.18**	**44.66**
Kwazulu-Natal	27.41	15.52	11.38	28.68	28.91	9.73	62.39	5.76	40.24	50.10
North West	**3.81**	**6.37**	**10.06**	**20.22**	**30.48**	**12.99**	**60.79**	**5.74**	**37.52**	**48.64**
Gauteng	1.31	1.47	4.40	20.06	14.92	7.80	49.59	6.28	21.69	31.24
Mpumalanga	**8.55**	**8.40**	**10.59**	**18.21**	**35.31**	**11.57**	**64.88**	**7.05**	**34.41**	**46.39**
Limpopo	8.83	11.55	11.32	27.83	38.02	6.61	75.31	2.39	40.98	66.16
SA Total	**12.54**	**8.77**	**11.88**	**24.41**	**26.35**	**10.33**	**58.95**	**6.10**	**30.51**	**44.89**

Author's calculations using GHS (2007) dataset.

Table 4b: The Headcount Ratio in Each Dimension (rankings)

Provinces	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7. Expenditure*	*8.Harassment*	*9. Health Proxy*	*10. Employment*
Western Cape	2	1	1	2	1	6	1	8	1	2
Eastern Cape	**9**	**9**	**8**	**9**	**6**	**9**	**8**	**4**	**8**	**8**
Northern Cape	3	4	3	8	2	3	3	6	4	3
Free State	**5**	**3**	**4**	**5**	**4**	**4**	**6**	**9**	**2**	**4**
Kwazulu-Natal	8	8	5	7	8	5	5	3	7	7
North West	**4**	**5**	**7**	**4**	**9**	**8**	**4**	**2**	**6**	**6**
Gauteng	1	2	2	3	3	2	2	5	3	1
Mpumalanga	**6**	**6**	**6**	**1**	**5**	**7**	**7**	**7**	**5**	**5**
Limpopo	7	7	9	6	7	1	9	1	9	9

Author's calculations using GHS (2007) dataset.

results is what Sen (2004, pp. 471-74) calls "objective illusion": people in Limpopo are much less aware of what sort of behavior constitutes sexual/physical harassment than those in Western Cape, and therefore, are less likely to self-report a harassment instance they have experienced. Similarly, the nutritional expectations of the people in Western Cape might be much higher than those in Limpopo (for example, some people may "adapt" to a full English breakfast and feel deprived if part of it is missing whereas others may not feel deprived with only plain bread as this is what they always had for breakfast). Therefore, the subjective hunger levels Western Cape inhabitants report might be higher than those reported in Limpopo because of differences in expectations[19] which can 'bias' the hunger indicator. These results may cast further doubt on indicator selection. However, these self-reported results provide valuable insights as they are and there is a lack of data on better indicators (as mentioned in the previous section). Northern Cape, one of the better off provinces, is especially deprived according to the phone/cell phone indicator. Relatively speaking, female-led households are better off in dimensions which are provided by public services (such as phone/cell phone) and these households are deprived especially in worst off provinces such as Limpopo and Eastern Cape . Therefore, it can be argued that female-led households suffer the most when multidimensional poverty is particularly high in a given province.

In addition to Table 4b which ranks the provinces according to the deprivation level in each dimension, Table 5 compares the rankings as a result of the expenditure-based FGT measure, the AS measure (according to various power-mean options used) and the AF measure, by using both the core and extended lists. The results show that there are variations in the rankings obtained. As expected, the two multidimensional measures indicate closer rankings to one another than to the unidimensional FGT measure, though there are a number of variations between the two as well. Western Cape and Gauteng take the first two places independent of the measure being used. Northern Cape would be considered poorer if policy-makers were to employ the FGT measure as their criterion rather than the AS or AF measure whereas the opposite is true for KwaZulu-Natal and North West provinces.

[19]Hence, the illusion of low hunger and harassment in Limpopo might have what Sen terms a "positionally objective basis" (Sen 2004, pp. 472).

Table 5: Comparative Rankings

	Expenditure-based FGT Poverty Line$_1$=827			AS measure			AF-based framework		
Provinces	**FGT (α=0)**	**FGT (α=1)**	**FGT (α=2)**	**AS (θ=1)**	**AS (θ=2)**	**AS (θ=3)**	**MultiD-HC**	**AF-CoreM$_0$** [1]	**AF-ExtM$_0$** [2]
Western Cape	1	1	1	1	1	1	1	1	1
Eastern Cape	**8**	**8**	**8**	**9**	**8**	**8**	**8**	**9**	**9**
Northern Cape	3	4	6	3	3	3	4	4	4
Free State	**5**	**7**	**7**	**4**	**4**	**4**	**3**	**3**	**3**
Kwazulu-Natal	6	3	3	7	6	6	7	8	7
North West	**4**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Gauteng	2	2	2	2	2	2	2	2	2
Mpumalanga	**7**	**6**	**4**	**6**	**7**	**7**	**6**	**6**	**6**
Limpopo	9	9	9	8	9	9	9	7	8

Author's calculations using GHS (2007) dataset.

Key:

MultiD-HC = Multidimensional HeadCount Ratio

AF-CoreM$_0$ = The Alkire-Foster family of measures using the core list

AF-ExtM$_0$ = The Alkire-Foster family of measures using the extended list

1 - The equal weighting scheme has been used for the AF-CoreM$_0$ column of Table 5

2 - The equal and the Principal Component Analysis (PCA) weighting schemes yield the same rankings reported in the AF-ExtM$_0$ column of Table 5

6 Policy Analysis

By allocating provincial revenues based on the unique provincial rankings[20] obtained using various families of measures, it is clear from the results section that different families of measures will yield different allocations. Even though the two extremes are relatively consistent[21], implying Western Cape and Gauteng are the two least deprived and Limpopo and Eastern Cape are the two most deprived no matter which measure we use, mid-level rankings are less robust. For example, KwaZulu-Natal would receive a lot less revenue or would have to wait a lot longer to receive government resources under the income-based measures such as the poverty gap and P_2 as it is the third "best" province (or seventh "worst") but is the seventh "best" (or third "worst") under the multidimensional measures such as AS (when $\theta = 1$) and AF (headcount and M_0) measures. The case of Free State would be the exact opposite. Qizilbash (2004) observes the same pattern.

This section explains the framework developed based on the AF measure to derive policy implications. The dimensional breakdown of poverty among provinces, using the framework developed in this paper based on the AF measure with the core list and equal weights, is shown in Table 6a & 6b. Tables 7-9 report the "deprivation shares" and precise revenue allocations to each dimension using the extended list with three different weighting schemes (the PCA scheme [Table 7a & 7b], the BNA scheme [Table 8a & 8b] and the equal weights scheme [Table 9a & 9b]). These are the key tables for policymakers as they show the contribution of each province to overall poverty. The following explains the key assumptions made and the interpretation of these tables.

Current policy in South Africa is influenced by sections 214 and 227 of the South African Constitution which require that an equitable share of nationally raised revenue be allocated to the provincial sphere of government to enable it to provide basic services and perform the other functions allocated to that sphere (National Treasury 2008, pp.10). In South Africa, the grants used to allocate nationally-raised revenue among provinces can be categorised as unconditional grants or Provincial Equitable Shares (PES), conditional grants and rare non-conditional grants. Among the spheres of

[20] For example, given that the South African government has a certain amount of lump-sum financial resources, it is likely that they would determine the allocation of these resources based on the rankings of deprivation among the provinces, or rankings of "need".

[21] This finding is consistent with the literature - see Qizilbash (2004).

government (national departments, provincial and local governments), the provincial governments receive around 43% of the nationally-raised revenue. Of this 43%, around 82% of the provincial revenues (and around 85% of national transfers) between 2005-2008 was distributed through PES (Division of Revenue Bill, 2009). Therefore, the PES calculation is crucial for revenue allocations among the provinces. The total PES allocation for province l is given as:

$$PES_l = E_l + F_l + B_l + I_l + S_l + R_l \qquad (9)$$

where E_l = education share (51%) - based on the size of the school age population (5-17 years of age) and the size of learners (the number of registered students from Grade R to 12) enrolled in public ordinary schools, F_l = health share (26%) - based on share of the population with and without access to health care, B_l = basic share (14%) - derived from each province's share of national population, I_l = institutional component (5%) - divided equally between the provinces, S_l = poverty component (3%) - reinforcing the redistributive bias of the formula and R_l = economic output component (1%) based on GDP by region (GDP-R) data. Even if the weights assigned to each component reflect the broad historical patterns[22], these may look arbitrary now (Alm and Martinez-Vazquez 2009, pp. 26).

The GHS 2007 data is used for the technical analysis of this paper. To make it comparable with the PES scheme, the PES-suggested allocation results of 2008/09 financial year have been considered which are based on the datasets and household surveys of 2006 and 2007. There is a considerable difference between the results obtained by the PES and the method derived in this paper, based on the AF measure. The following steps are taken in order to develop the AF-based method:

1) The "population" and the "dimension-weighted average" of each province, given in Tables 6a-9a, are multiplied.

2) The results, the population and dimension-weighted deprivation average of each province, are summed up to find the deprivation average of South Africa.

[22] "The components of the formula are neither indicative budgets nor guidelines for how much should be spent on those functions in each province or by provinces collectively. Rather, the education and the health components weighted broadly in line with historical expenditure patterns to provide an indication of relative need". (Division of Revenue Bill 2008, pp.74)

Table 6a: Contribution of each core dimension to overall poverty in each province - equal weights (k=1)

Provinces	*Population*	*1. Housing*	*2.Drinking Water*	*3.Years of Education*	*4.Hunger*	*5.Health Proximity*	*Dimension weighted Ave*	*Deprivation Share*
Western Cape	1362900	0.009	0.001	0.046	0.040	0.032	0.026	2.25%
		7.33%	***1.03%***	***35.69%***	***31.19%***	***24.77%***	***100.00%***	
Eastern Cape	1795900	0.326	0.218	0.288	0.135	0.316	0.257	29.57%
		25.41%	***17.00%***	***22.42%***	***10.56%***	***24.61%***	***100.00%***	
Northern Cape	293280	0.015	0.025	0.157	0.062	0.135	0.079	1.49%
		3.78%	***6.41%***	***39.87%***	***15.71%***	***34.24%***	***100.00%***	
Free State	872450	0.029	0.013	0.108	0.051	0.089	0.058	3.25%
		10.05%	***4.54%***	***37.34%***	***17.51%***	***30.56%***	***100.00%***	
Kwazulu-Natal	2535700	0.230	0.145	0.228	0.081	0.252	0.187	30.46%
		24.57%	***15.51%***	***24.38%***	***8.60%***	***26.94%***	***100.00%***	
North West	943780	0.034	0.052	0.193	0.092	0.204	0.115	6.95%
		5.84%	***9.01%***	***33.56%***	***16.10%***	***35.49%***	***100.00%***	
Gauteng	3240500	0.009	0.009	0.053	0.035	0.065	0.034	7.12%
		5.07%	***5.55%***	***30.76%***	***20.60%***	***38.02%***	***100.00%***	
Mpumalanga	887760	0.074	0.068	0.205	0.089	0.196	0.126	7.19%
		11.67%	***10.75%***	***32.54%***	***14.05%***	***30.99%***	***100.00%***	
Limpopo	1315800	0.074	0.098	0.231	0.052	0.240	0.139	11.73%
		10.60%	***14.17%***	***33.30%***	***7.44%***	***34.49%***	***100.00%***	
SA Total	13248000	0.108	0.079	0.161	0.069	0.171	0.118	100.00%
		18.40%	***13.47%***	***27.43%***	***11.71%***	***28.99%***	***100.00%***	

Author's calculations using GHS (2007) dataset.

Table 6b: The AF-measure-suggested revenue distribution to each dimension in each province - equal weights (k=1)

Provinces	*1. Housing*	*2.Drinking Water*	*3.Years of Education*	*4.Hunger*	*5.Health Proximity*	*Total*
Western Cape	329	46	1,600	1,398	1,110	4,483
Eastern Cape	**14,982**	**10,019**	**13,217**	**6,223**	**14,509**	**58,950**
Northern Cape	112	190	1,181	465	1,014	2,962
Free State	**651**	**295**	**2,421**	**1,135**	**1,981**	**6,483**
Kwazulu-Natal	14,922	9,421	14,806	5,223	16,360	60,732
North West	**810**	**1,249**	**4,649**	**2,230**	**4,917**	**13,855**
Gauteng	719	787	4,366	2,924	5,397	14,193
Mpumalanga	**1,672**	**1,541**	**4,662**	**2,013**	**4,440**	**14,329**
Limpopo	2,480	3,315	7,789	1,741	8,067	23,392
SA Total	**36,675**	**26,862**	**54,691**	**23,353**	**57,795**	**199,377**

Author's calculations using GHS (2007) dataset.

Note: In thousands of Rands.

Table 7a: Contribution of each dimension to overall poverty in each province - PCA weights (k=3)

Provinces	*Population*	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7.Expenditure*	*8.Harassment*	*9. Health Proximity*	*10. Employment*	*Dimension-weighted Average*	*Deprivation Shares*
Western Cape	1362900	0.010	0.001	0.042	0.117	0.090	0.068	0.161	0.018	0.045	0.128	0.081	10.29%
		1.30%	**0.14%**	**3.83%**	**16.16%**	**16.02%**	**5.14%**	**29.82%**	**0.33%**	**6.90%**	**20.34%**	**100.00%**	
Eastern Cape	1795900	0.339	0.223	0.263	0.277	0.351	0.151	0.566	0.043	0.355	0.435	0.351	13.56%
		10.33%	**5.46%**	**5.48%**	**8.86%**	**14.40%**	**2.62%**	**24.21%**	**0.19%**	**12.46%**	**16.00%**	**100.00%**	
Northern Cape	293280	0.018	0.024	0.108	0.231	0.270	0.080	0.371	0.033	0.165	0.254	0.191	2.21%
		1.01%	**1.10%**	**4.14%**	**13.56%**	**20.41%**	**2.57%**	**29.15%**	**0.26%**	**10.62%**	**17.18%**	**100.00%**	
Free State	872450	0.036	0.016	0.134	0.190	0.218	0.075	0.367	0.037	0.133	0.275	0.180	6.59%
		2.16%	**0.76%**	**5.46%**	**11.83%**	**17.48%**	**2.54%**	**30.66%**	**0.31%**	**9.10%**	**19.71%**	**100.00%**	
Kwazulu-Natal	2535700	0.251	0.149	0.102	0.237	0.260	0.091	0.450	0.029	0.308	0.358	0.269	19.14%
		9.99%	**4.78%**	**2.77%**	**9.87%**	**13.94%**	**2.07%**	**25.12%**	**0.16%**	**14.12%**	**17.18%**	**100.00%**	
North West	943780	0.035	0.059	0.089	0.173	0.246	0.112	0.394	0.031	0.260	0.317	0.209	7.12%
		1.80%	**2.41%**	**3.10%**	**9.27%**	**16.89%**	**3.26%**	**28.22%**	**0.22%**	**15.29%**	**19.54%**	**100.00%**	
Gauteng	3240500	0.008	0.008	0.027	0.126	0.101	0.063	0.211	0.019	0.102	0.141	0.099	24.46%
		0.90%	**0.72%**	**2.01%**	**14.31%**	**14.67%**	**3.90%**	**32.03%**	**0.29%**	**12.76%**	**18.41%**	**100.00%**	
Mpumalanga	887760	0.074	0.075	0.090	0.155	0.289	0.102	0.408	0.034	0.240	0.302	0.216	6.70%
		3.67%	**2.97%**	**3.03%**	**8.03%**	**19.26%**	**2.87%**	**28.27%**	**0.24%**	**13.66%**	**18.01%**	**100.00%**	
Limpopo	1315800	0.084	0.106	0.102	0.247	0.337	0.061	0.546	0.013	0.343	0.508	0.295	9.93%
		3.03%	**3.10%**	**2.51%**	**9.39%**	**16.43%**	**1.25%**	**27.74%**	**0.07%**	**14.30%**	**22.19%**	**100.00%**	
SA Total	13248000	0.116	0.082	0.100	0.191	0.222	0.088	0.373	0.027	0.218	0.292	0.206	100.00%
		6.00%	**3.43%**	**3.54%**	**10.36%**	**15.49%**	**2.60%**	**27.13%**	**0.20%**	**13.00%**	**18.26%**	**100.00%**	

Author's calculations using GHS (2007) dataset.

Table 7b: The AF-measure-suggested revenue distribution to each dimension in each province - PCA weights (k=3)

Provinces	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7.Expenditure*	*8.Harassment*	*9. Health Proximity*	*10. Employmet*	*Total*
Western Cape	104	11	308	1,300	1,289	413	2,399	27	555	1,636	8,044
Eastern Cape	**4,751**	**2,511**	**2,520**	**4,071**	**6,621**	**1,205**	**11,129**	**85**	**5,726**	**7,353**	**45,973**
Northern Cape	41	45	169	553	833	105	1,190	11	434	701	4,081
Free State	**247**	**87**	**625**	**1,353**	**1,999**	**291**	**3,507**	**35**	**1,041**	**2,255**	**11,438**
Kwazulu-Natal	4,969	2,375	1,377	4,908	6,931	1,030	12,488	80	7,019	8,541	49,718
North West	**259**	**348**	**447**	**1,337**	**2,435**	**470**	**4,069**	**32**	**2,205**	**2,817**	**14,420**
Gauteng	211	169	470	3,343	3,426	911	7,483	68	2,980	4,300	23,361
Mpumalanga	**515**	**417**	**424**	**1,125**	**2,698**	**402**	**3,961**	**33**	**1,913**	**2,523**	**14,010**
Limpopo	859	877	712	2,659	4,655	355	7,858	19	4,050	6,286	28,331
SA Total	**11,956**	**6,839**	**7,052**	**20,649**	**30,887**	**5,183**	**54,083**	**391**	**25,923**	**36,412**	**199,377**

Author's calculations using GHS (2007) dataset.

Note: In thousands of Rands.

Table 8a: Contribution of each dimension to overall poverty in each province - BNA weights (k=3)

Provinces	*Population*	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7.Expenditure*	*8.Harassment*	*9. Health Proximity*	*10. Employment*	*Dimension-weighted Average*	*Deprivation Shares*
Western Cape	1362900	0.011	0.002	0.030	0.058	0.064	0.053	0.075	0.012	0.038	0.065	0.037	2.91%
	0	**4.33%**	**0.65%**	**3.98%**	**7.77%**	**26.11%**	**21.44%**	**10.08%**	**1.57%**	**15.28%**	**8.81%**	**100.00%**	
Eastern Cape	1795900	0.332	0.220	0.230	0.228	0.324	0.147	0.458	0.042	0.336	0.359	0.270	27.88%
	0	**18.48%**	**12.24%**	**4.26%**	**4.23%**	**18.01%**	**8.17%**	**8.50%**	**0.79%**	**18.67%**	**6.65%**	**100.00%**	
Northern Cape	293280	0.017	0.025	0.084	0.154	0.221	0.069	0.229	0.032	0.143	0.142	0.103	1.74%
	0	**2.47%**	**3.68%**	**4.09%**	**7.46%**	**32.08%**	**9.99%**	**11.09%**	**1.53%**	**20.73%**	**6.89%**	**100.00%**	
Free State	872450	0.032	0.015	0.086	0.126	0.167	0.064	0.210	0.030	0.104	0.159	0.088	4.41%
	0	**5.43%**	**2.52%**	**4.88%**	**7.16%**	**28.56%**	**10.91%**	**11.96%**	**1.74%**	**17.77%**	**9.07%**	**100.00%**	
Kwazulu-Natal	2535700	0.239	0.147	0.089	0.174	0.240	0.085	0.335	0.029	0.267	0.279	0.192	28.05%
	0	**18.70%**	**11.45%**	**2.33%**	**4.52%**	**18.75%**	**6.64%**	**8.72%**	**0.75%**	**20.88%**	**7.27%**	**100.00%**	
North West	943780	0.034	0.057	0.072	0.133	0.220	0.098	0.262	0.030	0.222	0.205	0.130	7.06%
	0	**3.96%**	**6.64%**	**2.76%**	**5.11%**	**25.38%**	**11.37%**	**10.07%**	**1.16%**	**25.64%**	**7.90%**	**100.00%**	
Gauteng	3240500	0.009	0.010	0.017	0.058	0.068	0.048	0.101	0.017	0.075	0.069	0.044	8.30%
	0	**3.08%**	**3.26%**	**1.89%**	**6.47%**	**22.96%**	**16.08%**	**11.36%**	**1.89%**	**25.27%**	**7.73%**	**100.00%**	
Mpumalanga	887760	0.075	0.069	0.070	0.118	0.239	0.096	0.281	0.031	0.215	0.205	0.139	7.13%
	0	**8.05%**	**7.46%**	**2.52%**	**4.23%**	**25.74%**	**10.33%**	**10.08%**	**1.11%**	**23.11%**	**7.37%**	**100.00%**	
Limpopo	1315800	0.079	0.103	0.082	0.180	0.276	0.055	0.351	0.012	0.271	0.324	0.165	12.52%
	0	**7.19%**	**9.34%**	**2.50%**	**5.46%**	**25.04%**	**5.03%**	**10.63%**	**0.35%**	**24.63%**	**9.82%**	**100.00%**	
SA Total	13248000	0.112	0.081	0.081	0.131	0.188	0.078	0.250	0.025	0.186	0.200	0.131	100.00%
	0	**12.82%**	**9.26%**	**3.09%**	**5.00%**	**21.53%**	**8.92%**	**9.53%**	**0.94%**	**21.29%**	**7.62%**	**100.00%**	

Author's calculations using GHS (2007) dataset.

Table 8b: The AF-measure-suggested revenue distribution to each dimension in each province - BNA weights (k=3)

Provinces	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7.Expenditure*	*8.Harassment*	*9. Health Proximity*	*10. Employment*	*Total*
Western Cape	251	37	231	450	1514	1243	585	91	886	511	5798
Eastern Cape	**10274**	**6805**	**2368**	**2349**	**10012**	**4541**	**4728**	**438**	**10381**	**3698**	**55593**
Northern Cape	86	128	142	259	1115	347	385	53	721	240	3476
Free State	**478**	**221**	**429**	**630**	**2511**	**960**	**1051**	**153**	**1562**	**798**	**8793**
Kwazulu-Natal	10458	6403	1301	2527	10489	3716	4876	420	11676	4065	55932
North West	**557**	**935**	**389**	**719**	**3572**	**1600**	**1418**	**164**	**3610**	**1112**	**14076**
Gauteng	510	540	312	1071	3800	2661	1880	313	4182	1280	16549
Mpumalanga	**1143**	**1059**	**359**	**601**	**3657**	**1468**	**1432**	**157**	**3283**	**1047**	**14207**
Limpopo	1794	2331	623	1363	6248	1254	2653	88	6147	2450	24952
SA Total	**25552**	**18459**	**6154**	**9970**	**42918**	**17790**	**19008**	**1877**	**42447**	**15201**	**199377**

Author's calculations using GHS (2007) dataset.

Note: In thousands of Rands.

Table 9a: Contribution of each dimension to overall poverty in each province - equal weights (k=3)

Provinces	*Population*	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7.Expenditure*	*8.Harassment*	*9. Health Proximity*	*10. Employment*	*Dimension-weighted Average*	*Deprivation Shares*
Western Cape	1362900	0.012	0.001	0.048	0.121	0.092	0.075	0.168	0.028	0.047	0.133	0.073	4.28%
		1.61%	**0.18%**	**6.65%**	**16.70%**	**12.67%**	**10.29%**	**23.21%**	**3.93%**	**6.46%**	**18.31%**	**100.00%**	
Eastern Cape	1795900	0.340	0.224	0.267	0.278	0.352	0.155	0.574	0.050	0.358	0.438	0.304	23.61%
		11.21%	**7.38%**	**8.80%**	**9.16%**	**11.60%**	**5.09%**	**18.89%**	**1.66%**	**11.79%**	**14.43%**	**100.00%**	
Northern Cape	293280	0.018	0.025	0.115	0.237	0.273	0.082	0.377	0.047	0.169	0.258	0.160	2.03%
		1.12%	**1.57%**	**7.21%**	**14.77%**	**17.05%**	**5.13%**	**23.56%**	**2.96%**	**10.53%**	**16.11%**	**100.00%**	
Free State	872450	0.037	0.016	0.137	0.194	0.219	0.078	0.382	0.056	0.138	0.285	0.154	5.82%
		2.38%	**1.03%**	**8.88%**	**12.56%**	**14.19%**	**5.08%**	**24.77%**	**3.66%**	**8.96%**	**18.50%**	**100.00%**	
Kwazulu-Natal	2535700	0.252	0.150	0.103	0.239	0.262	0.092	0.455	0.039	0.312	0.363	0.227	24.89%
		11.12%	**6.63%**	**4.55%**	**10.53%**	**11.54%**	**4.07%**	**20.08%**	**1.70%**	**13.76%**	**16.02%**	**100.00%**	
North West	943780	0.035	0.059	0.091	0.174	0.247	0.114	0.401	0.041	0.265	0.323	0.175	7.15%
		2.02%	**3.39%**	**5.18%**	**9.96%**	**14.10%**	**6.52%**	**22.90%**	**2.37%**	**15.11%**	**18.44%**	**100.00%**	
Gauteng	3240500	0.008	0.008	0.029	0.129	0.102	0.065	0.220	0.030	0.106	0.146	0.084	11.82%
		1.01%	**1.00%**	**3.40%**	**15.33%**	**12.07%**	**7.74%**	**26.08%**	**3.52%**	**12.55%**	**17.30%**	**100.00%**	
Mpumalanga	887760	0.077	0.076	0.091	0.155	0.290	0.104	0.417	0.046	0.243	0.309	0.181	6.95%
		4.24%	**4.18%**	**5.05%**	**8.57%**	**16.03%**	**5.75%**	**23.08%**	**2.55%**	**13.46%**	**17.08%**	**100.00%**	
Limpopo	1315800	0.084	0.107	0.102	0.247	0.337	0.062	0.549	0.018	0.345	0.511	0.236	13.46%
		3.55%	**4.53%**	**4.32%**	**10.46%**	**14.27%**	**2.63%**	**23.25%**	**0.77%**	**14.59%**	**21.62%**	**100.00%**	
SA Total	13248000	0.117	0.083	0.102	0.193	0.223	0.090	0.381	0.037	0.221	0.297	0.174	100.00%
		6.68%	**4.75%**	**5.86%**	**11.06%**	**12.79%**	**5.19%**	**21.82%**	**2.12%**	**12.68%**	**17.04%**	**100.00%**	

Author's calculations using GHS (2007) dataset.

Table 9b: The AF-measure-suggested revenue distribution to each dimension in each province - equal weights (k=3)

Provinces	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Edcation*	*6.Hunger*	*7.Expenditure*	*8.Harassment*	*9. Health Proximity*	*10. Employment*	*Total*
Western Cape	137	16	567	1,424	1,080	877	1,979	335	551	1,561	8,527
Eastern Cape	**5,276**	**3,473**	**4,141**	**4,312**	**5,457**	**2,396**	**8,891**	**779**	**5,548**	**6,789**	**47,063**
Northern Cape	45	63	292	599	691	208	955	120	427	653	4,055
Free State	**276**	**119**	**1,031**	**1,458**	**1,647**	**590**	**2,875**	**425**	**1,040**	**2,148**	**11,608**
Kwazulu-Natal	5,517	3,288	2,259	5,224	5,726	2,020	9,964	843	6,828	7,949	49,618
North West	**289**	**484**	**739**	**1,420**	**2,010**	**930**	**3,266**	**338**	**2,154**	**2,629**	**14,259**
Gauteng	237	236	802	3,612	2,843	1,824	6,146	829	2,957	4,077	23,564
Mpumalanga	**588**	**580**	**699**	**1,187**	**2,221**	**796**	**3,197**	**353**	**1,864**	**2,365**	**13,849**
Limpopo	954	1,216	1,160	2,808	3,830	705	6,239	207	3,914	5,801	26,834
SA Total	**13,319**	**9,474**	**11,689**	**22,043**	**25,508**	**10,346**	**43,512**	**4,230**	**25,283**	**33,972**	**199,377**

Author's calculations using GHS (2007) dataset.

Note: In thousands of Rands.

3) The provincial averages are then divided by South Africa's average to obtain the "deprivation share" of each province.

4) The total revenue to be allocated by the PES in 2008 (R199.4 million) is multiplied by each provincial deprivation share to obtain the overall revenue allocation for each province.

5) Furthermore, these overall revenues are allocated among the well-being dimensions by multiplying them with the dimensional deprivation shares calculated previously.

6) As a result, alternative allocations of the same total revenue have been obtained by using a framework based on the AF measure.

Dimensional "deprivation shares" indicate the contribution of each dimension to the overall M_0 (which is taken as 100%) in a particular province and these are independent of other provinces' deprivation results. Hence, the dimensional deprivation shares of two provinces should not be compared to each other unless these provinces have similar values in the "dimension-weighted average" column. For example, two of the least deprived provinces (Western Cape and Gauteng) have relatively similar poverty levels; however, the dimensional contributions vary significantly. According to Table 6a, for example, the former is better off in terms of health dimension whereas the education level is more satisfactory in the latter. Water is not a significant problem in Western Cape unlike Gauteng. However, Gauteng is performing better in the nutrition dimension than Western Cape. Tables 6-9 show a detailed allocation scheme of revenues among the dimensions within each province according to the framework developed here, which is based on the AF measure and alternative weighting schemes.

Table 10 reports the breakdown of multidimensional poverty according to the population groups. The GHS (2007) sample is nationally representative. Gauteng has the largest share of the population (24.5%), followed by KwaZulu-Natal (19%) and Eastern Cape (13.5%). Northern Cape has the least number of South Africans (2.2%), followed by Free State (6.6%) and Mpumalanga (6.7%)[23]. In terms of the population groups[24], the distribution is dominated by "Africans" (78%), followed by "Whites" (12%), "Coloureds" (7.5%) and "Indians" (2.5%). Based on Table 10, averages obtained using the AF measure, which are both dimension and population-weighted, show

[23] The provincial populations used to calculate these ratios are available in Tables 6-9.

[24] "Africans" are black Africans, "Coloureds" are descendants of the mixed-race couples, "Indians" are descendants of Indian immigrants, "Whites" are descendants of European immigrants. These racial categories are inherited from the Apartheid era.

Table 10: Contribution of each dimension to overall poverty of each population group - equal weights (k=3)

Provinces	*Population*	*1. Housing*	*2.Drinking Water*	*3.Sanitation*	*4.Home/Cell phone*	*5.Years of Education*	*6.Hunger*	*7.Expenditure*	*8.Harassment*	*9. Health Proximity*	*10. Employment*	*Dimension-weighted Average*	*Deprivation Shares*
Africans	10319000	0.130	0.096	0.105	0.162	0.205	0.088	0.293	0.032	0.198	0.245	0.155	96.39%
		8.35%	**6.15%**	**6.77%**	**10.46%**	**13.19%**	**5.64%**	**18.90%**	**2.04%**	**12.73%**	**15.76%**	**100.00%**	
Coloureds	1017700	0.008	0.008	0.030	0.094	0.087	0.042	0.104	0.021	0.045	0.080	0.052	3.18%
		1.60%	**1.55%**	**5.79%**	**18.17%**	**16.78%**	**8.15%**	**19.95%**	**3.99%**	**8.69%**	**15.32%**	**100.00%**	
Indians	324640	0.000	0.000	0.000	0.026	0.012	0.014	0.033	0.000	0.018	0.033	0.014	0.27%
		0.00%	**0.36%**	**0.36%**	**19.18%**	**8.81%**	**10.37%**	**23.97%**	**0.00%**	**13.12%**	**23.83%**	**100.00%**	
Whites	1586900	0.000	0.000	0.000	0.004	0.001	0.001	0.002	0.001	0.004	0.004	0.002	0.17%
		0.00%	**0.83%**	**1.97%**	**22.46%**	**7.97%**	**6.29%**	**11.05%**	**3.22%**	**24.33%**	**21.90%**	**100.00%**	
SA Total	13248000	0.102	0.075	0.084	0.135	0.167	0.072	0.238	0.026	0.158	0.198	0.125	100.00%
		8.10%	**5.98%**	**6.72%**	**10.75%**	**13.29%**	**5.74%**	**18.94%**	**2.10%**	**12.62%**	**15.78%**	**100.00%**	

Author's calculations using GHS (2007) dataset.

the dramatic fact that more than 96% of total poverty in South Africa affects Africans, followed by 3% Coloureds. Indians and Whites share the remaining half a percent, Whites being less deprived than Indians. The equal weights scheme have been employed for the results shown in Table 10; however, these results are robust to other weighting schemes available.

Table 11 summarises the total provincial revenue-allocation findings (without detailed dimensional breakdown) of Tables 6-9, and compares them with the current provincial revenue allocation by using the PES scheme. Based on the R199.4 million allocated to provinces in 2008, the AF measure suggests a higher level of revenue to be allocated to more deprived provinces such as KwaZulu-Natal and Eastern Cape and less revenue to relatively better-off ones such as Western Cape and Gauteng, as shown in Table 11. The difference with the PES allocation can be as high as R24 million in the case of Eastern Cape, for example, when the BNA weighting scheme is employed.

Even though both of these methods share the same goals[25] in general, the PES formula is population-driven[26] whereas our allocation suggestions based on the AF measure are deprivation-driven. In addition, the ratios that lead to the ultimate weighted-average of PES are obtained through interprovincial calculations whereas the final outcome of the AF measure is province-specific. Hence, if there was a certain revenue for each component (i.e. education), PES would suggest (albeit controversially) how much of it should be allocated to a particular province[27]. However, since the revenues are allocated to provincial governments which further allocate[28] this revenue into individual components, it can be argued that the framework developed

[25] The target of PES is "to strengthen the social services programmes that have a high impact on human development and quality of life" (National Treasury 2008, pp.11). Three main policy priorities underpinning equal share revisions are public schooling, health and social development programmes.

[26] "Because the formula is largely population-driven, the allocations it generates are sensitive to and capture shifts in population across provinces". (National Treasury 2008, pp.12)

[27] This would still be controversial as the criteria of this component is the size of the school-age population. A province with, say, five million school-age population where "only" one million are having difficulties in registering as a member of a school or to have a teacher would require less money than a province that has a school-age population of three million with two million of them being "education-deprived".

[28] "Provincial executive councils have discretion regarding the determination of departmental allocations for each function, taking into account the priorities that underpin the division of revenue". (Division of Revenue Bill 2008, pp. 65)

Table 11: Comparison of revenue allocations - current PES vs. AF-based method by using the extended list and the alternative weighting schemes

	Current PES		AF-based method					
			PCA-weighted		*BNA-weighted*		*Equal weighted*	
Provinces	Percentage Revenue	Revenue	Percentage Revenue	Revenue	Percentage Revenue	Revenue	Percentage Revenue	Revenue
Western Cape	8.9%	17,739	4.0%	8,044	2.9%	5,798	4.3%	8,527
Eastern Cape	**15.8%**	**31,383**	**23.1%**	**45,973**	**27.9%**	**55,593**	**23.6%**	**47,063**
Northern Cape	2.7%	5,341	2.0%	4,081	1.7%	3,476	2.0%	4,055
Free State	**6.2%**	**12,414**	**5.7%**	**11,438**	**4.4%**	**8,793**	**5.8%**	**11,608**
Kwazulu-Natal	21.7%	43,246	24.9%	49,718	28.1%	55,932	24.9%	49,618
North West	**6.9%**	**13,821**	**7.2%**	**14,420**	**7.1%**	**14,076**	**7.2%**	**14,259**
Gauteng	16.6%	33,064	11.7%	23,361	8.3%	16,549	11.8%	23,564
Mpumalanga	**8.2%**	**16,436**	**7.0%**	**14,010**	**7.1%**	**14,207**	**6.9%**	**13,849**
Limpopo	13.0%	25,935	14.2%	28,331	12.5%	24,952	13.5%	26,834
SA Total	**100%**	**199,377**	**100%**	**199,377**	**100%**	**199,377**	**100%**	**199,377**

Source: Division of Revenue Bill 2008 (pp.25, 63, 66) and author's calculations using GHS (2007) dataset.

Note: Revenue columns are in thousands of Rands.

here based on the AF measure provides better guidance for within-province allocations. More importantly, the policy implications of PES are more obscure as the components are not always stated explicitly or the final outcome cannot be decomposed adequately[29].

Therefore, the policy implications of a decomposable multidimensional measure (such as the Alkire-Foster) are two-fold: Firstly, for a given set of weights, it suggests a unique provincial ranking that affects the initial allocation of funds from the central government. Intuitively, given that the measure itself is robust, these ranking should be more reliable as the AF measure considers a wide range of dimensions that affect the well-being of the citizens. Secondly, it further decomposes the overall poverty level shown by the measure into the dimensions chosen. This key virtue empowers the provincial governments to determine how to allocate the funds (as shown in Tables 6-9) and where to start. Moreover, it provides guidance for the central government to be able to oversee the process for policing purposes.

7 Conclusion

The application of Foster-Greer-Thorbecke, Anand-Sen and Alkire-Foster families of measures yield different provincial deprivation rankings in the South African context (Table 5). This paper takes the ranking analysis one step further and develops a framework based on the AF measure which provides direct policy implications in provincial revenue allocation. As a result, based on three weighting schemes, three provincial revenue-allocation schemes have been obtained (Tables 7a-9a). More importantly, based on ten well-being dimensions, precise dimensional allocation of these revenues have been calculated for each province (Tables 7b-9b).

Different poverty measures yield different provincial allocations of lump-sum revenues; however, due to the necessity for multidimensional decomposability, only a limited number of measures can precisely allocate this sum to individual well-being dimensions. The Provincial Equitable Shares method, which is currently used in South Africa, is population driven whereas the decomposable AF measure is deprivation-driven. Hence, the AF-based framework developed in this paper suggests higher revenues[30] to be allocated to

[29] Some further problems with PES are analysed by Alm and Martinez-Vazquez (2009).

[30] The BNA-weighted scheme favors KwaZulu-Natal around R12 million and Eastern Cape around R24 million as opposed to the PES scheme, and allocates around R17 million

poor provinces such as KwaZulu-Natal and Eastern Cape (as high as R24 million when BNA weighting scheme is used) and lower revenues to be allocated to relatively better-off provinces such as Western Cape and Gauteng, as opposed to the current PES allocation scheme. The results are robust to alternative selections of across-dimension cut-offs and weighting schemes.

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9 Appendix

9.1 Poverty-Line Adjustments for FGT measures

The poverty lines used and the policy suggestions they yield vary according to each individual municipality. The Department of Provincial and Local Government (DPLG) recommends R800 as an income threshold but municipalities use two and three-folds of this quantity per month (Woolard and Leibbrandt, 2006). Therefore, for comparability, we use R800, R1600 and R2400 poverty lines which yields R827, R1655 and R2483, respectively, in July 2007 prices. These values have been used in this paper and the formula used to obtain them is the same as below.

In addition to these three lines that we have used to estimate the headcount ratio at the household level, we consider the Consumer Price Index-adjusted \$1/day and \$2/day poverty lines here for comparison purposes. In order to calculate the purchasing power parity (PPP) conversion factors to adjust for inflation changes since the end of the Apartheid era (1993), we use the Consumer Price Index (CPI) for the month of survey (July 2007) and the technical explanations are given in Woolard and Leibbrandt (2006). CPI data is available in Statistics South Africa (SSA) and the PPP data is from

less to Gauteng and R12 million less to Western Cape.

Penn World Tables at http://pwt.econ.upenn.edu/. Hence, for South Africa, we have:

Current PPP = 1993PPP * (CPIcurrent/ CPIave1993)

where

1993PPP= 1.67

CPIjul2007 = 144.4

CPIave1993 = 61.2

Thus:

Jul2007PPP = R1.67/$ * (144.4/61.2) = R3.94/$

Hence the "$1-a-day" (which is really $370 per annum or $1.08 per day in 1993PPP prices) is equivalent to R4.26 per day at October 2008 prices. (R127.7/month)

Likewise, "$2-a-day" is the equivalent of R255.4/month.

By looking at the Population and Household Projections 2001 – 2021 report (Aart, 2007), a crude estimate of the average household size would be 3.51 (given that it was 4.48 in 1996 and 3.69 in 2005 and the trend is downwards since then). Therefore, the household correspondence of the "$1-a-day" (per person) would be R448.23 (and similarly, "$2-a-day" would be R896.46).

9.2 Axioms (mentioned)

A complete list of axioms can be found in the Alkire and Foster (2007). The axioms used here are the following:

Decomposability – for any two subgroups (n_1 and n_2) of the population n, with achievement matrices x_1 and x_2, we have

$M(x; z) = \frac{n_1}{n} M(x_1; z) + \frac{n_2}{n} M(x_2; z)$

Weak Monotonicity – if a new matrix x is obtained from another matrix y by a simple increment, then $M(x; z) \leq M(y; z)$.

Monotonicity – in addition to weak monotonicity condition, the following condition should be satisfied: if a new matrix x is obtained from another matrix y by a deprived increment among the poor, then $M(x; z) \leq M(y; z)$.

Dimensional Monotonicity – if a new matrix x is obtained from another matrix y by a dimensional increment among the poor, then $M(x; z) \leq M(y; z)$.

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