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Multidimensional Poverty in Bhutan: Estimates and Policy Implications

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Abstract

This paper estimates multidimensional poverty in Bhutan applying the methodology developed by Alkire and Foster using the 2007 Bhutan Living Standard Survey data. Five dimensions are considered for estimations in both rural and urban areas: income, education, room availability, access to electricity and access to drinking water, and two additional dimensions are considered for estimates in rural areas only: access to roads and land ownership. It is found that multidimensional poverty is mainly a rural phenomenon, although urban areas present non-depreciable levels of deprivation in room availability and education. Within rural areas, weighting each indicator equally, deprivation in electricity, education room and income are the highest and similar in contribution to aggregate multidimensional poverty. When weights derived from the Gross National Happiness Survey are used, income deprivation significantly increases its contribution as it receives a higher weight. Rankings of districts by their poverty estimate are found to be robust for a wide range of poverty cutoffs. The methodology is suggested as a potential formula for national poverty measurement as well as a tool for budget allocation.

Keywords: multidimensional poverty measurement, counting approach, Bhutan, budget distribution, MDGs.

JEL classification: D31, I32.

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Acronyms

BLSS	Bhutan Living Standard Survey
GNHS	Gross National Happiness Survey
HDI	Human Development Index
HPI	Human Poverty Index
MDGs	Millenium Development Goals
NSB	National Statistics Bureau
RGB	Royal Government of Bhutan

The Oxford Poverty and Human Development Initiative (OPHI) is a research centre within the Oxford Department of International Development, Queen Elizabeth House, at the University of Oxford. Led by Sabina Alkire, OPHI aspires to build and advance a more systematic methodological and economic framework for reducing multidimensional poverty, grounded in people's experiences and values.

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1. Introduction

Fostered by Sen's (1985, 1990, 1999) pioneering 'capability approach', there is now an increasing consensus that poverty is an intrinsically multidimensional phenomenon. This has led scholars to propose different multidimensional poverty measures. However, some of the proposed measures seem to have incorporated a multidimensional perspective at the cost of giving up the simplicity and intuition that characterise the unidimensional measures. Departing from this, Alkire and Foster (2007) propose a new family of multidimensional poverty measures, which is a variant of the extensively used Foster, Greer and Thorbecke's (1984) class of one-dimension poverty measures (FGT hereafter). The *dimension adjusted* FGT measures keep the simple structure of the one-dimension case and satisfy a set of convenient properties, among which decomposability across population subgroups and the possibility to break it down by dimension are useful for policy purposes.

In this paper, the Alkire and Foster class of measures is applied to estimate multidimensional poverty in Bhutan. Constituting an extremely interesting example of how a country can define development goals, tailor its policies to these goals, and see them materialise, since 1961, Bhutan implemented coordinated efforts towards development through ten consecutive five-years-plans. In particular, the country has made significant progress in extending access to safe drinking water and sanitation, protecting and managing the country's natural resources, providing basic health care and increasing access to primary education. However, more can still be done in some of these areas, as well as in others. Within this development agenda, the Millennium Development Goals (MDGs) play a key role, as Bhutan is seriously committed to contributing to the realisation of the Millennium Declaration.

In this context, this paper intends not only to present estimates of multidimensional poverty in Bhutan, which would complement the income poverty estimates performed by the National Statistics Bureau, but also to suggest the applied methodology as a potential formula for budget allocation among the twenty districts, and within each district, among the different *gewogs*, the lowest administration units.

The data used in this paper correspond to the 2007 Bhutan Living Standard Survey. It constitutes a unique data source, representative both at the national and district levels. Estimations are performed for rural and urban areas considering five dimensions, and for rural areas exclusively, two additional dimensions. Each measure is also estimated at the district level using two alternative weighting structures: a baseline of equal weights and one with weights derived from the ranking of 'sources of happiness' identified through the Gross National Happiness Survey (GNHS).

Results confirm that, indeed, income deprivation should not be the only considered dimension. Deprivation in other dimensions such as education, access to electricity and room availability in the house are significant both in rural and urban areas, and not necessarily related to deprivation in income. Additionally, deprivation in access to roads is a significant component of multidimensional poverty in the rural areas. Land ownership in rural areas and access to drinking water in both rural and urban areas, seem to be relatively less important. It is also found that multidimensional poverty is mainly a rural problem, which is particularly important given that 74 per cent of the population in Bhutan live in rural areas. When analysing at the district level, it is suggested that a ranking of the districts by the multidimensional poverty estimates could prove to be useful for per capita budget allocation among districts and within them across dimensions, given than these rankings seem to be robust across different cutoffs that identify the multidimensionally poor.

The rest of the paper is organised as follows. Section 2 briefly revises the literature on multidimensional poverty measures. Section 3 presents the methodology used in the paper (measures estimated, dataset used, selected dimensions, deprivation cutoff values and weighting structures). Section 4 presents the estimation results, and Section 5 contains the concluding remarks.2 Gross National Happiness Index

2. Literature Review

Since Sen (1976), the measurement of poverty has been conceptualised as following two main steps: identification and aggregation. In the unidimensional space, the identification step is a relatively easy one. Even when it is recognised that the concept of a poverty line—as a threshold that dichotomises the population into the poor and the non-poor—is somehow artificial, it is agreed to be necessary. Greater consideration is given to the properties that should be satisfied by the poverty index that will aggregate individuals' data into an overall indicator. However, in the multidimensional context, the identification step is more complex. Given a set of dimensions, each of which has an associated deprivation cutoff or poverty line, it is possible to identify for each person whether he/she is deprived or not in each dimension. However, the difficult task is to decide who is to be considered multidimensionally poor.

One proposed approach to identify the multidimensionally poor has been to aggregate achievements in each dimension into a single cardinal index of well-being, and set a deprivation cutoff value for the well-being measure rather than for each specific dimension. This approach has some practical drawbacks, in particular, that it is based on a number of restrictive assumptions such as the existence of prices for all dimensions. Moreover, it does not agree with the conceptual framework of the capability approach that considers each dimension to be intrinsically important. Each dimension with its corresponding deprivation cutoff value then needs to be considered at the identification step of the multidimensionally poor.

In this perspective, two extreme approaches have been traditionally used. On one hand there is the *intersection* approach, which requires the person to be poor in every dimension under consideration so as to be identified as multidimensionally poor. Clearly, this is a demanding identification criterion by which the set of the poor is reduced as the number of dimensions considered increases, and may exclude people that are indeed deprived in several important dimensions. On the other hand there is the *union* approach, which requires the person to be poor in at least one of the considered dimensions. Clearly, with this criterion, the set of poor increases as the number of dimensions does, and it may include people that many would not consider to be multidimensionally poor (Alkire and Foster 2007: 8). The union approach has received important support both in the theoretical and empirical literature. In particular, Tsui (2002) and Bourguignon and Chakravarty (2003) adopt it for the measures they propose.

Tsui (2002) develops an axiomatic framework for multidimensional poverty measurement (which includes subgroup consistency) and derives two relative multidimensional poverty measures, one of which is a generalisation of Chakravarty's (1983) one-dimensional class of poverty indices, and the other is a generalisation of Watt's (1969) poverty index. He also derives two absolute multidimensional poverty measures.[1]

Bourguignon and Chakravarty (2003) distinguish two groups of multidimensional poverty indices, depending on whether they consider dimensions to be independent or to have some substitutability or complementarity. Those that consider attributes to be independent satisfy what they call the One Dimensional Transfer Principle, by which poverty decreases whenever there is a Pigou-Dalton progressive transfer of the achievement in some dimension between two poor people. The progressive nature of the transfer is judged by the achievements of the two poor people in that specific dimension, independent of the achievements in the other dimensions. These indices are additively decomposable.

[1] The distinction between relative and absolute poverty indices is due to Blackorby and Donaldson (1980). Relative poverty indices are invariant to changes in scale, such as a doubling of the poverty line and all incomes, while absolute indices are invariant to translations or additions of the same absolute amount to each income and to the poverty line (Foster and Shorrocks 1991). In practice, relative poverty indices are most frequently used.

The second group of indices are non-additive—i.e. non decomposable—and by choosing appropriate values of the parameters they can reflect either a substitutability or a complementarity relationship between the dimensions. For both groups of indices, extensions of the FGT class are proposed.

On a more practice-based perspective, the Unsatisfied Basic Needs Approach, widely used in Latin America, also uses a union criterion, identifying households with unsatisfied basic needs those that are deprived in one or more of the selected indicators.

In view of the two prevailing criteria to identify the multidimensionally poor, Alkire and Foster (2007) propose a new identification methodology which, while containing the two extremes, also allows for intermediate options, such as identifying as multidimensionally poor those that are deprived in k number of dimensions out of the total 'd' number of dimensions (three out of four dimensions, for example). For the aggregation step they use the FGT class of poverty indices. The resulting family of measures satisfies a set of convenient properties, including decomposability by population subgroups and the possibility of being broken down by dimensions, which make it particularly suitable for policy targeting. Additionally, the class includes measures that can be used with ordinal data, which is very common in a multidimensional context. A detailed description of this class of measures is presented in Section 3.2.

A final note must acknowledge probably the most popular multidimensional poverty measures, the Human Poverty Index (HPI) developed by Anand and Sen (1997), as a companion index to the Human Development Index (HDI). Both indices are periodically estimated by the United Nations Development Programme for all countries to monitor the level of deprivation and development correspondingly with a broader perspective than income. The components of the HPI are survival deprivation (measured by the probability at birth of not surviving to age 40), deprivation of education and knowledge (measured by the adult literacy rate) and economic deprivation (measured by the average of the percentage of population without access to an improved water source and children under weight for their age). In developed countries the indicators for each of the components are specified according to the higher living standards. An important advantage of the HPI is that it only requires macro-data, which can be especially important for countries in which micro-data collection is undeveloped and its quality is not assured. However, it has some disadvantages. Clearly it can be argued that the three selected dimensions are arbitrary as well as the weighting system used to calculate the measure. Also it does not allow identifying households or people suffering coupled deprivations. When micro-data sets are available more informative measures can be calculated, with a higher number of dimensions and alternative weighting systems.

3. Methodology

3.1 Data

The dataset used is the 2007 Bhutan Living Standard Survey (BLSS) conducted by the National Statistics Bureau (NSB). There are 9,798 households in the sample and 49,165 people. This is the second BLSS performed; previously done in 2003. Both surveys have followed the Living Standard Measurement Study methodology developed by the World Bank. However, the 2007 survey more than doubled the 2003 sample size and also has extended coverage, so the sample is representative both nationally and at each of the 20 Bhutanese districts (Dzongkhags), in rural and urban areas.

The unit of analysis to identify the poor is the household. However, households are weighted by their size (as well as by their sample weights), so that results are presented in population terms. Table A.1 in the Appendix presents the composition of the sample.

3.2 Multidimensional Poverty Measures

The poverty measure applied in this paper corresponds to Alkire and Foster's (2007) family of multidimensional poverty measures. Before introducing it, it is convenient to clarify the notation.

Assume for the moment that all dimensions are equally weighted. Let $M^{n,d}$ denote the set of all $n \times d$ matrices, and interpret a typical element $y \in M^{n,d}$ as the matrix of achievements of n people in d different dimensions. For every $i = 1,2,...,n$ and $j = 1,2,...,d$, the typical entry y_{ij} of y is the achievement of individual i in dimension j. The row vector $y_i = (y_{i1}, y_{i2},...., y_{id})$ contains the achievements of individual i in the different dimensions; the column vector $y_j = (y_{1j}, y_{2j},...., y_{nj})'$ gives the distribution of achievements in dimension j across individuals. Let $z_j > 0$ be the deprivation cutoff value (or poverty line) in dimension j. Following the Alkire and Foster (2007) notation, the sum of entries in any given vector or matrix v is denoted by $|v|$, while $\mu(v)$ is used to represent the mean of v (or $|v|$ divided by the number of entries in v).

For any matrix y, it is possible to define a matrix of deprivations $g^0 = [g_{ij}^0]$, whose typical element g_{ij}^0 is defined by $g_{ij}^0 = 1$ when $y_{ij} < z_j$, and $g_{ij}^0 = 0$ when $y_{ij} \geq z_j$. That is, the ij^{th} entry of the matrix is 1 when person i is deprived in dimension j, and 0 when he/she is not. From this matrix, define a column vector of deprivation counts, whose i^{th} entry $c_i = |g_i^0|$ represents the number of deprivations suffered by person i. If the variables in y are cardinal, then a matrix of normalised gaps $g^1 = [g_{ij}^1]$ can be defined, where the typical element $g_{ij}^1 = (z_j - y_{ij}) / z_j$ when $y_{ij} < z_j$, and $g_{ij}^1 = 0$ otherwise. The entries of this matrix are non-negative numbers between 0 and 1, and each non-zero entry gives the extent of the deprivation experienced by person i in dimension j. This matrix can be generalised to $g^\alpha = [g_{ij}^\alpha]$, with $\alpha > 0$, whose typical element g_{ij}^α is the normalised poverty gap raised to the α-power.

The Alkire and Foster (2007) methodology to identify the multidimensionally poor compares the number of deprivations with a cutoff level k. Then, this methodology is said to be a *dual cutoff* method, because it uses the *within dimension* cutoffs z_j to determine whether an individual is deprived or not in each dimension, and the *across dimensions* cutoff k to determine who is to be considered multidimensionally poor. It is also presented as a *counting approach*, since it identifies the poor based on the number of dimensions in which they are deprived. In general, for any weighting system, let ρ_k be the identification method such that $\rho_k(y_i, z) = 1$ when $c_i \geq k$, and $\rho_k(y_i, z) = 0$ when $c_i < k$. That means that an individual is identified as multidimensionally poor if he/she is deprived in at least k dimensions. If all dimensions are equally weighted, when $k = 1$, the identification criterion corresponds to the union approach, whereas when $k = d$, the identification criterion corresponds to the intersection approach. The range of k values for other weighting structures is explained below.

Once identification is applied, a censored matrix $g^0(k)$ can be obtained from g^0 by replacing the i^{th} row with a vector of zeros whenever $\rho_k(y_i, z) = 0$. Matrix $g^\alpha(k)$ can be defined analogously for $\alpha > 0$, with its typical entry $g_{ij}^\alpha(k) = g_{ij}^\alpha$ if i is such that $c_i \geq k$, while $g_{ij}^\alpha(k) = 0$ if i is such that $c_i < k$.

A first natural measure to consider is the fraction of the population that is multidimensionally poor: the multidimensional Headcount Ratio $H = H(y;z)$ defined by $H = q/n$, where q is the number of people identified as multidimensionally poor. This measure is analogous to the unidimensional Headcount Ratio, and has the advantages that it is easy to compute and understand, and can be calculated with ordinal data. However, it suffers from the disadvantages identified by Watts (1969) and Sen (1976) for the one-dimensional case, namely, being insensitive to the depth and distribution of poverty, violating monotonicity and the transfer axiom. Moreover, in the multidimensional context, it also violates what Alkire and Foster (2007) call *dimensional monotonicity*: if a poor person becomes deprived in an additional dimension (in which he/she was not previously deprived), H does not change (unless the intersection approach is ued in the identification step).

Considering this, Alkire and Foster (2007) propose the dimension adjusted FGT measures, given by $M_\alpha(y;z) = \mu(g^\alpha(k))$ for $\alpha \geq 0$. When $\alpha = 0$, the measure is the Adjusted Headcount Ratio, given by $M_0 = \mu(g^0(k)) = HA$, which is the total number of deprivations experienced by the poor ($|c(k)| = |g^0(k)|$), divided by the maximum number of deprivations that could possibly be experienced by all people (nd). It can also be expressed as the product between the percentage of multidimensionally poor individuals (H) and the average deprivation share across the poor, which is given by $A = |c(k)|/(qd)$. In words, A provides the fraction of possible dimensions d in which the average multidimensionally poor individual is deprived. In this way, M_0 summarises information on both the incidence of poverty and the average extent of a multidimensional poor person's deprivation. As H, this measure is easy to compute, and can be calculated with ordinal data. However, it is superior to H in that it satisfies dimension monotonicity: if a poor becomes deprived in an additional dimension, A will increase and therefore M_0 will also increase. The M_0 measure can be applied to ordinal or categorical data, since it only requires a dichotomization of the population into being deprived or not in each dimension.

When $\alpha = 1$, the measure is the Adjusted Poverty Gap M_1, which incorporates the average depth of deprivation among the poor (ie. satisfying monotonicity). When $\alpha = 2$, the measure is the Adjusted Squared Poverty Gap M_2, which—by squaring the gaps—provides incentives to prioritize the poorest among the poor (ie. it is sensitive to inequality of deprivations among the poor). Obviously, the M_1 and M_2 measures require cardinal data to be computed.

All members of the $M_\alpha(y;z)$ family are decomposable by population subgroups. Given two distributions x and y, corresponding to two population subgroups of size $n(x)$ and $n(y)$ correspondingly, the weighted sum of the subgroup poverty levels (weights being the population shares) equals the overall poverty level obtained when the two subgroups are merged:

$$M(x,y;z) = \frac{n(x)}{n(x,y)} M(x;z) + \frac{n(y)}{n(x,y)} M(y;z)$$

Clearly, this can be extended to any number of subgroups.

Additionally, once the identification step has been completed, all members of the $M_\alpha(y;z)$ family can be broken down into dimension subgroups. To see this, note that the measures can be expressed in the following way: $M_\alpha(y;z) = \sum_{i=1}^{n} \mu(g_{*j}^\alpha(k))/d$, where g_{*j}^α is the j column of the censored matrix $g^\alpha(k)$. Strictly speaking, this is not decomposability in terms of dimensions, since the information on all dimensions is needed to identify the multidimensionally poor. However, it is still a very convenient break-down property. Once identification has been applied, and the non-poor rows of g^{α} have been censored to obtain $g^{\alpha}(k)$, for each j, $(\mu(g^{\alpha}_{*j}(k))/d)/M_{\alpha}(y;z)$ can be interpreted as the post-identification contribution of dimension j to overall multidimensional poverty.

Because of its completely additive form, the $M_{\alpha}(y;z)$ family evaluates each individual's achievements in each dimension independently of the achievements in the other dimensions and of others' achievements, that is, it adopts the neutral assumption of considering dimensions as independent. In this way, the $M_{\alpha}(y;z)$ family can be associated with the first group of measures of Bourguignon and Chakravarty (1983).[2]

Until now, the $M_{\alpha}(y;z)$ family has been presented assuming that all dimensions receive the same weight. However, the family can be extended into a more general form, admitting different weighting structures. Let w be a d dimensional row vector, whose typical element w_j is the weight associated with dimension j. Then, define the matrix g^{α} of size $n \times d$, where the typical element $g^{\alpha}_{ij} = w_j((z_j - y_{ij})/z_j)^{\alpha}$ when $y_{ij} < z_j$, while $g^{\alpha}_{ij} = 0$ otherwise. As before, a column vector of deprivation counts can be defined from this matrix, whose i entry $c_i = |g^0_i|$ represents the sum of weights for the dimensions in which person i is deprived. c_i varies between the minimum weight ($\min\{w_j\}$) and d, and so the dimensional cutoff for the identification step of the multidimensionally poor will be a real number k, with $k = \min\{w_j\},...,d$. Note that when $k = \min\{w_j\}$, the criterion coincides with the union approach, whereas when $k = d$, it is the intersection approach. Also note that when $w_j = 1$, it is the previous case where all dimensions receive the same weight and the dimensional cutoff k is an integer. Then, the methodology works exactly in the same way as before, defining the censored matrices $g^{\alpha}(k)$, and the $M_{\alpha}(y;z)$ measures being the mean of the corresponding matrix.

3.3 Dimensions and Deprivation Cutoffs

The selection of the dimensions for the multidimensional poverty measure is guided by the eight Millenium Development Goals (MDGs) defined by the Millenium Declaration—to which Bhutan has seriously committed— with some restrictions due to data availability.[3] Table 1 presents the dimensions with their corresponding cutoff values.

Having an adequate income, and for rural households, having access to roads and owing some land, can be framed into the first MDG, which is *to eradicate extreme poverty and hunger*. For the income cutoff, the official Bhutanese poverty line was used, which is calculated in Nu 1,096.94 per capita, per month. During 2007, this was equivalent approximately to US$25. This poverty line is composed of a food

[2] Alkire and Foster (2007) explain that their measures can be converted into measures that consider either all dimensions as substitutes or all dimensions as complements, and in this way, they would be in line with the second type of measures considered by Bourguignon and Chakravarty (2003). However, such transformation would be at the cost of losing the possibility of breaking down the measure into dimensions.

[3] The eight MDGs are: 1: Eradicate extreme poverty and hunger, 2: Achieve universal primary education, 3: Promote gender equality and empower women, 4: Reduce child mortality, 5: Improve maternal health, 6: Combat HIV/AIDS, malaria and other diseases, 7: Ensure environmental sustainability, 8: Develop a global partnership for development.

poverty line, which is the cost of a food basket consisting of 53 items considered to fulfil the requirement of 2,124 Kcal. per person per day, plus a non-food allowance.[4] Given that the percentage of people below the food poverty line is only 6 per cent, the target in Bhutan with respect to this MDG is halving poverty —rather than only extreme poverty (Royal Government of Bhutan, RGB hereafter, 2005). This is why the overall poverty line and not just the food poverty line is used for the multidimensional poverty estimation. If a household does not make a monthly per capita income of at least Nu 1,096.94, it is considered *income deprived*, and so are all its household members.

To achieve the goal in terms of income poverty, Bhutan faces some significant constraints, one of which is the geographical isolation of some rural areas. Lack or limited road access and links to markets impede the development of the area and, more seriously, can cause food shortage in remote regions. The further development of rural road and communication infrastructure and access to markets has become a priority in the country. Based on this, access to services is included among the selected dimensions. A household in a rural area that can not reach a road within 30 minutes by any means of transport, it is considered to be *access deprived*, and so are all its household members.[5]

Table 1: Selected dimensions, deprivation cut-off values and weights

Dimension	Deprivation cutoff value
Rural and Urban Areas	
Related to MDG 1: Eradicate Extreme Poverty and Hunger	
Income	Have monthly per capita income of Nu 1096.94 pc p/month (Bhutan Poverty Line)
Related to MDG 2: Achieve Universal Primary Education	
Education	At least one literate household member and all children between 6 and 16 are going to school
Related to MDG 7: Ensure Environmental Sustainability	
Electricity	Access to electricity
Drinking Water	Access to either pipe in dwelling, neighbour's pipe, public outdoor tap or protected well
Room Availability	Less than 3 people per room
Rural Areas Only: Two additional MDG1-related dimensions are considered	
Roads	Access to a road in 30 minutes or less by any means of transport
Land	Own at least 1 acre of land of any kind (Land is the sum of wet land, dry land, orchard and tseri)

Another potential constraint to reduce poverty regards land ownership. Households in rural areas with small land holdings are at risk in terms of food access, since small land holdings are usually compounded with low productivity, inadequate storage facilities, poor irrigation and vulnerability to natural disasters, crop depredation by wild animals, birds and pests (RGB 2005: 26-28). The BLSS has information on different types of land holdings: wet land, dry land, orchard, sokshing (leaf litter wood lot), pasture and

[4] The 2,124 Kcal per person per day is the nutritional norm applied in Nepal, and the NSB decided to follow it for the case of Bhutan. The cost of the food poverty line is Nu 407.98, which in 2007 was equivalent to US$9 approximately. The NSB does not account for differences in nutritional requirements across age and sex, that is, they do not use equivalised scales. They do not account for economies of scale in the household either. Although it is a common practice to consider both issues in poverty estimates, it was decided to stick to the NBS methodology to make the results of this paper comparable to the official income poverty estimates. The non-food allowance is estimated averaging the non-food per capita expenditure of households in the reference population that spent for food a value near the food poverty line.

[5] Roads include either feeder or tarred ones.

tseri (swidden cultivation land). Given that sokshing and pastures have been recently nationalised, it was decided to only consider the other four types of land. Despite the differences of land qualities between the various types of land, a deprivation cutoff of 1 acre of total land holding (either any of them or the sum of any combination) was defined. The selected threshold is clearly debatable; however, 1 acre seems a reasonable amount of land that would allow cultivation for subsistence, even considering that land quality may vary.[6] A household in a rural area with less than 1 acre of land holdings is considered to be *land deprived*, along with all its members.

A third selected dimension is closely related to the second MDG: *achieve universal primary education*. Bhutan's target is that by 2015 all children are able to complete a full course of primary schooling. The country has achieved significant progress towards this target, raising the primary enrolment rate from 55 per cent in 1990 to 84 per cent in 2004. Reaching children in rural and remote communities, reducing early dropouts, and improving the quality of education are among the priorities of the education policy and programmes. A need to expand secondary school education has also been identified, as the number of those completing primary education continues to increase.

The education indicator constructed for this paper is composed of two requirements. First, following Basu and Foster's (1998) idea of *proximate literacy*, it is required that at least one household member is literate. The logic behind this is that illiterate people that live in a household where at least someone is literate enjoy some of the literate person's abilities; in other words, they enjoy an intra-household externality. Despite the literacy rate in the country being low (55 per cent), the proximate literacy requirement is a mild one, since even if the adults in the household are illiterate, as long as the children are literate—which is very likely given the progress in primary school enrolment, the household will be considered literate. However, the second requirement for the education indicator is that all children between 6 and 16 years of age are attending school; in line with the MDG. On the one hand, it is more demanding than the target set in the MDG, in that children are required to be in school even at an older age than what primary education demands. On the other hand, it is not excessively demanding since children are not required to be in the school grade corresponding to their age (even if a 16 year old was in primary school, the household would satisfy the requirement). A household with no-literate member and with children between 6 and 16 years of age that are not attending school is considered to be *education deprived*, and so are all its household members. If a household has no children between 6 and 16 years, only the literacy requirement applies.

The following two dimensions are directly related to MDG 7: *ensure environmental sustainability*. Increasing the access to electricity (especially in rural areas) is one of the key objectives within this goal, since it will not only improve the living conditions of the rural population but it will also reduce the proportion of population using solid fuels, thereby improving air quality. Bhutan would like to achieve 'electricity for all' by 2020 and it is working steadily towards this goal. A household with no access to electricity is considered to be *electricity deprived*, and so are all its members. Access to safe drinking water is another key objective within this goal and Bhutan has progressed significantly in increasing this access.[7] However, there are areas in which more progress can still be made, so this dimension was selected as one to be considered for multidimensional poverty measurement. A household with no access to either a pipe in dwelling, a neighbour's pipe, a public outdoor tap or a protected well, is considered to be *water deprived*, and so are all its members.

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6 Although an absolute poverty line approach is followed for all indicators in this paper, it is worth mentioning for reference that 1 acre is half of the median rural land holdings and less than the country's median land holdings (which is 1.32 acres).

7 Between 2002 and 2005, the proportion of the population without access to safe drinking water was reduced by two thirds (RGB, 2005: 10)

It is worth mentioning that the goal of ensuring environmental sustainability includes increasing access to safe sanitation. However, as Bhutan has progressed tremendously in extending access to improved sanitation, only 3.6 per cent of the population is deprived in this dimension. Therefore, it was decided not to include it among the dimensions of the multidimensional poverty measure to be estimated.

Finally, the number of people per room in the household is also considered. Although this is not included as a target in the MDGs, it is a commonly used socio-economic assessment indicator, providing a measure of housing quality. It is mentioned as an indicator in UNDP (2003) *Indicators for Monitoring the Millennium Development Goals*, and can be related to MDG7 since overcrowding incubates disease and does not contribute to a sustainable environment. A household with three or more people per room is considered to be *room deprived*, and so are all its members.[8] The number of rooms excludes kitchens, bathrooms, toilets and balconies.

Clearly, the list of dimensions is not intended to be exhaustive. There are another four MDGs that Bhutan is trying to accomplish, and within all eight goals there are other indicators that could be considered. However, there are two difficulties. First, not all goals and targets are applicable to obtain a multidimensional poverty estimate from micro-data that is relevant for the whole population. For example, while *improving maternal health* (MDG 5) is of utmost importance, indicators that account for these issues at the household level would only have meaning for households with pregnant or recently pregnant women. Second, even when indicators on some goals, such as *reducing child mortality* (MDG 4), or *combating HIV/AIDS, malaria and other diseases* (MDG 6) could be included, the BLSS does not provide information on these issues. MDG 3, *promoting gender equality and empowering women*, is fundamental, but centred on a specific part of the population. Finally, the targets included in MDG 8 of *developing a global partnership for development* (such as telephone density or computers in use) might not be necessarily associated with poverty, especially in a country that is in the first stages of modernisation.

All the selected dimensions refer to material conditions. However, there is basis to argue that other non-material conditions should also be included in the measurement of multidimensional poverty, as is suggested by the capability approach. The Oxford Poverty and Human Development Initiative (OPHI), at the University of Oxford, has identified five *missing dimensions* of poverty, namely: the quality of employment, empowerment (agency), physical safety, the ability to go about without a shame, and psychological and subjective well-being (Alkire 2007). Unfortunately data on any of these dimensions is not available in the BLSS, so indicators related to these dimensions can not be included in the estimations of this paper. Most of these data are available in this GNHS but the period of survey and respondents are not compatible with the BLSS dataset. The GNHS does not include questions on a few requisite data like water. However, Bhutan is planning to incorporate questions on these issues in poverty surveys in the near future. This will eventually allow broadening and enriching the present analysis.

In any case, given Bhutan's interest in non-traditional dimensions and in a holistic approach to the measurement of well-being, the main purpose of this paper is an illustrative one: to demonstrate the methodology and its potential both for multidimensional poverty measurement as well as for budget allocation. A different list of dimensions could be used eventually.

Provided that four out of the seven selected indicators are dichotomous variables, only the multidimensional Headcount Ratio H and M_0 are estimated. These two measures are estimated for both urban and rural areas considering the five dimensions applicable to both areas: Income, Education,

[8] This is the threshold commonly used.

Room Availability, Electricity and Water. The two measures are also estimated only for rural areas considering all the seven dimensions.

3.4 Weighting

The selection of dimensions to be included is not the only controversial task when measuring multidimensional poverty. Defining the weights to give to each dimension is another difficult issue since it implicitly entails value judgements (Decanq and Lugo 2008). In this paper, two groups of estimations were performed for each measure. One of them uses equal weights, assigning a value of one to each dimension. This can be thought as a benchmark, since it implicitly assumes that all dimensions are equally important.

The second group of estimates uses a set of weights derived from the 2007 GNHS. One of the questions in the survey, which had a sample size of 950 people, required the respondent to rank his/her sources of happiness. The question was an open one, so that the respondent could mention any source of happiness that was important to them. Answers were then grouped and categorised. Interestingly, the seven dimensions selected in this paper are among the dimensions ranked in the ten first places.[9] The percentage of people that placed each of the selected dimensions at some point in the ranking was re-scaled so as to add up to the total number of dimensions used, obtaining the weights listed in Table 2.

Table 2: Weights derived from the Gross National Happiness Survey

Dimension	Respondents who identified source of happiness (%)	Weights used for estimations in the urban & rural areas	Weights Used for estimations in the rural areas only
Income	41	2.0	2.0
Education	27	1.3	1.3
Room Availability	14	0.7	0.7
Electricity	16	0.8	0.8
Water	4	0.2	0.2
Access to Roads	27	-	1.3
Land Ownership	15	-	0.7
		5	**7**

Note: Room Availability was not listed itself as a source of happiness, but 'Housing' was, so the percentage of people mentioning this was used to derive this weight. Access to roads was listed within 'Transportation'.

[9] The list of 'sources of happiness' derived from this question of the GNHS, ranked in order of their preference reads: financial security, transportation, education, good health, family relationships, agricultural productivity, electricity, basic needs (food, clothing, shelter, cleaning drinking water), land, housing, good governance, health infrastructure and facilities, faith and spiritual practices, community relationship, job, national security, communication facilities, environment, sports and travel (around the country and abroad).

4. Estimation Results

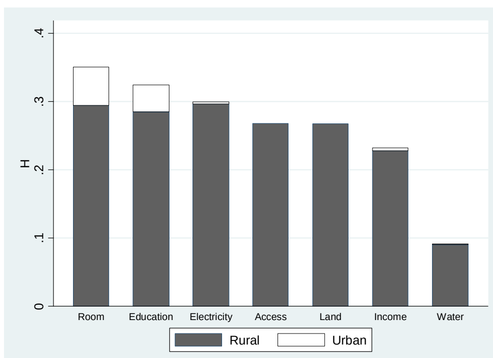
4.1 Aggregate deprivation by dimension

Figure 1 presents the estimated headcount in each dimension, ranked from highest to lowest. It also shows the contribution to the overall deprivation in each of them by rural and urban areas. Note that, by definition, all of the deprivation in Access to Roads and Land Ownership corresponds to rural areas.

From this figure, it can be seen that while 23 per cent of the population do not earn enough income to afford the basic needs basket, the incidence of deprivation in all the other dimensions except for water is higher. In particular, 35 per cent of the population of Bhutan live in a household with three or more people per room, 32 per cent live in a household where either no-one is literate or there are children of school age not going to school and 30 per cent who do not have access to electricity. Only 9 per cent do not have access to drinking water.

Virtually all the deprived population in electricity, income and water live in rural areas. Most of the population deprived in room and education also live in rural areas, although it is worth noting that 12 per cent of all the deprived in room and 15 per cent of all the deprived in education live in urban areas, suggesting that improvement in these two dimensions is also needed in urban areas. Among people living in rural areas, 26.7 per cent do not have access either to a tarred or to a feeder road within 30 minutes, and the same percentage owns less than one acre of land.

Figure 1: Head Count Ratio in each Dimension Rural and Urban Contributions



These figures provide a first basis for priorities within the selected dimensions in terms of policy design. They also suggest that deprivation is mainly a rural phenomenon, where 74 per cent of the population in Bhutan live, providing a strong reason to focus deprivation-reducing efforts in these areas.

4.2 Aggregate multidimensional poverty estimates

Rural and urban estimates with five dimensions

Table 3 presents the estimates of the Multidimensional Headcount Ratio (H) and the Adjusted Headcount Ratio (M_0) for both urban and rural areas using the five dimensions applicable to both, for different values of k, using equal weights and the weights derived from the GNHS.

It should be noted that the meaning of each k-value in the estimates using the GNHS weights differs from the meaning when equal weights are used. With equal weights, $k=1$ requires for someone to be considered multidimensionally poor to be deprived in at least one of the five dimensions, which can be any of them. With GNHS weights, $k=1$ implies requiring being deprived in at least a dimension or a combination of dimensions which weights add to 1. For example, someone deprived only in safe water is not considered to be multidimensionally poor with $k=1$, neither is considered someone deprived only in room or in electricity. However, someone deprived only in income or only in education is considered multidimensionally poor with $k=1$, as well as someone deprived both in electricity and room, or electricity and water, for example. The H and M_0 measures using GNHS weights were estimated for all possible values of k, which range from 0.2 to 5. For simplicity and comparison purposes Table 3 presents the estimates only for the same five values of k for which the measures using equal weights were estimated.

By definition, both with equal weights and GNHS weights, the multidimensional poverty estimates decrease as k increases. With equal weights, estimates indicate that 64 per cent of the population is deprived in one or more of any of the five dimensions, and—on average—they are deprived in two dimensions, so that the Adjusted Headcount Ratio M_0 is 0.26. This is a very high level of multidimensional poverty, and the average deprivation indicates that, even when the union approach is used, those identified as multidimensionally poor do experience coupled deprivations. Analogously, 37 per cent of the population in rural and urban areas is deprived in two or more of the five dimensions, and on average, they are deprived in 2.7 dimensions, so that the Adjusted Headcount Ratio is 0.20. The percentage of people deprived in three or more dimensions is 20 per cent, with M_0 being 0.14 and people being deprived on average in 3.5 dimensions. The estimates are smaller for $k=4$ and, finally, only 1.4 per cent of the population is deprived in all five dimensions. The estimates of H using GNHS weights are smaller for $k=1$ to $k=3$, which is a consequence of the lower importance given to some of the dimensions such as people per room, electricity and water, so that combinations of these deprivations are equivalent to being deprived only in income or only in education, and also to the fact that income is not the dimension with the highest deprivation levels. However, the estimates for M_0 for these k values are very similar to those with equal weights, since the average deprivation is higher. With $k=4$, H and M_0 with GNHS weights are slightly higher than with equal weights because people deprived in a combination of three dimensions (such as income, education and room) are considered multidimensionally poor (since their weights add up to 4) but are not considered multidimensionally poor with $k=4$ in the equal weighting structure. Obviously, when it is required to be deprived in all 5 dimensions to be considered multidimensionally poor, all estimates coincide and are indeed very low.

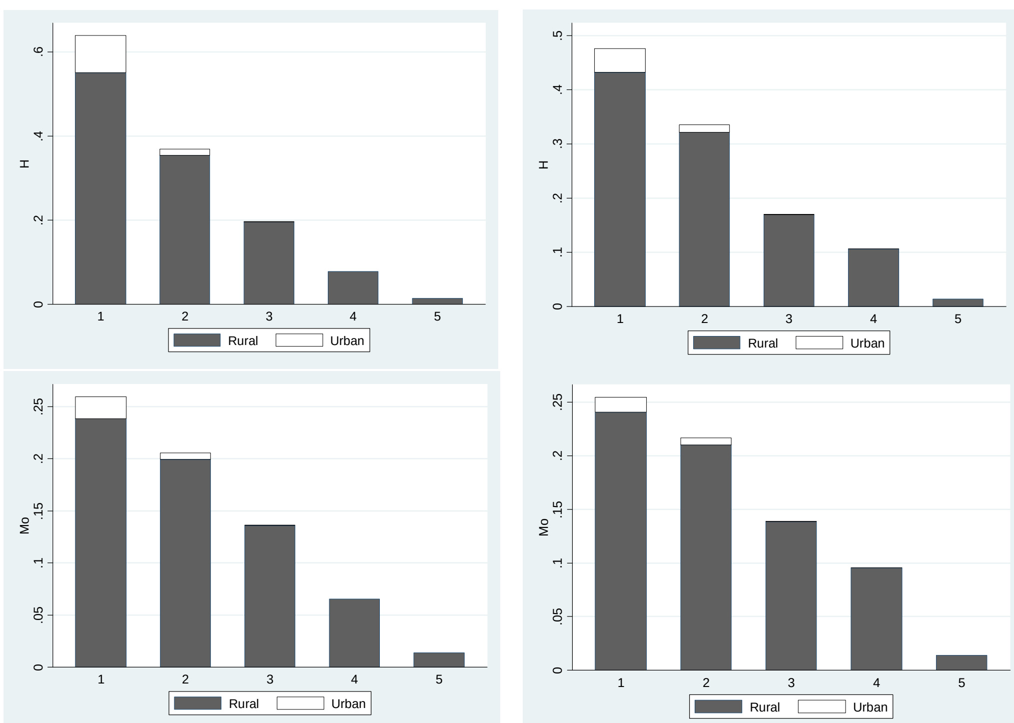
Table 3: Multidimensional Headcount Ratio (*H*) and Adjusted Headcount Ratio (M_0) in rural and urban areas—different *k* values—equal weights and GNHS weights, five dimensions considered

	Equal Weights			GNHS Weights		
k	***H***	M_0	**Average Deprivation**	***H***	M_0	**Average Deprivation**
1	0.64	0.26	2.0	0.48	0.25	2.6
2	0.37	0.20	2.7	0.34	0.22	3.2
3	0.20	0.14	3.5	0.17	0.14	4.1
4	0.08	0.06	3.75	0.11	0.095	4.3
5	0.014	0.014	5	0.014	0.014	5

The multidimensional poverty incidence estimates (H) can be related to the one-dimensional (income) poverty incidence, which is 23 per cent. Even when it is necessary and important to present the estimates for the different k-values, for policy purposes, it may be required to choose a value of k. For such purposes and given the obtained estimates, $k = 2$ might be a reasonable intermediate cutoff which focus the attention on a set of people narrow enough so as to ensure that they are indeed multidimensionally deprived, and broader enough so as to include people that, even if not deprived in a high number of dimensions, they still experience deprivation in several relevant ones.

Figure 2 presents the estimates of H and M_0 contained in Table 3 with the corresponding contributions of rural and urban areas. These are consistent with what was suggested in Figure 1. Only in the case of $k = 1$ does the urban areas have some contribution to overall H and M_0, which is 14 per cent to overall H with equal weights and 9 per cent with GNHS weights, 8 per cent to overall M_0 with equal weights and 6 per cent with GNHS weights. These results reinforce previous results from the 2004 and 2007 *Poverty Analysis Reports*, which had identified income poverty as a predominantly rural phenomenon. The estimates in this paper suggest that multidimensional poverty is also fundamentally a rural problem.

Figure 2: Multidimensional Poverty Headcount Ratio and Adjusted Headcount Ratio Different *k*—Rural and Urban Contributions



(a) Equal Weights **(b) GNHS Weights**

Rural estimates with seven dimensions

Table 4 presents the estimation results for rural areas only, expanding the set of dimensions to also include deprivation in access to roads and land ownership.

Table 4: Multidimensional Headcount Ratio (*H*) and Adjusted Headcount Ratio (M_0) in rural areas only—different *k* values—equal weights and GNHS weights, seven dimensions considered

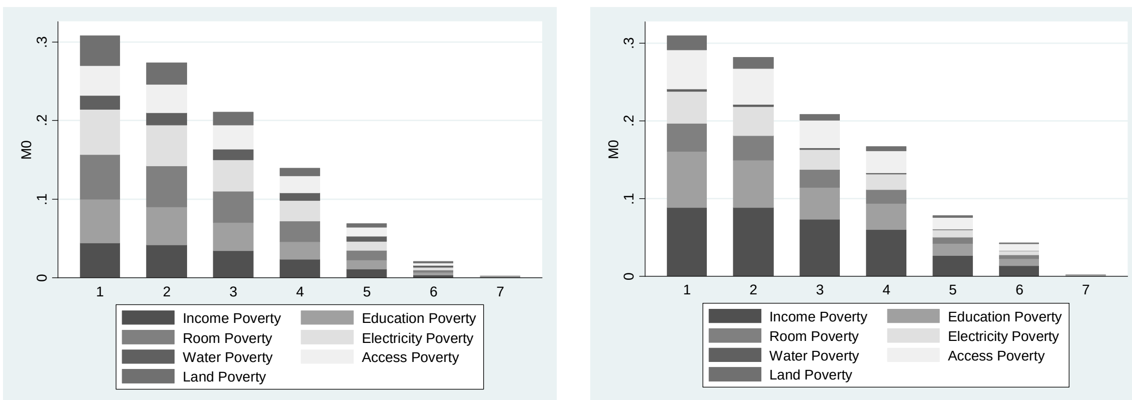
	Equal Weights			GNHS Weights		
k	***H***	M_0	**Average Deprivation**	***H***	M_0	**Average Deprivation**
1	0.84	0.31	2.6	0.68	0.31	3.2
2	0.60	0.27	3.1	0.54	0.28	3.6
3	0.38	0.21	3.9	0.32	0.21	4.6
4	0.21	0.14	4.6	0.24	0.17	5
5	0.09	0.07	5.4	0.09	0.08	6.2
6	0.024	0.021	6.1	0.05	0.04	5.6
7	0.002	0.002	7	0.002	0.002	7

Clearly, both the H and M_0 estimates are much higher than those in Table 3 both because these refer only to rural areas which are the main focus of multidimensional poverty, and because a higher number of dimensions are being considered. Using equal weights, estimates suggest that 84 per cent of the population in rural areas is deprived in at least one of the seven considered dimensions, being deprived on average in 2.6 dimensions giving a M_0 value of 0.31. This indicates a striking level of deprivation in rural areas. Sixty per cent are deprived in two or more, 38 per cent in three or more and 21 per cent in four or more, increasing the average deprivation among these groups and reducing M_0 correspondingly. As in the case of the urban and rural estimates (Table 3), using GNHS weights, the multidimensional H in the rural areas is lower for $k = 1$ to $k = 3$ than the ones obtained with equal weights, while the M_0 estimates are very similar. Note that starting with $k = 5$, estimates both using equal weights and GNHS weights decrease to virtually zero (less than 1per cent). Also note that the percentage of the multidimensionally poor (H) obtained using a cutoff value of $k = 3$ is comparable to the income Poverty Headcount Ratio for rural areas, which is 30.9 per cent, and may therefore be a reasonable cutoff for monitoring multidimensional poverty in the rural areas of Bhutan.

A natural question is how does deprivation in each dimension contributes to the overall multidimensional poverty. This can be analysed breaking down M_0 by the dimensions, which is precisely one of the advantages of this measure. Figure 3 presents such decomposition in the form of a bar graph for each k value with each of the weighting systems for the case of the rural areas, which are indeed the most deprived ones.

By definition, the contribution of each dimension to overall M_0 changes with the weighting system. When equal weights are used, deprivation in electricity, education, room and income are among the highest contributors to overall poverty in rural areas with similar contributions each. These are followed by deprivation in access to roads, deprivation in land ownership and finally, water.[10] Within the four dimensions with the highest contributions, deprivation in room availability, electricity and education contribute with between 18 and 19 per cent depending on the k value, followed by deprivation income, which contributes with 14 to 17 per cent. Deprivation in access to roads and land contributes with 12.4 per cent each with $k=1$, with the contribution of deprivation in access to roads increasing as k increases, and the contribution of deprivation in land ownership decreasing as k increases. Deprivation in water is the lowest, contributing with 5.7 to 7 per cent as k increases. When the GNHS weights are used, income and education tend to have higher contributions to overall poverty relative to electricity and room because of the higher importance attributed to these two dimensions.[11]

Figure 3: Multidimensional Adjusted Headcount Ratio (M_0) in rural areas only —different *k*—contributions by each of the seven dimensions



(a) Equal Weights **(b) GNHS Weights**

4.3 Overlapping and correlation between dimensions

The typical argument to focus poverty analysis exclusively on income is that income is highly correlated with achievements in other dimensions, such as education. If this was the case, by targeting the income-poor, one would be targeting the deprived in other dimensions. However, this does not seem to be the case in Bhutan.

A first simple exercise is to analyse the correlation between the variables. Given that most of the used variables are of dichotomous type, the Kendall *Tau b* coefficient is used, which—as the Spearman coefficient—is a rank correlation coefficient. However, the Kendall *Tau b* coefficient can also be interpreted as a coefficient of concordance between the rankings generated by two variables. Moreover, being a variant of the Kendall *Tau a* coefficient, the Kendall *Tau b* corrects for the possibility of tied

10 The contribution of each of the five dimensions that apply to the estimates of both urban and rural areas follows the same pattern as the one described for rural areas (obviously without the two additional dimensions).

11 With GNHS weights, the contribution of income to overall M_0 is around 30 per cent for all k values; for education is around 20 per cent; whereas for room and electricity it is between 10 and 12 per cent depending on the k value. Deprivation in access accounts for 16 to 21 per cent of overall M_0 depending on the k value, having a similar contribution than that of education for $k \geq 5$ (these two dimensions receive the same weight). Deprivation in land ownership accounts for 3 to 10 per cent of overall M_0 depending on the k value, and finally water accounts always for about 1 per cent of overall M_0.

ranks, which typically occur with ordinal and dichotomous variables. A definition of both Kendall coefficients (*Tau a* and *b*) is presented in the Appendix. Table 5(a) presents the Kendall *Tau b* coefficient between the different pairs of dimensions used to estimate multidimensional poverty in both rural and urban areas, using the total sample. Table 5(b) presents the same, but for all pairs of dimensions used for the estimations in rural areas only.

Table 5: Kendall *Tau b* coefficient between dimensions

(a) Rural and Urban Areas-Five Dimensions

	Income	Education	Room	Electricity
Education	0.25*			
Room	-0.37*	-0.15*		
Electricity	0.31*	0.22*	-0.23*	
Water	0.14*	0.14*	-0.11*	0.22*

*: Significant at the 95% level.

(b) Rural Areas Only- Seven Dimensions

	Income	Education	Room	Electricity	Water	Access
Education	0.21*					
Room	-0.39*	-0.15*				
Electricity	0.21*	0.16*	-0.22*			
Water	0.08*	0.11*	-0.09*	0.17*		
Access	0.20*	0.14*	-0.20*	0.36*	0.21*	
Land	-0.09*	-0.01*	-0.006	-0.10*	0.02*	-0.07*

*: Significant at the 95% level.

All the correlation coefficients are significant at the 1 per cent level (except for the correlation between land ownership and people per room in the rural areas). The highest rank correlations are between income and room availability (with a value of -0.37 in urban and rural areas and of -0.39 when only rural areas are considered), between income and electricity (with a coefficient of -0.31 in urban and rural areas), and between electricity and land access in the rural areas (with a coefficient of 0.36), but even these are not very high. The other correlations are of 0.25 or lower. This suggests that multidimensional analysis is indeed important and that a policy targeted to the income poor might not reach other segments of the population deprived in other dimensions.

A second exercise consists of analysing whether there is overlap between the group of poor identified with the multidimensional approach and the group of poor identified with the traditional income approach. Ruggeri-Laderchi, Saith and Stewart (2003) present empirical evidence of significant lack of overlap in the identification by the monetary and the capability approach for the case of India and Peru. Similar evidence is found in the case of Bhutan.

Table 6 (Panels a and b) present the percentage of population that is income non-poor but multidimensionally poor, and the percentage of the population that is income poor but multidimensionally non-poor, for the different k values in the estimates of rural and urban areas using equal weights and GNHS weights. Similar tables can be constructed for the estimates of rural areas only. By definition, the percentage of the income non-poor that are multidimensionally poor decreases as k increases, being zero when $k = d$, since all the multidimensionally poor in that case are deprived in every considered dimension, including income. For the same reason, the percentage of income poor that are not multidimensionally poor increases as k increases. It goes from 0 when $k = 1$, since in that case all the income deprived are considered multidimensionally poor, to a percentage close to the aggregate income Headcount Ratio when $k = d$, given that in that case only the income deprived that are also deprived in all the other dimensions are considered multidimensionally poor.

This suggests that if one would want to reach the multidimensionally poor by using income poverty as a 'proxy' variable there would always be some non-depreciable error: either a group that is only income poor but not multidimensionally poor would be included, which would be a Type-I error, or a part of the multidimensionally poor would be excluded for not being income poor, which would be a Type-II error. If one considers the minimum possible k value to be the relevant to identify the multidimensionally poor, using an income approach in that case minimises the Type-II error but maximises Type-I error. On the other hand, if one considers that $k = d$, is the relevant deprivation cutoff to identify the multidimensionally poor, using an income approach minimises Type-I error but maximises Type-II error. For k-values in the middle of the extremes, there is some combination of each error type when an income approach is used.

Table 6: Lack of overlap between Income and Multidimensional Poverty

(a) Rural and urban areas, five dimensions, equal weights

% of Population	*k=1*	*k=2*	*k=3*	*k=4*	*k=5*
Income Non-Poor but Multidimensionally Poor	40.7	15.8	4.6	0.5	0
Income Poor but Multidimensionally Non-Poor	0	2.1	8.1	15.9	21.8

(b) Rural and urban areas, five dimensions, GNHS weights

% of Population	*k=1*	*k=2*	*k=3*	*k=4*	*k=5*
Income Non-Poor but Multidimensionally Poor	24.4	10.4	0.54	0	0
Income Poor but Multidimensionally Non-Poor	0	0	6.7	12.5	21.8

4.4 Analysis at the district level

Table 7 presents H and M_0 estimated at the district level for both rural and urban areas of each district, using five dimensions, with $k = 2$, and the GNHS weights. It also presents the income Headcount Ratio in each district. Districts can be ranked according to the estimate in each measure. In the table, they are placed in descending order according to the Income H. It is particularly interesting to compare the ranking obtained with the Income H, presented in column 3, with the one obtained with M_0, presented in column 6. Column 7 presents the difference in the rank order obtained by each district in the two mentioned rankings.

It is interesting to note that the districts having the lowest estimates of Income *H* are not necessarily the ones having the lowest estimates of multidimensional H and M_0. Looking at column (7), it can be seen that although the change in the rank order when moving from Income H to M_0 is not striking, there are some interesting cases, such as the districts of Gasa and Tsirang. When ranked in descending order by Income H, the district of Gasa ranks in 18th place, since its income H is one of the lowest (only 4 per cent of the population is income poor), and the district of Tsirang ranks in 15th place (with only 14 per cent of the population being income poor). However, when ranked by M_0, Gasa is ranked in the 11th place, that is, it climbs seven places in the ranking because its M_0 estimate is 0.21, whereas Tsirang ranks in 9th place, with an M_0 estimate of 0.24, climbing six places in the ranking.

The explanation for such change in the relative positions of these two districts can be found in Figure 4, where the 20 districts have been ranked from highest to lowest by the M_0 estimates in rural and urban areas (for $k = 2$ and GNHS weights). The bar for each district also presents the composition of multidimensional poverty by each of the dimensions. There, it can be seen that in the case of Gasa only a very small fraction of multidimensional poverty in this district is explained by income. However, even if not highly deprived in income, significant parts of the population in this district are deprived in the other considered dimensions. In fact, while deprivation in income accounts for only 8 per cent of overall M_0, deprivation in education accounts for 48 per cent of the overall multidimensional poverty estimate, deprivation in electricity accounts for 25 per cent, deprivation in room accounts for 14 per cent of M_0 and deprivation in drinking water accounts for 5 per cent. The high levels of deprivation in the other dimensions relative to the income deprivation explain the big change between the ranking by income H and by M_0. When equal weights are used, the contribution to overall M_0 of deprivation in income is even lower, relative to the contribution of the other dimensions.[12] Moreover, it is a paradox that given Bhutan's achievement in terms of access to drinking water (such that only 9 per cent of the population in the country is deprived in this dimension), being Gasa one of the richest districts in income terms, it is the one that has the highest deprivation in access to water (43 per cent of the population do not have access to drinking water). In the case of Tsirang, deprivation in income accounts for 23 per cent of overall M_0, but deprivation in education accounts for 38 per cent, deprivation in electricity accounts for 25 per cent and deprivation in room availability for 14 per cent. The significant contribution of deprivations in the other dimensions apart from income explains the change in the ranking position.

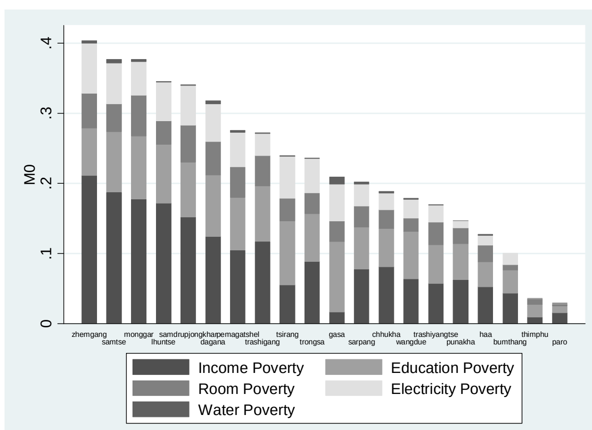
In most of the other districts, deprivation in income accounts for a very significant part of overall multidimensional poverty, which explains why they do not have such striking changes in the rank order when moving from Income H to M_0. It is important to consider that the contribution of deprivation in each dimension reflected in Figure 5 is dependent on the GNHS weights applied and that even with this weighting system, which gives income the highest importance, there are changes in the rankings when moving from the unidimensional income space to the multidimensional one. Moreover, the fact that there are districts that do not change significantly their relative position in the M_0 ranking when compared with the income H ranking, does not mean that deprivation in income would suffice for a comprehensive poverty analysis. On the contrary, it suggests that these districts experience a coupled disadvantage. Similar conclusions can be drawn for the estimates for rural areas only, not presented here for the sake of brevity.

[12] With equal weights M_0 in Gasa is 0.32, with deprivation in income contributing with 3 per cent, deprivation in education contributing with 26 per cent, deprivation in room contributing with 17 per cent, deprivation in water accounting with 36 per cent and deprivation in electricity accounting with 29 per cent of overall M_0.

Table 7: Income H, Multidimensional H and M_0 by districts
Urban and Rural Areas—five dimensions considered, *k*=2, GNHS weights

District	Pop. Share (%)	Income *H*	Desc. Rank Order Inc. *H*	Multi. *H* (*k*=2)	M_0 (*k*=2)	Desc. Rank Order M_0	Diff. betw. Rank Order in Inc. *H* and M_0
	(1)	(2)	(3)	(4)	(5)	(6)	(3)-(6)=(7)
Zhemgang	3.11	0.529	1	0.584	0.404	1	0
Samtse	8.85	0.468	2	0.548	0.377	2	0
Monggar	6.06	0.444	3	0.544	0.377	3	0
Lhuntse	2.49	0.430	4	0.532	0.345	4	0
Samdrup Jonkar	5.55	0.380	5	0.485	0.341	5	0
Dagana	3.00	0.311	6	0.499	0.318	6	0
Trashingang	7.58	0.293	7	0.432	0.272	8	-1
Pemagatshel	3.76	0.262	8	0.444	0.276	7	1
Trongsa	2.32	0.222	9	0.371	0.236	10	-1
Chhukha	10.74	0.203	10	0.288	0.189	13	-3
Sarpang	6.38	0.194	11	0.307	0.202	12	-1
Wangdue	5.70	0.158	12	0.311	0.179	14	-2
Punakha	4.03	0.156	13	0.264	0.147	16	-3
Trashiyangtse	2.89	0.143	14	0.289	0.169	15	-1
Tsirang	3.01	0.139	15	0.384	0.240	9	6
Haa	1.99	0.132	16	0.197	0.128	17	-1
Bumthang	2.55	0.109	17	0.178	0.101	18	-1
Gasa	0.60	0.041	18	0.384	0.209	11	7
Paro	5.63	0.039	19	0.050	0.029	20	-1
Thimpu	13.77	0.024	20	0.077	0.036	19	1
Bhutan	**100%**	**0.23**		**0.34**	**0.22**		

Figure 4: Composition of the Adjusted Headcount Ratio (M_0) in each Bhutanese district Rural and urban areas—five dimensions—*k*=2—GNHS weights



From a policy perspective, given that the M_0 can be decomposed by districts as well as broken down by dimensions, it could be used as a tool for assigning public budget among the different districts and within each district among the different dimensions. In this way, districts with higher M_0 would be given a higher per-capita budget. However, the ranking of the districts by their estimates of M_0 is subject to the selected value of k, the weighting system, the chosen dimensions and the deprivation cutoffs. Therefore, it would be recommended that per capita budget assignment would be based on robust results regarding M_0 estimates.

One possible robustness check consists of analysing the robustness of the M_0 rankings across the different k values. Given that the Kendall *Tau* coefficient —both *Tau a* and *b*— (Tau b has already been used in Section 4.3) can be interpreted as a measure of concordance between rankings, it is useful for exploring the robustness of these ranks. In this case, the variables are the M_0 district rankings for each of the possible k values. A high Kendall's tau coefficient indicates a high concordance between the M_0 district rankings obtained with different k values, suggesting that the ranking is robust.

Table 8 presents Kendall's *Tau a* coefficients for the M_0 district rankings obtained with different k values.[13] Although this was computed for all the possible k values, for analysis purposes it is enough to present the results for the two extreme k values (0.2 and 5), the entire numbers in-between, and the two k values nearest to the maximum k, 4.8 and 4.9. The results suggest that the correlation between the different pairs of M_0 district rankings is 0.8 or higher except for the pairs that include the ranking with the highest (or almost the highest) k value. Note the abrupt decrease in Kendall's *Tau a* coefficient is in the cases in which the ranking obtained with the maximum k value (4.9 or 5) is in the pair. This suggests that as one gradually moves from the union approach (minimum k) to the intersection approach (maximum k), the rankings of districts are similar, i.e. robust, except for the extreme case of $k = 5$. This can be understood as a restricted robustness. It should be considered, however, that the M_0 estimates when $k = 5$ are virtually zero.[14] Therefore, it can be said that for all the *relevant* k values, the ranking of the districts presented in column 7 of Table 7 is robust, and could be used as a tool for assigning public budget in per capita terms.

Table 8: Kendall's *Tau a* coefficient between the M_0 district rankings by different k values

	0.2	1	2	3	4	4.8	4.9
1	0.95*						
2	0.95*	0.96*					
3	0.83*	0.86*	0.88*				
4	0.75*	0.78*	0.80*	0.83*			
4.8	0.79*	0.78*	0.80*	0.85*	0.87*		
4.9	0.46*	0.49*	0.49*	0.53*	0.50*	0.53*	
5	0.46*	0.49*	0.49*	0.53*	0.50*	0.53*	1

*: Significant at the 95% level.

5. Concluding Remarks

This paper has estimated multidimensional poverty in Bhutan using a recently developed methodology by Alkire and Foster (2007). The selection of dimensions was based on the MDGs that are applicable for estimations of poverty at the household level and for which the BLSS provides data. For the case of both urban and rural areas five dimensions were selected: income (access to the basic basket), education (at least one literate person in the household and all children attending school), number of people per room (less than three), access to electricity and access to drinking water. Estimations for rural areas included two additional dimensions: access to roads (within 30 minutes or less) and land ownership (at

13 Given that the M_0 estimate is a continuous variable, there are no tied ranks, so the *Tau a* coefficient can be used.

14 The maximum estimate of M_0 when $k = 5$ is 0.04 which corresponds to the district of Samtse, and there are five districts with an estimate equal to zero (Punhakha, Thimpu, Trongsa, Trashiyangtse and Bhumthang). This is consistent with the aggregate estimates, indicating that in all districts only a marginal fraction of the population is deprived in all five dimensions.

least 1 acre). In each case, two alternative weighting structures were applied: one using equal weights and one using weights derived from the ranking of 'sources of happiness' identified through the GNHS.

Estimates suggest that 37 per cent of the population in both rural and urban areas is deprived in two or more of the five considered dimensions, and—on average—they are deprived in 2.7 dimensions (producing an estimate of 0.20 for M_0), while 20 per cent are deprived in three or more dimensions, being deprived—on average—in 3.5 dimensions (producing an estimate of 0.14 for M_0 with this k value). When dimensions are weighted using the ranking of sources of happiness obtained from the GNHS, income receives a weight that is one and a half times the weight given to education, 2.5 times the weight given to electricity, 2.8 times the weight given to room availability, and ten times the weight given to water. With those weights, the multidimensional Headcount estimates for $k=1$ to $k=3$ are lower while the M_0 estimates are similar, since although income is not the dimension with highest deprivation rates, as it is highly weighted, it produces a higher average deprivation.

The results also indicate that multidimensional poverty is mainly a rural phenomenon, although urban areas present non-depreciable levels of deprivation in room availability and education. Within rural areas, when equal weights are used, deprivation in electricity, education, room and income are the ones with the highest and similar shares of aggregate M_0, while land deprivation comes at a second place, and deprivation in water at the last one. When GNHS weights are used, deprivation in income has the highest contribution to overall M_0, followed by education and deprivation in access to roads, these two with similar contributions, followed then by deprivation in room and electricity, land, and finally in water. The contribution of each dimension is dependent on the weighting system and policy design based on this would need to make a choice on the weights to use (and the basis for this) to proceed accordingly.

The different districts can be ranked by their M_0 estimate. The estimates of Kendall's *Tau a* coefficient suggest that, for a given weighting structure, the ranking of districts is robust to changes in the k value for the relevant range, that is, excluding the intersection approach, which produces levels of poverty that are virtually zero. Therefore, the ranking of districts could be used as a tool for the allocation of public budget (in per capita terms) among the different districts, and within each district, once a weighting structure has been selected, the contribution of deprivation in each dimension to overall M_0 could be used as a guide to prioritise spending in those dimensions that show a higher contribution. The case of the district of Gasa constitutes an interesting example of how a district that is among the richest in income terms, still needs a lot of investment in other fundamental dimensions such as education, electricity, room in the dwellings and even access to drinking water.

The paper is innovative not only in that it changes the focus from the traditional unidimensional perspective of poverty, centred on income, to a broader multidimensional one, but it also provides with a methodology that is potentially useful for allocating the budget among the districts and within them, among the different dimensions. The property of the Alkire and Foster (2007) M_0 measure of being decomposable in population subgroups and allowing for a break down into dimensions is what makes it suitable for such purpose.

Bhutan constitutes a striking example of how significant and fast progress can be made towards development when goals are clearly set and policies specifically designed to fulfil them. The proposed methodology could prove to be a useful instrument to monitor such progress.

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Appendix

Table A.1: Sample size by district and by rural and urban areas

District	Rural	Urban	Total	Weighted sample
Bumthang	1051	286	1337	16,033
Chhukha	2930	2088	5018	67,606
Dagana	1362	104	1466	18,867
Gasa	1076	48	1124	3749
Haa	1079	138	1217	12,511
Lhuntse	1206	81	1287	15,705
Monggar	2529	436	2965	38,187
Paro	2615	175	2790	35,475
Pemagatshel	1649	184	1833	23,646
Punakha	1879	134	2013	25,346
Samdrup Jongkhar	2027	679	2706	34,940
Samtse	3490	717	4207	55,727
Sarpang	2119	802	2921	40,182
Thimpu	662	5482	6144	86,717
Trashingang	3301	388	3689	47,704
Trashi Yangtse	1274	175	1449	18,216
Trongsa	1097	176	1273	14,585
Tsirang	1385	121	1506	18,970
Wangdue	2223	564	2787	35,890
Zhemgang	1257	176	1433	19,606
Bhutan	**36,211**	**12,954**	**49,165**	**629,662**

Definition of the Kendall's rank correlation coefficients: *Tau a* and *b* (Kendall and Gibbons 1990:4-5, 40-41)

Given $i = 1,...,n$ observations with respect to two variables x and y, each one generating a ranking. Two pairs of observations (x_i, y_i) and (x_j, y_j) are concordant if $y_i < y_j$ when $x_i < x_j$, or $y_i > y_j$ when $x_i > x_j$ (equivalently $(x_i - x_j)(y_i - y_j) > 0$). Similarly, two pair of observations are discordant if $y_i < y_j$ when $x_i > x_j$, or $y_i > y_j$ when $x_i < x_j$ (equivalently $(x_i - x_j)(y_i - y_j) < 0$). That is, each pair with a score of +1 is concordant, and each pair with a score of -1 is discordant. Name P the number of concordant pairs and Q the number of discordant pairs, and note that the total number of pairs is given by $n(n-1)/2$, which equals the possible maximum score, that is, when there is perfect concordance. The Kendall *Tau a* coefficient is the proportion of concordant pairs minus the proportion of discordant pairs relative to the maximum possible score: $t_a = (P-Q)/(n(n-1)/2)$.

Suppose that variable x generates tied ranks of u consecutive members, the scores from any pair chosen from them is zero. Same for variable y generating tied ranks of v consecutive members. To account for that, the Kendall *Tau b* coefficient is defined as $t_b = (P-Q)/(\sqrt{(1/2)n(n-1)-U}\sqrt{(1/2)n(n-1)-V})$, with $U = (1/2)\sum u(u-1)$ and $V = (1/2)\sum v(v-1)$.