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Tracking Poverty Reduction in Bhutan: Income Deprivation Alongside Deprivation in Other Sources of Happiness

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Abstract This paper analyses poverty reduction in Bhutan between two points in time—2003 and 2007—from a multidimensional perspective. The measures estimated include consumption expenditure as well as other indicators which are directly (when possible) or indirectly associated to valuable functionings, namely, health, education, access to electricity, safe water, improved sanitation, enough room per person in dwelling, access to roads and land ownership. Interestingly, most of these indicators have been identified as sources of happiness in the 2007 Gross National Happiness Survey. Twelve different measures are estimated with a variety of values for the different parameters involved for robustness analysis. Also, estimates are bootstrapped creating 95 % confidence intervals. We find that over the study period there was an unambiguous reduction in multidimensional poverty regardless of the indicators' weights, deprivation cutoffs and identification criterion of the poor. This reduction was mainly led by a reduction in the proportion of the poor which was accompanied by a reduction in the intensity of poverty among those who were less intensively poor, although not among those who were more intensively poor. Rather than accomplishing this poverty reduction by improving achievements in one or two indicators, there were significant reductions in several deprivations, especially in access to roads, electricity, water, sanitation, and education. We also find that when income alone is used to target the poor, inclusion errors are marginal but exclusion errors are sizeable. Despite

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Bhutan's significant progress, challenges remain as poverty is still high in rural areas. A multidimensional measure in the lines proposed in this paper can prove useful for monitoring poverty reduction, prioritizing groups and evaluating upon investment.

Keywords Multidimensional poverty measurement · Counting approach · Happiness · South Asia · MDGs · Bhutan

1 Introduction

Bhutan is a small, landlocked, rural developing country located in South Asia. Since 1961, Bhutan implemented coordinated efforts towards development through ten consecutive five-years-plans. This resulted in a remarkable growth performance over the last thirty years which is depicted in Fig. 1. The average annual growth rate has been 5.8 % between 1981 and 2011 such that the country moved from being in the low income category to the lower middle income one.[1] Yet, Bhutan's achievements go beyond the economic sphere. The country is well-known for its goal of promoting Gross National Happiness (GNH) by which the quality of life is understood in a holistic way, exceeding economic wellbeing as it would be measured by per capita Gross Domestic Product (GDP), and exceeding subjective wellbeing, as it is conceived in the western literature on happiness (Ura et al. 2012b).

Maximizing GNH was first proposed in the late 1980s. However, "many of its underlying principles have guided the country's development for much longer" (Bhutan HDR 2005, p. 15). The guiding premise is that "…the beneficial development of human society takes place when material and spiritual development occurs side by side to complement and reinforce each other" (http://www.educatingforgnh.com/) and "the practical strategic focus is on creating an enabling environment for a flourishing of human potential at its fullest" (Bhutan HDR 2005, p. 18). GNH is based on four pillars: (1) sustainable development, (2) preservation and promotion of culture, (3) conservation of the environment and (4) good governance.

Within this approach, the Millennium Development Goals (MDGs) have become core development priorities in the country.[2] 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. This has been reflected in a steady increase of the Human Development Index (HDI) from 0.325 in 1984 to 0.583 in 2003 (RGB 2005b, p. 47).[3]

Bhutan's GNH approach means that the country has a multidimensional perspective towards development. In this paper, rather than looking at a dashboard of independent indicators, as it would be the case if we looked at MDGs indicators separately, or at a composite index, as it would be the case of the HDI, we focus on the *joint distribution* of several indicators. In other words, we concentrate on those who experience multiple

[1] There is no information on GDP prior to 1981. Economic growth has been mainly fostered by hydropower development and the export of surplus electricity to India (RGB 2005b, p. 23).

[2] In fact, the Tenth Plan (2008–2013) is significantly based on the MDGs, and poverty reduction is the overarching goal. However, the results of this plan cannot be analyzed with the data considered in this paper, as this corresponds to the years 2003 and 2007.

[3] These HDI estimates are from the National Human Development Report (RGB 2005b) and differ from those in the Global Human Development Report (HDR) (UNDP 2011), which provides estimates only for the years 2010 and 2011. According to the global HDR, the HDI in 2010 is of 0.518, lower than that reported in the National Report for 2005.

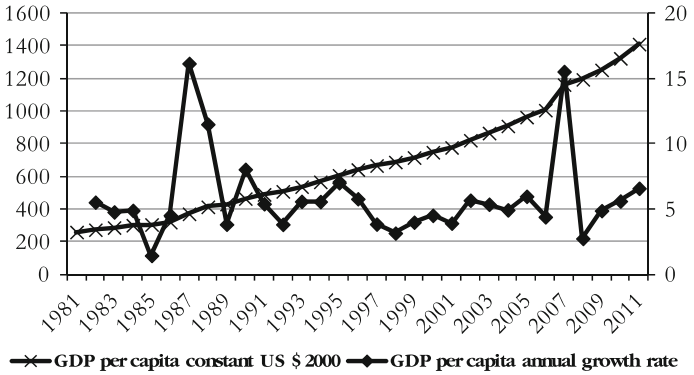

Fig. 1 Bhutan's GDP per capita and annual growth rate (1981–2011). *Source* World Development Indicators

deprivations simultaneously—the multidimensionally poor—and how they have fared over a 5 years time span for which data is available: 2003–2007. This new empirical evidence complements evidence on the progress made on independent indicators, including income poverty.

To perform this analysis we use the Alkire and Foster (2007, 2011)'s methodology for multidimensional poverty measurement. We choose this methodology because it is the only available one which, while using a counting approach for identifying the poor, it does not follow the union approach exclusively.[4] In this way, the methodology allows focusing on those who experience several deprivations at the same time. The measure used in this paper is the so called M_0 measure which, as described in the Introduction to this Special Issue (Alkire and Santos 2013a), it is convenient because (a) it is well suited for combining ordinal variables with cardinal ones, (b) it satisfies a set of desirable properties, (c) it is composed of two intuitive partial measures: poverty incidence (H) and poverty intensity (A) and (d) it has a sensible interpretation: it reflects the proportion of weighted deprivations that the poor experience in a society out of all the total potential deprivations that the society could experience.

The datasets used correspond to the 2003 and 2007 Bhutan Living Standard Survey. The selection of dimensions for the multidimensional poverty measure is guided by the MDGs. The selection of indicators combines the definition of the MDGs' indicators with the requirements to construct a multidimensional poverty measure which is relevant to the whole population under analysis. While constructing the indicators we also had to comply with data constraints. We consider eight indicators for urban and rural areas: consumption expenditure, education and health of the household, access to clean water, improved sanitation and clean cooking fuel, access to electricity and room availability. Two additional indicators are considered for rural areas only: access to roads and land ownership. These indicators are related to 'sources of happiness' as revealed by the Gross National Happiness Survey conducted in 2007. To test the robustness of the results two alternative deprivation cutoffs are used as well as three alternative weighting structures, one of which is derived from the ranking of the 2007 GNH Survey.

The measures estimated in this paper build upon two antecessors and a related index, all of them using the M_0 measure of Alkire and Foster or a variant of it. One of them is that

[4] A counting approach to multidimensional poverty measurement implies identifying the poor by counting the number of deprivations they experience. With the union approach to identification anyone experiencing at least one deprivation is considered multidimensionally poor.

presented in Santos and Ura (2008). The measure estimated here considers three additional indicators (sanitation, cooking fuel and the health indicator) and offers a broader range of robustness tests via two sets of deprivation cutoffs, one further weighting structure, and bootstrapped confidence intervals. Secondly, there is the Multidimensional Poverty Index (MPI), developed by Alkire and Santos (2010) in collaboration with the UNDP Human Development Report Office. The MPI is an internationally comparable measure of *acute* multidimensional poverty which is included in the Human Development Report.[5] It comprises ten indicators within three dimensions: health (mortality and nutrition), education (years of schooling and child attendance to school) and living standard (water, sanitation, cooking fuel, electricity, floor and assets). While the MPI allows placing Bhutan relative to other countries in terms of the acutely poor, the measures explored here may contribute to design in future a national multidimensional poverty measure more tailored to the particular country context that serves the purpose of monitoring poverty. Additionally, the measure proposed here incorporates consumption expenditure deprivation as an indicator, allowing a more precise comparison between income and multidimensional poverty. The third related measure is the Gross National Happiness Index of the Royal Government of Bhutan (Ura et al. 2012a), designed as a quantitative tool to monitor performance according to the national objective of maximising national happiness. As opposed to the measures of this paper, the GNH Index uses 'sufficiency cutoffs' in each indicator—how much is 'enough'—rather than deprivation cutoffs, and the overall value of the Index reflects well-being rather than poverty.

How does Bhutan currently compare with the other countries in its region? Figure 2 summarises some development indicators for the seven South Asian countries. Bhutan's GDP per capita is similar to that of Sri Lanka and substantially higher than that of all the other countries except for Maldives. Bhutan has the median HDI value among the seven considered countries and it is categorised as of medium human development together with India, Sri Lanka, Maldives and Pakistan. In terms of income poverty, Bhutan has 10 % of people living with less than $1.25(PPP)/day, above the 7 % of Sri Lanka but much lower than the 22 % or above of the other countries. Finally, in terms of acute multidimensional poverty, Bhutan has a Multidimensional Poverty Index (MPI) of 0.119, poorer than the Maldives and Sri Lanka, but substantially less poor than Pakistan, India, Bangladesh and Nepal.

However, with a population of just above 700,000 people in 2008, Bhutan is comparable to its neighbor Indian state of Sikkim, whose MPI, at 0.150, is a bit higher than Bhutan's MPI of 0.119 (Alkire et al. 2011). Yet, we look at this small country because it is as an example of significant poverty reduction within an integrated and holistic development approach. Bhutan's reduced-scale experience may be helpful for approaching development in geographical units of similar size in other countries of the region. However, it must be noted that the focus of this paper is on the estimation and analysis of multidimensional poverty over the study period. A thorough discussion linking our findings to the policies implemented in Bhutan during the study period falls beyond the scope if this paper, but would be a natural topic for future research.

The paper is structured as follows: Section 2 describes the datasets used, the selection of dimensions, indicators and weights. Section 3 presents the results and Section 4 concludes.

[5] It is said to measure acute poverty because it looks at people deprived in 33.33 % of the indicators and because the deprivation cutoffs used are relatively low-demanding, following international standards of the MDGs.

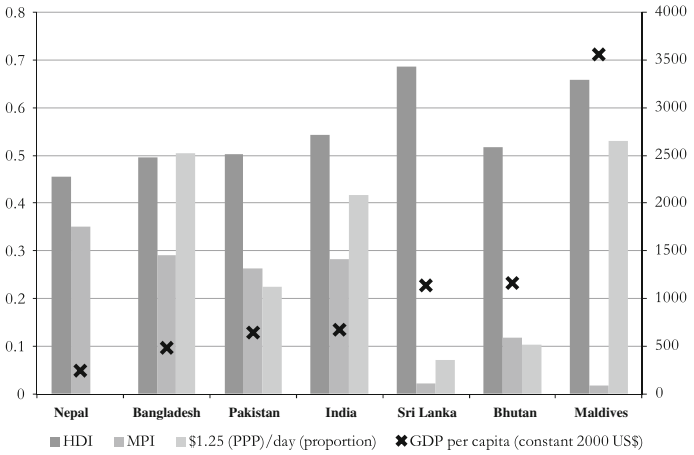

Fig. 2 Bhutan compared with other South Asian countries. *Source* GDP per capita and $1.25 (PPP)/day figures are from World Development Indicators. HDI and MPI are from International Human Development Indicators (MPI figures originally comes from Alkire, Roche, Santos, Seth, 2011). *Note* GDP per capita corresponds to the year 2007 (as this is the year of the most recent data used in this paper). Proportion of people living with less than $1.25/day (PPP) corresponds to various years: 2003 for Maldives, 2005 for Bangladesh and India, 2006 for Pakistan and 2007 for Bhutan and Sri Lanka. HDI values are those of 2010 and MPI values correspond to various years: 2009 for Bangladesh, 2003 for Sri Lanka, 2005 for India, 2006 for Nepal, 2007 for Bangladesh and Pakistan, 2009 for Maldives and 2010 for Bhutan

2 Methodology

2.1 Datasets

The datasets used in this paper are the 2003 and 2007 Bhutan Living Standard Survey (BLSS) conducted by the National Statistics Bureau (NSB). Both surveys have followed the Living Standard Measurement Study methodology developed by the World Bank. However, the sampling frame, geographic coverage and questionnaires are not the same and thus estimates are not perfectly comparable. In particular, the consumption module was more comprehensive in 2007 than in 2003, covering 118 food items as opposed to 83 items in 2003. The recall periods used in each questionnaire were also slightly different.[6]

The 2003 data contains information on 4,007 households and 19,248 people. The 2007 one collected a much bigger sample of 9,798 households and 49,165 people. Both surveys are nationally representative, as well as representative at urban and rural areas.[7] Only the 2007 survey is representative at each of the 20 Bhutanese districts (Dzongkhags).

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 5 in the Appendix presents the composition of the sample in each year.

[6] Recall periods in the 2007 BLSS for food items were last 1 week, last 1 month, and last 12 months, whereas in the 2003 BLSS they were last 1 week, *typical month*, and last 12 months. For non-food items, the recall period in 2007 BLSS was 12 months and last 1 month whereas it was only the last 12 months in 2003 BLSS (NSB 2007a).

[7] However, the 2003 survey did not collect information on rural areas in the districts of Sandrupjongkhar and Sarpang (NSB 2003).

2.2 Dimensions, Indicators and Deprivation Cutoffs

The selection of the dimensions and indicators for the multidimensional poverty measure is guided by the eight MDGs, with some restrictions due to data availability. This seems a reasonable choice given the relevance of the MDGs in Bhutan's national development strategy. Estimations are performed for rural and urban areas considering seven indicators, and for rural areas exclusively, two other indicators are added. Two sets of deprivation cutoffs are used, a standard one which follows the MDG criteria as much as possible (following the MPI-style) and a more demanding one for robustness checks. We also use three alternative sets of weights. A baseline of equal-nested weights, which follows the MPI structure and two alternative sets to check for robustness: one which follows preferences as suggested by the 2007 Gross National Happiness Survey (GNHS) and another set which gives the same weight to each indicator. These are explained in the next section. Table 1 summarises the selection of indicators and cutoff values.

We first consider the MDG of *eradicating extreme* (income) *poverty and hunger*. Within that goal we consider per capita family consumption expenditure. Information on household expenditure is obtained adding the various goods and services purchased, consumed from own production and received as gifts. Details on the methodology for collection and processing of the expenditure data can be found in NSB (2003, 2007a). The baseline deprivation cutoff identifies a household as *consumption deprived* if the per capita monthly family consumption expenditure falls below Nu. 403.79 in 2003 and below Nu. 688.96 in 2007. These are the national food poverty lines and they were equivalent to approximately US$9 and 17 correspondingly in the respective year. They correspond to the cost of a food basket considered to fulfil the requirement of 2,124 kcal. per person per day.[8] With the more demanding set of deprivation cutoffs, a household is considered consumption deprived if its per capita monthly family consumption expenditure is below Nu. 740.36 in 2003, and below Nu. 1,096.94 in 2007. These income poverty lines were equivalent to approximately US$16 and 28 correspondingly in the respective year, and they are the cost of the basic food basket plus a non-food allowance.[9] It is worth noting that the standard deprivation cutoff is higher than the PPP $1.25/day stated by the MDG indicator, but is in line with the country's priorities. Clearly, it would be important to complement the income poverty indicator with nutritional indicators, as suggested by the MDGs. Unfortunately, such information is not available in the BLSS.

To achieve this MDG, 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 indicators for rural areas. The standard set of cutoffs identifies a rural household as *access deprived* when it cannot reach a road (either feeder or tarred)

[8] 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 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 NSB methodology to make the results of this paper comparable to the official income poverty estimates.

[9] The conversions to dollars use the midpoint exchange rate registered over the entire year. 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.

Table 1 Selected indicators and deprivation cut-off values

Indicator	Deprivation cutoff value	
	MDG cutoffs (MPI-style) (baseline set)	More demanding cutoffs
Rural and urban areas		
Related to MDG 1: eradicate extreme poverty and hunger		
Consumption	Have monthly per capita consumption expenditure of Nu 403.79 in 2003 and of Nu 688.96 in 2007 (Bhutan Food Poverty Line)	Have monthly per capita consumption expenditure of Nu 740.36 in 2003 and of Nu 1,096.94 in 2007 (Bhutan Total Poverty Line)
Related to MDG 2: achieve universal primary education		
Education	At least one literate household member and all children between 6 and 12 are going to school	At least one literate household member and all children between 6 and 16 are going to school
Related to MDG 7: ensure environmental sustainability		
Drinking water	Access to either pipe in dwelling, neighbour's pipe, public outdoor tap or protected well within a distance of 30 min	Access to either pipe in dwelling, neighbour's pipe, public outdoor tap or protected well within a distance of 15 min
Sanitation	Access to flush toilet, pit latrine with or without septic tank and not shared	Access to flush toilet or pit latrine with septic tank and not shared
Electricity	Access to electricity	Access to electricity
Room availability	Less than 4 people per room	3 or less people per room
Related to MDG 4, 5 and 6: health		
Health	Not having been sick or injured in the past 4 weeks in such a way that the person was prevented from doing usual activities for more than 7 days	Not having been sick or injured in the past 4 weeks in such a way that the person was prevented from doing usual activities for more than 3 days
Rural areas only: two additional MDG1-related dimensions are considered		
Roads	Access to a road in 30 min or less by any means of transport	Access to a road in 15 min 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)	Own at least 1.5 acres of land of any kind (Land is the sum of wet land, dry land, orchard and tseri)

within 30 min by any means of transport, whereas with the more demanding set of cutoffs the requirement is of 15 min.

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 2005a, pp. 26–28). The baseline set of cutoffs considers a rural household as *land deprived* if it owns less than one acre. 1 acre seems a reasonable amount of land that would allow cultivation for subsistence, even considering that land quality and water availability varies.[10] However, for robustness check an alternative of 1.5 acres is used.

[10] Although an absolute poverty line approach is followed for all indicators in this paper, it is worth noting that 1 acre is half of the median rural land holdings in 2007 and less than the country's median land holdings (which is 1.32 acres).

Secondly, we consider the MDG of *achieving 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 already raised the primary net enrolment rate from 62 % in 1990 to 83.7 % in 2007 (BO Focus, Sept 2010). 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 %), the proximate literacy requirement is mild: even if the adults in the household are illiterate, as long as the children are literate, the household will be considered literate. We were not able to consider years of schooling as in the MPI because this information is not available in the BLSS. The second requirement for the education indicator is that all children between 6 and 12 years of age are attending school. Given that primary education lasts 7 years in Bhutan, this covers the age range in which children should be attending primary school and thus it is in line with the MDG indicator as well as with the MPI one. A more demanding variant of this indicator requires that all children between 6 and 16 years of age are attending school, which includes the age range of secondary education. It is worth noting that none of the two alternative cutoffs is excessively demanding since children are not required to be in the school grade corresponding to their age. A household with no literate member or with children between 6 and 12 years who are not attending school age (or between 6 and 16 years of age in the more demanding version) is considered to be *education deprived*, and so are all its members. If a household has no children in the corresponding age range, only the literacy requirement applies.

There are three MDGs related to health: MDG 4 of reducing child mortality, MDG 5 of improving maternal health, and MDG 6 of combating HIV/AIDS, malaria and other diseases. It is not possible to consider them with the indicators suggested by the MDGs because the necessary information on child and maternal mortality and of HIV/AIDS and malaria's incidence is not available in the BLSS. The survey provides information on whether each household member has been sick or injured in the past 4 weeks, and the number of days she was prevented from performing her regular activities as a consequence of such sickness or injury. Analogously to the case of education, an intra-household externality is assumed by which all household members are affected when one of them is seriously ill or injured. Thus we define a household as *health deprived* if at least someone has been sick or injured in the past 4 weeks and this prevented the person from doing her regular activities for more than 7 days with the baseline set of cutoffs, and for more than 3 days with the more demanding set of cutoffs. The requirement on the number of days intends to assure—although imperfectly—that the sickness or injury is serious enough so as to produce a state of deprivation. In future, it would be a significant improvement if BLSS incorporated a better set of questions on health, such as some of those asked in the Demographic and Health Surveys (DHS).

Fourthly, we consider the MDG 7: *ensure environmental sustainability*. Two of the considered indicators within this goal are usual MDG indicators: access to clean water and improved sanitation. Bhutan has progressed significantly in increasing access to both, yet

much more progress can be made.[11] A household with no access to a pipe in dwelling, a neighbour's pipe, a public outdoor tap or a protected well within a 30 min distance roundtrip is considered to be *water deprived*, and so are all its members. With the more demanding set of cutoffs, we require the water source to be within 15 min walking distance roundtrip. In terms of sanitation, with the baseline set of cutoffs, a household is considered *sanitation deprived* if it does not have a flush toilet or a pit latrine—either with or without septic tank, which is not shared. With the more demanding set of cutoffs, the household needs to have access at least to a non-shared pit latrine with septic tank.

A third indicator we include within this goal is access to electricity. Although this is not an MDG 7 indicator, it is one of the key objectives in the country, since it improves the living conditions both by allowing independence from daylight as well as by contributing to air purity. Bhutan would like to achieve 'electricity for all' by 2020. A household with no access to electricity is considered to be *electricity deprived*, and so are all its members. We decided not to include cooking fuel, which is an MDG indicator, because it has a high correlation with electricity and because it was not listed as a source of happiness whereas electricity was.[12]

Finally, the number of people per room in the household is also included. Although this is not one of the main MDG indicators, it is listed as a complementary one (UN 2003). It is a commonly used socio-economic assessment indicator, providing a measure of housing quality. It can be related to MDG7 since overcrowding incubates disease and does not contribute to a sustainable environment; it is also connected to the goal of achieving an adequate shelter for all (UN Conference on Human Settlements 1996). Following the standard of UNHabitat (2006), a household with four or more people per room is considered to be *room deprived*, and so are all its members. A more demanding cutoff considers a household deprived if there are more than three people per room (this cutoff is used in the Latin American Unsatisfied Basic Needs Indicator, INDEC 2003). The number of rooms excludes kitchens, bathrooms, toilets and balconies.

2.3 Correlations Between Indicators

Table 2 presents the Spearman correlation coefficients between the indicators of deprivation for 2003 and 2007, using the more demanding set of deprivation cutoffs. We present this set of correlations as an 'upper bound', because correlations using the standard (less demanding) set of deprivation cutoffs are lower. It can be seen that no correlation coefficient exceeds 0.41, which is the correlation of electricity and sanitation, electricity and expenditure and people per room and expenditure, all in 2003. In general, electricity was the indicator most highly correlated with the other living standard indicators, but all these correlations decreased significantly by 2007. It is also worth noting that deprivation in consumption expenditure has correlations no higher than 0.41 with all the other indicators, even when using the total poverty line and not just the food one as the deprivation cutoff. Another interesting point is that land ownership has correlations below 0.10 with all the other indicators, many are non-significant and several are negative. Thus, there seems to be good empirical basis to support a multidimensional approach to poverty measurement, which goes beyond income and asset ownership.

[11] Between 2002 and 2005, the proportion of the population without access to safe drinking water was reduced by two-thirds (RGB 2005a, p. 9).

[12] Deprivation in cooking fuel has a spearman correlation coefficient with deprivation in electricity of 0.70 both in 2003 and 2007.

Table 2 Spearman correlation coefficients between deprivations

		Roads	Land	Water	Sanitation	Electricity	Room	Education	Health
Expenditure	2003	0.21*	0.04*	0.29*	0.26*	0.41*	0.41*	0.26*	0.12
	2007	0.22*	−0.07*	0.16*	0.20*	0.30*	0.37*	0.24*	0.09*
Roads	2003		−0.04*	0.15*	0.11*	0.33*	0.19*	0.16*	0.06*
	2007		−0.08*	0.16*	0.14*	0.33*	0.17*	0.15*	0.05*
Land	2003			−0.04	0.03*	−0.05*	0.02*	0.01	−0.08*
	2007			−0.03*	0.01	−0.08*	−0.004	−0.01*	−0.06*
Water	2003				0.34*	0.39*	0.29*	0.21*	0.21*
	2007				0.21*	0.25*	0.18*	0.13*	0.06*
Sanitation	2003					0.41*	0.25*	0.21*	0.15*
	2007					0.25*	0.22*	0.15*	0.07*
Electricity	2003						0.29*	0.36*	0.21*
	2007						0.25*	0.22*	0.08*
Room	2003							0.23*	0.11*
	2007							0.17*	0.07*
Education	2003								0.11*
	2007								0.06*

* Significant at the 95 % level

2.4 Weighting

Defining the weights to give to each dimension implicitly entails value judgements (Decancq and Lugo 2012). Thus, three alternative weighting structures are used. The baseline set of weights follows the MPI structure of equal-nested weights, assigning 1/3 to health, 1/3 to education and 1/3 to living standard. Within living standard, in the measure with seven indicators, half of the weight is given to expenditure (1/6) and the other half is equally distributed among water, sanitation, electricity and people per room, with a weight of 1/24 each. In the measure with nine indicators, half of the weight is assigned to expenditure and land ownership, equally distributed between the two so that each receives a weight of 1/12. The other half is equally distributed between access to roads, water, sanitation, electricity and people per room, with a weight of 1/30 each. We name this set of weights Equal-Nested weights.

The second weighting structure is derived from the 2007 GNH survey. This is in line with Fleurbaey et al. (2009)'s proposal of considering people's 'valuation orderings' to weight the various dimensions of life. It is also related to Haisken-DeNew and Sinning (2007) weighting proposal.[13] The 2007 GNH Survey was the first GNH survey, carried out by the Centre for Bhutan Studies. Due to budget constraints, the sample size was of 950 respondents in 12 districts.[14] However, it was nationally representative. The survey

[13] Haisken-DeNew and Sinning (2007) propose to derive weights for a multidimensional measure (of social inclusion) from the extent to which each of the considered characteristics contributes to the individual general life satisfaction using a linear fixed effects model. We cannot implement a similar procedure here because the data source from which we derive the weights (GNH Survey) differs from that which contains the material conditions of the household (BLSS).

[14] The survey was conducted in the districts of Dagana, Tsirang, Wangdiphodrang, Samtse, Zhemgang, Pemagatshel, Samdrupjongkhar, Trashigang, Tashiyangtse, Gasa, Haa and Thimphu. This survey was

included one open-ended question where the respondent had to rank her sources of happiness.[15] Answers were then grouped and categorised. Interestingly, seven of the nine indicators considered here were explicitly mentioned as sources of happiness, namely: financial security, roads, education, good health, electricity, clean drinking water and land ownership. Access to improved sanitation and enough room per person were not explicitly listed.[16] However, because these are indicators internationally regarded as important (UN 2003), we decided to keep them with a non-zero weight in this structure. We assigned to sanitation the same weight as to clean water, as the two are connected to the same target within the MDG of environmental sustainability. We assigned to people per room the weight corresponding to 'housing' in the list of the GNH survey. The percentage of people that placed each of the selected indicators at some point in the ranking was re-scaled so as to add up to the total number of indicators used. While using weights derived from what people say that matters to them is very attractive, it has well-known drawbacks such as adaptive preferences and the fact that the ranking is likely to change over time, which can make poverty estimates change, even if there has been no objective change in deprivations. Thus, rather than advocating for this particular weighting structure, we advocate for using alternative weighting schemes in order to test the robustness of the results.

The third weighting structure assigns the same weight to each indicator. The reason to do this is that indicators can actually be grouped in several alternative ways. For example, they could have been grouped by the MDG to which they are associated, and a nested weighting structure could have been constructed under this scheme. Or, water and sanitation could be grouped together with the health indicator. Thus, this weighting structure keeps the weighting independent of any particular grouping of the indicators. This implicitly assumes that each indicator (but not each potentially defined dimension) is equally and independently important. This weighting does not intend to be a normative stand as people per room having the same weight as education is obviously questionable; it merely constitutes a way to test for the robustness of the results. Note that given that we consider five indicators related to MDG7, this goal implicitly receives a higher weight with this weighting structure, followed by MDG1, MDG2 and the health MDG with one indicator each for urban and rural areas. In the case of the rural areas estimates, MDG1 has three indicators and thus receives an implicit higher weight than MDG2 and the health MDG. For simplicity, in what follows we refer to this weighting structure as 'Equal Weights'.

Table 3 presents the three alternative relative weighting structures.

Footnote 14 continued
repeated in 2010 using a bigger sample size but results were still not publicly available at the time of writing this paper. Moreover, using the 2007 GNH ranking matches the year of one of the BLSS used here.

[15] The question was: What are the 6 or 7 things that you consider to be most important that leads to a happy and content life?

[16] The list of 'sources of happiness' derived from this question of the GNHS, ranked in order of their preference reads: financial security (51.5 %), transportation (32.4 %), education (26.9 %), good health (26.6 %), family relationships (21.1 %), agricultural productivity (21.5 %), electricity (16.3 %), basic needs (food, clothing, shelter, cleaning drinking water; 16.1 %), land ownership (14.9 %), housing (14.1 %), good governance (13.5 % total), health infrastructure and facilities (11.6 % total), faith and spiritual practices (9.2 %), community relationship (8.5 %), job (8.5 %), national security (5.3 %), communication facilities (3.7 %), environment (2.9 %), sports (0.8 %) and travel (0.4 %).

Table 3 Alternative weighting structures

Indicator	Equal-nested weights		GNHS weights		Equal weights	
	Urban and rural areas (%)	Rural areas only (%)	Urban and rural areas (%)	Rural areas only (%)	Urban and rural areas (%)	Rural areas only (%)
Income	17	8	31	22	14	11
Roads	–	3	–	20	–	11
Land	–	8	–	8	–	11
Water	4	3	3	2	14	11
Sanitation	4	3	3	2	14	11
Electricity	4	3	13	9	14	11
Room	4	3	10	8	14	11
Education	33	33	20	14	14	11
Health	33	33	20	14	14	11
Total	100	100	100	100	100	100

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

The effective weight each indicator receives is affected not only by the explicit assigned relative weight but also by the deprivation rate in that indicator. Indicators with higher deprivation level effectively weight more. Figure 3 depicts the deprivation rates in each indicator using the two sets of cutoffs. With the baseline set of cutoffs deprivation rates can be grouped into three intervals in each year. The lowest deprivation rate corresponds both in 2003 and 2007 to consumption expenditure, with a small increase from 3.8 to 5.9 % in this time range.[17] At the other extreme, the highest deprivation rates in 2003 were those of education, with 37 % of people in households with either no literate member or children in school age not attending school, access to roads, with 53 % of people in rural households with no access to a road within 30 min and electricity, with 60 % deprived people. Deprivation in the other indicators ranged from 19 % in health to 26 % in clean water. In 2007, the very high deprivation rates of access to roads and electricity had been halved, and the deprivation rate in education had been reduced to 21 %. Deprivation in the other indicators also decreased between 4 and 2 percentage points, except for land ownership, which increased from 22 to 27 %.[18] Using the more demanding set of deprivation cutoffs, deprivation rates are substantially higher, especially for sanitation.[19] But these higher cutoffs are an instrument for robustness tests for the multidimensional measure rather than normative standards.

The explicit weights assigned to each indicator interact with the deprivation rates. Thus, with the equal-nested weights, the relatively high weight that the health and income indicators receive is compensated by the relatively low deprivation rate. Conversely, the

[17] This increase might be due to differences in the questionnaires as the 2007 BLSS covered many more food items (NSB 2007b).

[18] Land holdings became more unequally distributed between 2003 and 2007. The Lorenz curve for 2003 strictly dominates that of 2003.

[19] There is significant variation in the proportion of people deprived in clean water and improved sanitation by different data sources. The differences come from differences in survey codings as well as in the definitions used. Our figures for 2007 are close to those from the 2005 Population and Housing Census of Bhutan (PHCB) (RGB 2005c).

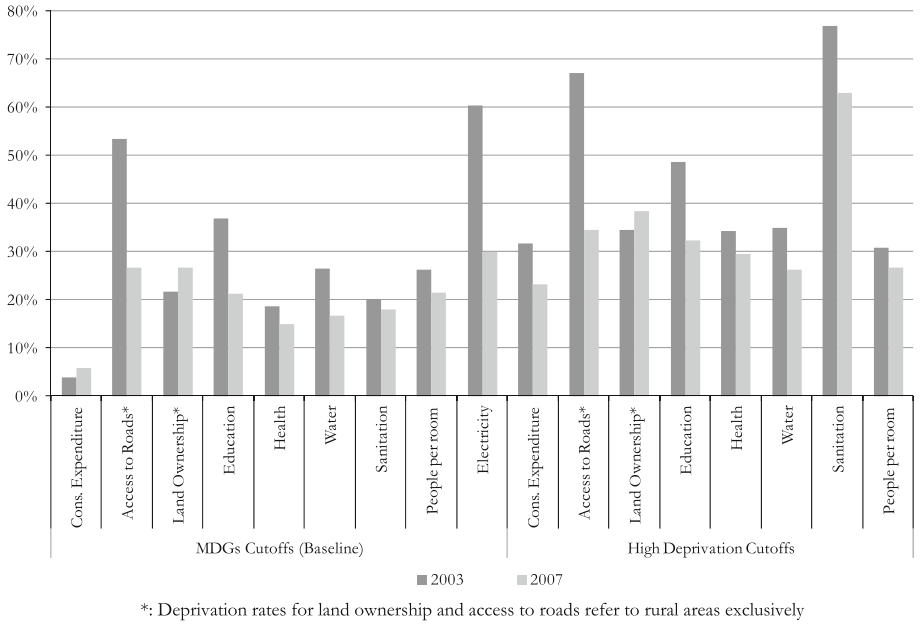

Fig. 3 Deprivation rates by indicator—baseline and more demanding deprivation cutoffs. *Deprivation rates for land ownership and access to roads refer to rural areas exclusively

relatively low explicit weight given to electricity and access to roads is compensated by the relatively high deprivation rates. However, the relatively high weight on education is reinforced by the high deprivation rate in this indicator. With GNHS weights on the other hand, the relatively high weights of access to roads, electricity and education are reinforced by their high deprivation rates, whereas the one on income and health are compensated by the low deprivation rates. With the Equal Weights structure, the 'effective' weights will reflect the pattern of deprivation rates. Section 3.3 analyzes the composition of poverty across the different weighting structures.

2.5 Comparison with Other Multidimensional Measures

It is worth noting the ways in which the measures estimated here compare to the MPI. As in the MPI, indicators can be grouped into the dimensions of health, education and living standards, and the baseline set of deprivation cutoffs coincides in many cases with that of the MPI or at least follows the same principle of MDG standards. The baseline weights follow the MPI's weighting structure. Thus the general structure is the same.

However, the indicators themselves differ in several cases. The living standard dimension includes consumption expenditure while the health dimension excludes an indicator for nutrition. This is because there is no survey for Bhutan (and nor for most of the countries) which collects information on expenditure *and* on anthropometric variables.[20] Consumption expenditure is not a good proxy indicator for nutrition. However, for

[20] Nutritional information is available in the 2010 Bhutan Multiple Indicators Cluster Survey (BMICS), but this dataset does not contain consumption expenditure information and there is no other available BMICS dataset for comparison over time.

the purpose of this particular paper we understand that there is a value added in using a dataset which allows incorporating consumption expenditure at the expense of nutritional indicators because (a) we can track progress from 2003 to 2007, and (b) we can cross-tab income deprivation with deprivation in the other indicators simultaneously, which offers insights for the multidimensional approach versus the unidimensional one. Secondly, our measures do not contain the MPI's asset indicator as these items are already considered in the consumption expenditure variable. Thirdly, the measures estimated here do not include the MPI's floor indicator. Although relevant for housing quality, this is not an MDG indicator. Instead, we include the overcrowding indicator following UN (2003).[21] Fourthly, the measures considered here do not consider cooking fuel due to the high correlation observed with the electricity indicator. Finally, the measure for rural areas also includes two indicators—access to roads and land ownership, which can be regarded as living standard ones, and are particularly relevant to the rural areas in Bhutan.

The health indicator considered here differs from the two MPI's ones due to data constraints already mentioned. The education indicator also differs from the MPI ones in two ways. First, it requires having at least one literate household member rather than having at least one member who has completed 5 years of education; in this respect it is less demanding, although it may be more appropriate for the Bhutanese context given the high proportion of illiteracy. Second, it combines having a literate household member with requiring children in school age to be attending school into a composite educational indicator, rather than keeping the two separately. In this respect, it is more demanding than the MPI. Failing in any of the two requirements makes a household to be considered education deprived, whereas with the MPI a household can fail in one indicator and not in the other, receiving half of the weight of the dimension in their deprivation count score.

The measures computed here also differ from the GNH Index. The GNH Index covers 9 dimensions, using 33 indicators drawing on 124 variables, many of which are subjective indicators. In particular, this index considers health, education, living standard, psychological wellbeing, time use, cultural diversity, good governance, community vitality, and ecological diversity. Secondly, as stated in the Introduction, the GNH Index is sort of an inverse poverty index, as it uses sufficiency cutoffs and provides a value of well-being rather than poverty.[22]

The list of dimensions included in the measures of this paper is not intended to be exhaustive. There are two other MDGs not addressed in any way by the measure. One of them is the MDG 3 of *promoting gender equality and empowering women*. It would be possible to incorporate a gender condition in the educational indicator. For this paper we prefer to privilege indicators that are applicable to the whole population as well as to preserve the simplicity of the measure. Thus we keep the gender MDG as a separate indicator with which the current multidimensional measure may be complemented. The other MDG not included in the measure is MDG 8 of *developing a global partnership for development*. Indicators related to this goal, 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.

It s also worth noting that all the selected dimensions and indicators refer to material conditions. Given Bhutan's holistic approach to development and its emphasis on maximising GNH, there is basis to argue that other non-material conditions should also be

[21] The MPI could not include overcrowding because this information is not present in many internationally comparable surveys as the MPI requires.

[22] For a detailed description of the GNH Index see Ura et al. (2012a).

included in the measurement of multidimensional poverty. The capability approach as well as participatory studies from the ground also favor the consideration of a broader set of dimensions (see for example Sen 1985, 1999; Narayan 2000). In fact, these arguments have led the Oxford Poverty and Human Development Initiative (OPHI) to identifying 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 these or related dimensions are not available in the BLSS. However, some of these dimensions are available in the dataset of the 2007 and 2010 GNH Survey (used to estimate the GNH Index), but the respondents are not compatible with the BLSS dataset. Given that the BLSS dataset contains high quality consumption expenditure information and allows comparing poverty estimates in 2003 with those in 2007, it is preferred over the GNH one. Moreover, although it would be interesting to explore adding non-material dimensions into the measure, parsimony is also a convenient quality.

In summary, the measures estimated here may be seen as a middle ground between the MPI and the GNH Index. The first one focuses on the acutely poor, that is, those with an inability to meet minimum internationally agreed standards in a set of core human functionings and rudimentary services simultaneously (Alkire and Santos 2013b). The latter offers a measure of well-being with a broader set of dimensions which go beyond material conditions. The measures in this paper focus on material variables and are MDG-based but (a) consider a set of indicators and deprivation cutoffs in certain cases a bit more demanding than those of the MDG, (b) offers a wide range of alternative specifications to test robustness in various aspects and (c) allows comparing income poverty viz a viz multidimensional poverty.

Because seven out of the ten selected indicators are either dichotomous or ordinal variables, only the M_0 measure is estimated, with its components H and A. Given that there are two sets of measures, one with seven indicators and another with nine, two sets of deprivation cutoffs and three possible weighting structures, twelve different measures are estimated for each year. All are decomposed by urban and rural areas. Additionally the year 2007, they are decomposed by district. All sets of estimates were bootstrapped using 1,000 replications, accounting for the two-stage survey design.

3 Estimation Results

3.1 Overview of Multidimensional Poverty Rates

In the first place, we examine one of the M_0 components: poverty incidence. Figure 3 presents the multidimensional headcount ratio for the two sets of measures (with seven and nine indicators) and the three different weighting structures in 2003 and 2007, using the baseline set of deprivation cutoffs. Each set of measures is estimated for a range of poverty cutoffs, from being deprived in 10 % of the weighted indicators to being deprived in all of them (100 %). The number of deprivations implied by each poverty cutoff is clearly different under each weighting structure, producing varying poverty rates across the sets of weights.

Let us first examine the measure for urban and rural areas using seven indicators. Results are provided in the top two graphs of Fig. 4. A 10 % poverty cutoff requires being deprived in any indicator when equal weights are used (union approach), thus poverty rates can be very high. In fact, 82 % of the population in Bhutan was deprived in at least one

indicator in 2003; this decreased to 67 % in 2007. When GNHS weights are used, a 10 % poverty cutoff is not a union approach although close to it, as someone deprived in anything but water or sanitation is to be considered poor. Still, poverty rates are lower: 74 % in 2003 and 52 % in 2007. With equal-nested weights, someone is poor with the 10 % cutoff if she is deprived in income, health or education, or three of electricity, room, water or sanitation. Thus, with these weights, poverty rates at 10 % are even lower: 52 % in 2003 and 37 % in 2007. For each weighting structure, as the poverty cutoff increases, rates by definition fall. Poverty rates become 10 % or lower with poverty cutoffs of 60 % or higher for all weighting structures in 2003, and for a poverty cutoff of 50 % or higher in 2007. This indicates that less than 10 % of people experience so many simultaneous deprivations.

Using the measure for rural areas only, which includes access to roads and land ownership, poverty rates with the 10 % cutoff using equal weights were as high as 94 % in 2003 and 85 % in 2007, and lower with the two other weighting structures, namely 83 and 73 % in 2003 with GNHS and equal-nested weights correspondingly, and 63 and 57 % in 2007. Regardless of the weighting structures, poverty rates fall to 10 % or lower for poverty cutoffs of 60 % in 2003 and 50 % in 2007.

What is a sensible poverty cutoff to monitor poverty? With the baseline of equal-nested weights, 30 % seems to be a reasonable poverty cutoff both normatively and from a policy perspective.[23] Normatively, this implies deprivation in at least the equivalent of one dimension: education, health or living standard. This implicitly poses a higher requirement on deprivations in the living standard dimension, as health and education only have one indicator each. However, given that the deprivation cutoffs in the living standard indicators are relatively less demanding than those in the education and health indicators, this is somehow compensated. It is also worth noting that deprivation in one sole indicator may not be due to poverty. For example, a household might choose not to earn their income from farming (choosing not to own land), or it may choose to live in a very small house but located in a convenient area. However, deprivation in several living standard indicators (as required by the 30 % cutoff) is less likely to have been chosen. From a policy perspective, with this cutoff, 32 % of people in urban and rural areas were poor in 2007 (much lower than the 47 % that were poor in 2003).[24] In the rural areas only, with the 9 indicators measure, the poverty rate in 2007 at the 30 % cutoff was of 38 % of people being poor (lower than the 53 % who were poor in 2003). These proportions of population might be feasible to be prioritised in poverty reduction programmes. If budget constraints forced to narrow programmes to a smaller group, focus could be placed on the group experiencing deprivations in 40 % or more, which is about half of those who are poor with a k value of 30 %.[25]

[23] Both in the measure with seven indicators and in the one with nine indicators, when equal-nested weights are used, the 30 % cutoff is in practice equivalent to a cutoff of 33.33 % as used in the MPI (Alkire and Santos 2013b).

[24] It is worth noting that despite the differences with the MPI, the proportion of the population identified as poor with the 30 % cutoff in the measure with seven indicators is just slightly higher than the proportion identified as poor by MPI using the 2010 BMICS, which is 27.2 % (HDR 2011).

[25] With GNHS weights, given the high weight attached to consumption expenditure, the 30 % cutoff implicitly poses a lower requirement on the living standard dimension and a higher requirement on health and education. In fact, someone is poor if she is deprived in consumption expenditure, or in the health or education variables *combined* with room or electricity. With equal weights the 30 % cutoff implies deprivation in *any* three indicators. These alternative requirements produce lower poverty rates (20 % with GNHS weights and 17 % with equal weights in 2007).

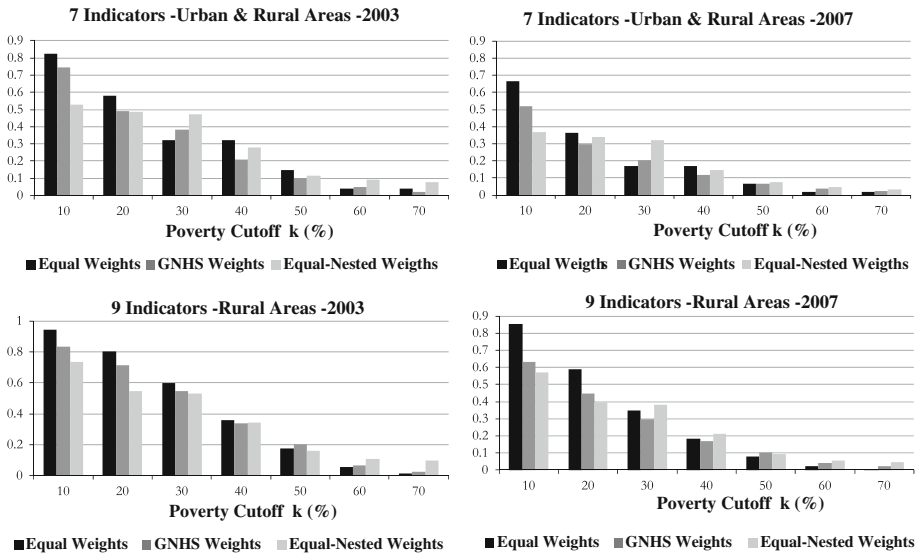

Fig. 4 Multidimensional headcount ratios using the baseline set of deprivation cutoffs

3.2 Poverty Intensity

We now focus on the other component of M_0: poverty intensity. Figure 5 depicts the average deprivation share among the poor—poverty intensity—for the two sets of measures (with seven and nine indicators) and the three different weighting structures in 2003 and 2007, using the baseline set of deprivation cutoffs, and various poverty cutoffs. By definition of the M_0 measure, poverty intensity increases as the poverty cutoff increases, tending to 1 as we move to the intersection approach. It is worth noting that even with the low poverty cutoff of 10 %, poverty intensity is no lower than 30 % of the weighted indicators, suggesting that in Bhutan deprivations tend to go together.[26]

Using the measure with seven indicators and a poverty cutoff of 30 %, the average deprivation share among the poor using equal-nested weights was 47 % in 2003 and 44 % in 2007. These were similar with GNHS weights but higher with equal weights (52 % in 2003 and 50 % in 2007). With the measures for rural areas, intensities are higher at the 30 % cutoff, with the average poor being deprived in 53 to 59 % of the weighted indicators in 2003 and between 29 and 38 % in 2007, varying with the weighting structures.

The intensities discussed are averages. Yet it is worth exploring how intensity is distributed among the poor and how this changed between the two considered points in time. For this purpose we focus on rural areas, given that—as we shall see in the next section—poverty is mainly a rural phenomenon. This is depicted in Fig. 6 where we can see the proportion of poor people with different intensities of poverty. There we see that in 2003, 35.6 % of the poor in rural areas were deprived in 30–39 % of the weighted indicators, just above a third were deprived in 40–49 % of the weighted indicators and the remaining share (just below a third) was deprived in 50 % or more of the weighted indicators; within this group. In 2007, the distribution of poverty intensity in rural areas improved overall, with

[26] The only exception is using equal weights in 2007, when poverty intensity with a k of 10 % is 27 % which in any case is close to 30 %.

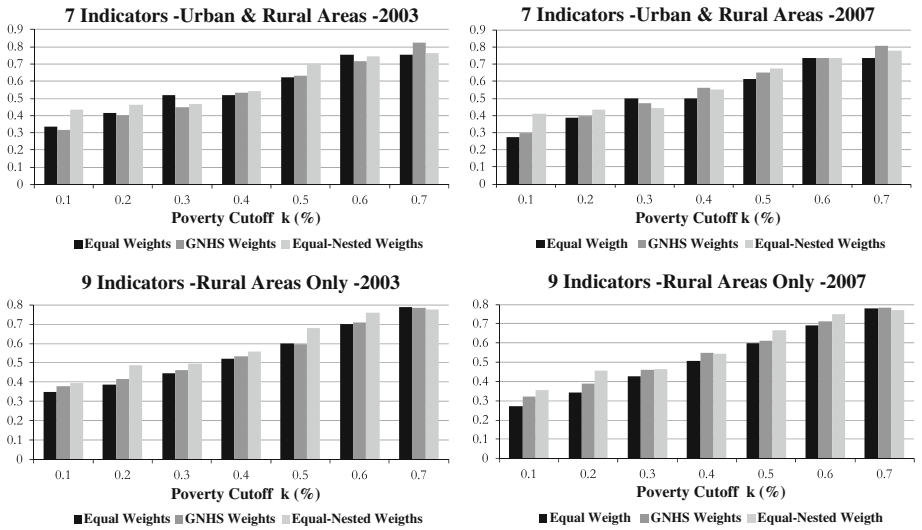

Fig. 5 Intensity of multidimensional poverty using the baseline set of deprivation cutoffs

the proportion of the poor being deprived in 30–39 % of the indicators increasing to almost 45 %, and the proportions in the other categories decreasing in most cases, except for two marginal increases among the group of deprived in 60–69 % of the weighted indicators (it increased from 2 to 2.6 % of people) and the group deprived in 90–100 % of the indicators (which increased from 0.2 to 0.4 %). The distribution of intensity also improved when urban areas are included.

3.3 Urban Versus Rural Areas

Given that Bhutan is essentially a rural country, one may for see that poverty in Bhutan is predominantly a rural phenomenon. However, for the sake of comparability, in Fig. 7 we present the M_0 estimate for the measure of seven indicators for urban and rural areas, as

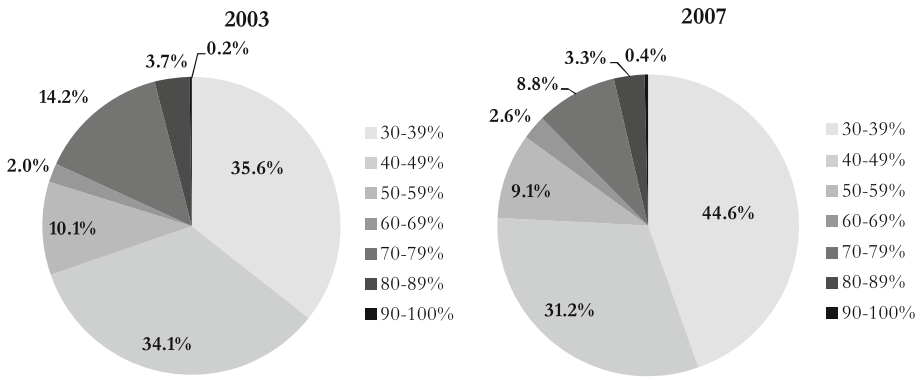

Fig. 6 Distribution of poverty intensity among the poor. Rural areas. Baseline set of deprivation cutoffs. 30 % Poverty cutoff. Equal-nested weights

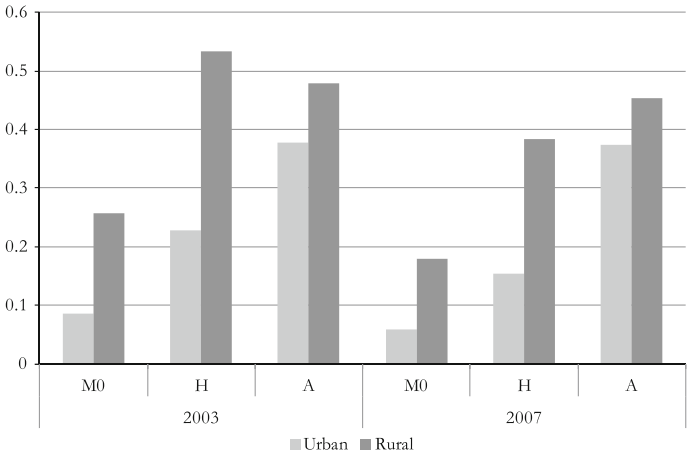

Fig. 7 Multidimensional poverty in rural versus urban areas. Baseline set of deprivation cutoffs. 30 % poverty cutoff. Equal-nested weights

well as its components, incidence and intensity. We present this for a poverty cutoff of 30 % and using the baseline set of deprivation cutoffs and equal-nested weights, but similar results hold for the other two weighting structures, other poverty cutoffs and the more demanding set of deprivation cutoffs.

In the Fig. 7 we can see that multidimensional poverty in rural areas is substantially higher than in urban ones; in fact, M_0 is three times higher in both years. This is mainly a consequence of a much higher incidence rather than a much higher intensity. The multidimensional headcount ratio is over twice as high in rural areas than in urban ones in both 2003 and 2007, whereas intensity is only 1.2 and 1.3 times higher in 2003 and 2007 correspondingly. For higher poverty cutoffs the rural–urban gap is accentuated, as incidence becomes virtually zero for poverty cutoffs of over 30 % in urban areas, while they are 15 % or higher in rural areas depending on the weighting structure and year. These findings reinforce results from the 2004 and 2007 *Poverty Analysis Reports* (NSB 2004, 2007b), 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. However, for the few urban poor, their poverty seems to be almost as intense as that of rural habitants.

3.4 Multidimensional Poverty Over Time

As discussed in the Section 1, Bhutan has made progress in several indicators of development including growth and many of the MDG's indicators. Also, most of the deprivation rates of the indicators considered in the measures estimated here exhibited significant decreases, as it can be verified in Fig. 8. However, the significant improvements in most of the indicators do not necessarily imply reduction in multidimensional poverty. It could be the case that those who are no longer deprived in an indicator (say water) are not precisely those who are also deprived in other indicators. In other words, we are interested in whether there have been improvements for those who experience joint deprivations. In this section we examine whether multidimensional poverty has decreased, whether this is robust and in which ways it has decreased, namely, via a reduction of the proportion of the

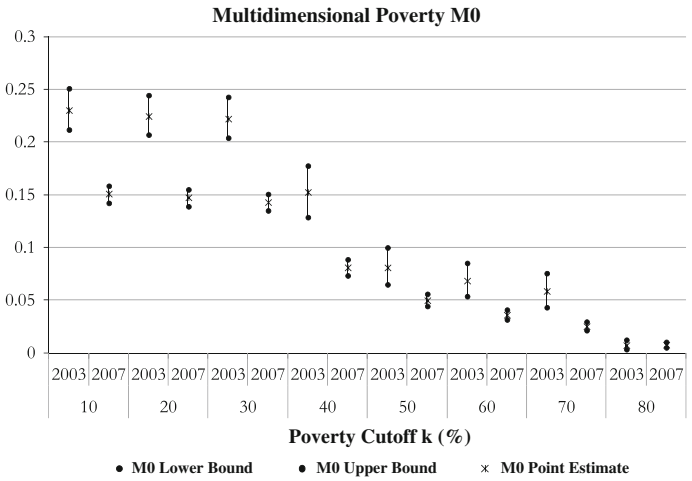

Fig. 8 Bootstrapped confidence intervals of M_0 estimate. Urban and rural areas. Baseline set of deprivation cutoffs. Equal-nested weights

poor and/or a reduction in poverty intensity. To test the robustness of any change we estimate bootstrap confidence intervals (at the 95 % level of confidence) for each M_0 measure as well as its components, the multidimensional headcount H and poverty intensity A. We do this using 1,000 replications and considering the complex survey design.

Figure 8 presents the bootstrapped M_0 estimates of the measure with 7 indicators, using the baseline set of cutoffs and equal-nested weights. There it can be seen that M_0 unambiguously decreased between 2003 and 2007 for all k poverty cutoffs from 10 to 70 %, as for each k value the confidence intervals between years do not overlap. Above the 70 % cutoff the reduction is no longer robust simply because the M_0 estimate is virtually zero. The decrease in M_0 has been high and relatively homogeneous across the k cutoffs, with reductions between 34 and 56 %, the highest being for people deprived in 70 % of the weighted indicators.

Is this reduction in M_0 a consequence of a decrease in the proportion of the poor, in the intensity of poverty or in both? Figure 9 exhibits the bootstrapped estimates for these component indices of the M_0 measure. The answer is that the decrease in M_0 has been mainly driven by a reduction in the proportion of the poor. The first panel of Fig. 9 shows that H decreased unambiguously across the k values. However, in the second panel of Fig. 9 we can see that for k values of up to 30 %, the reduction in H was accompanied by a reduction in poverty intensity, but for higher k values, this does not hold as A's confidence intervals overlap. Interestingly, this result holds across the different weighting structures. It also holds for the measure using nine indicators, across the three weighting structures. This is a strong result given that (a) rural areas are much poorer and (b) the measure with nine indicators includes access to roads, an indicator with one of the highest deprivation rates, and land ownership, one of the two indicators which registered a small increase in its deprivation rate.

What happens when we use the more demanding set of cutoffs? Impressively, the bootstrapped estimates of M_0 also exhibit a significant and unambiguous reduction across the different poverty cutoffs, weighting structures and the two measures (the one with

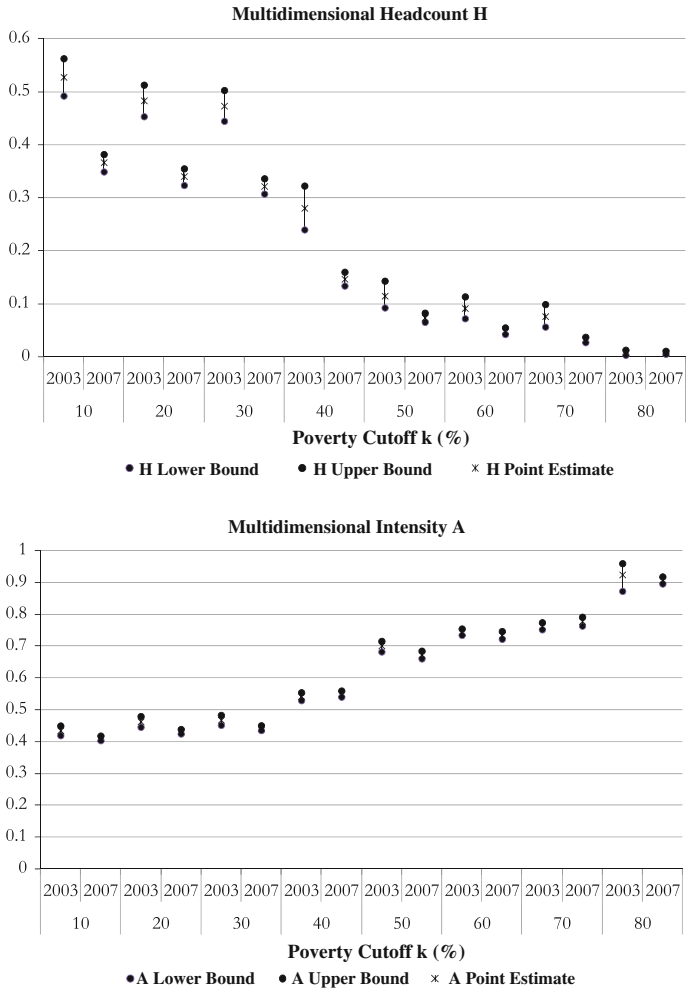

Fig. 9 Bootstrapped confidence intervals of H and A estimates. Urban and rural areas. Baseline set of deprivation cutoffs. Equal-nested weights

seven and the one with nine indicators). Interestingly, with this set of cutoffs the reduction in M_0 is a consequence of both an unambiguous reduction in H as well as an unambiguous reduction in A across all the different cutoffs values (and not just up to 30 %). Combined with the previous results, this suggests that the group of the poorest poor—those with higher poverty intensity (40 % or higher) when the baseline (lower) deprivation cutoffs are used—were in 2007 as intensively poor as in 2003.[27]

3.5 Income Poverty Versus Multidimensional Poverty

Some argue that although poverty is multidimensional, income is an indicator good enough to measure it (Ravallion 2011). If that was the case, there should be an almost perfect

[27] Full estimation results are available in the Supplementary Data.

overlap between those who are identified as multidimensionally poor and those who are identified as income or consumption poor. Yet, as in other cases (Rugeri Laderchi et al. 2003; Alkire and Santos 2010) the evidence from Bhutan does not confirm this hypothesis. Here we refer to income poverty in a generic way to monetary poverty, which may be income, consumption or expenditure. The indicator used in this particular case is actually consumption expenditure.

By construction of the AF measures, when income is included as an indicator and a union approach to identification is used, the inclusion error is cero. In fact, if people deprived in any indicator are considered multidimensionally poor, all who are income deprived are counted as multidimensionally poor. However, as one raises the poverty cutoff k requiring to be deprived in an increasing number of weighted indicators, inclusion error will increase in as much as income imperfectly identifies the multidimensionally poor, and it will be maximum when an intersection approach is used; at that k value, inclusion error equals the income poverty rate minus the multidimensional poverty rate. On the other hand, also by construction, when income is included as an indicator of the AF measures and an intersection approach is used for identification, the exclusion error is cero. In fact, if one requires being deprived in all indicators in order to be considered multidimensionally poor, there will be no one who is identified as poor and yet not deprived in income. For less demanding poverty cutoffs, exclusion error will be positive in as much as income imperfectly identifies the multidimensionally poor, and it will be maximum when a union approach is used; at that k value, the exclusion error equals the multidimensional poverty rate minus the income poverty rate. In summary, as long as income is not a perfect proxy for multidimensional poverty, we see that as the poverty cutoff k increases, inclusion error increases and exclusion error decreases.

How sizeable are these errors in practice in the case of Bhutan? We estimate both types of errors, as well as the proportion of people in which both approaches (income and multidimensional) coincide in identifying the poor for all the twelve measures, across the range of k cutoffs, in 2003 and 2007. The main findings are as follows.

When the baseline set of cutoffs is used (which uses the food poverty line for identifying those deprived in consumption), the inclusion error is as high as the exact proportion of those who are subsistence income poor, regardless of the year, the weighting structure and whether it is the measure with seven or nine indicators. In other words, inclusion error with a k value of 100 % is 3.8 % in 2003 and 5.9 % in 2007, when both urban and rural areas are considered (measure with 7 indicators), and 4.7 % in 2003 and 8 % in 2007 when only rural areas are considered (measure with 9 indicators). This is because there is no one deprived in all the indicators considered; in fact, we have seen in Fig. 4 that the multidimensional headcount ratio becomes negligible for a k of 70 % and above. A similar finding holds when the more demanding set of cutoffs is used (which uses the total poverty line for identifying those deprived in consumption).

Conversely, exclusion errors are maximum with the union approach to identification. For a k cutoff of 10 %, exclusion error equals the multidimensional headcount minus the proportion of those who are income deprived, in other words, all those who are deprived in one or more indicators but not in income.[28] With the measure using seven indicators, this

[28] Although a k value of 10 % does not coincide with a union approach when GNHS or equal-nested weights are used, for the purposes of exclusion error, it works the same as if it was a truly union approach. This is because the weight attached to consumption expenditure is 11 % or higher in all the weighting structures except for the case of the measure with nine indicators and equal-nested weights (in which case exclusion error is marginally higher than the multidimensional headcount minus the income deprived).

ranges from a maximum of 78 % of people in 2003 when equal weights and baseline deprivation cutoffs are used, to 30 % of people in 2007, when equal-nested weights and baseline deprivation cutoffs are used. With the measure for rural areas only, using nine indicators, the proportion of people identified as poor with a k value of 10 % who are not income poor ranges from 89 % in 2003 when equal weights and baseline deprivation cutoffs are used, to 38 % in 2007, when equal-nested weights and baseline deprivation cutoffs are used.

Two points are worth noting. First, exclusion errors are higher than inclusion ones in Bhutan. This is a reasonable finding. Bhutan is a rural country with a significant share of subsistence agriculture, markets are still incipient and there is limited access to basic services such as water, sanitation, electricity, education, health and access to roads. In this context, income poverty is likely to underestimate poverty. Second, the maximum exclusion error is lower when more demanding deprivation cutoffs are used, as this includes using the total income poverty line (rather than the subsistence-food poverty line) and thus a higher proportion of people are identified as deprived. However, for the same reasons, inclusion error is higher with this set of cutoffs. Table 6 in the Appendix presents the maximum exclusion and inclusion errors for each measure and year.

Thus, when any of the two extreme criterion to identify the multidimensionally poor (union or intersection) is used, one of the two errors is maximized if income is taken as a proxy variable. Yet, one may think that some middle-ground identification criterion is more applicable. For example, how are the errors' magnitudes with the 30 % cutoff? One may also examine the size of the errors when the income and the multidimensional poverty rates are matched, which—by definition—implies equalizing the exclusion and exclusion errors.

Table 4 presents, in Panel A, the magnitudes of the errors and coincidences when equal-nested weights and the baseline set of cutoffs are used, for a k value of 30 % in the year 2007. In Panel B, Table 4 presents the magnitudes of the errors and coincidences when the headcount of multidimensional poverty is matched with that of income poverty using the higher set of cutoffs (as with the baseline ones income poverty is too low). This is done using equal nested weights and it also corresponds to the year 2007.

As we have previously discussed, inclusion error is at its maximum equal to the income poverty rate, and with the baseline set of cutoffs (which uses the food poverty line), we know this is a small proportion of the population. Thus, it is expectable to find a negligible inclusion error for any k value lower than 100 %. However, exclusion errors are sizeable: 28.4 % of people in 2007 were deprived in 30 % or more of the weighted indicators, yet they were not consumption poor, as measured by the food poverty line. Exclusion errors were bigger in 2003 and are also bigger when only rural areas are considered.[29] When the income and the multidimensional poverty rates are matched using the total income poverty line, which occurs at a k value of 50 % in 2007, exclusion and inclusion errors are 6.8 %. This indicates that even when matched, about 30 % of the multidimensionally poor (6.8/23.2) are not income poor and *viceversa*. In summary, results here suggest that if we use income as a proxy variable to target the multidimensionally poor in Bhutan, we are likely to either ignore a considerable fraction of the poor or, if we try to match the population poor by income with that poor by the multidimensional criterion, we are likely to commit non-trivial both inclusion and exclusion errors.

[29] These errors are a bit smaller with GNHS and equal weights with the measure with 7 indicators. With the measure of 9 indicators, the exclusion error is higher with equal weights than with equal-nested weights but lower with GNHS weights than with equal-nested weights.

Table 4 Matches and mismatches between consumption and multidimensional poverty

	Panel A				Panel B		
	2007, $k = 30$ %, baseline cutoffs				2007, $k = 50$ %, higher cutoffs		
	Multidimensionally				Multidimensionally		
Consumption	Poor	Non-poor	Total	Consumption	Poor	Non-poor	Total
Poor	5.9	**0**	5.9	Poor	16.4	**6.8**	23.2
Non-poor	**28.4**	65.7	94.1	Non-poor	**6.8**	70	76.8
Total	34.3	65.7	100	Total	23.2	76.8	100

Equal-nested weights—percentage of population

Urban and rural areas—measure with 7 indicators

3.6 Composition of Poverty

One of the reasons to take a multidimensional approach to poverty measurement is the need to identify the particular deprivations people experience to better inform policy design; the income approach does not allow such detailed information. As opposed to some multidimensional measures which do not allow a break down into the particular deprivations, the AF measures permit such decomposability.

Given that Bhutan is a rural country and that all censored headcount ratios were below 9 % in urban areas in 2007, in this section we focus the analysis on the measure for rural areas only.[30] Figure 10 synthesises three pieces of information: composition of poverty across weights, its change over time and how this compares to changes in raw headcount ratios. Panels A and B depict the censored headcount ratios for each of the indicators, using the different weighting structures with a poverty cutoff of 30 % and the baseline set of deprivation cutoffs in 2003 (Panel A) and in 2007 (Panel B). The censored headcount ratios are the proportion of people who are identified as poor and are deprived in each particular indicator. The graph facilitates identifying the more prevalent deprivations among the poor.

In Panel A, we can see that in 2003, regardless of the weighting structure, the most salient deprivations experienced by the poor were electricity, access to roads and education. For example, using equal-nested weights, about 42 % of the population was poor and had no access to electricity; the same proportion lived in a household where there was no literate member or there were children in school age not attending school, or both. About 30 % were poor and had no access to roads within 30 min. These were followed by deprivation in water, room, land and health. Deprivations in sanitation and consumption expenditure were the lowest. The exact proportions obviously vary across weights, as—for example—equal-nested weights place much higher weight on education than on roads access; thus the censored headcount ratio of education is higher with these weights than with the other weighting structures and the one of access to roads is lower. Still, the pattern is quite consistent.

Over the considered time period there were substantial reductions in deprivations in all but one of the indicators. This can be verified in Panel B of Fig. 10. Deprivations in roads,

[30] In 2003, 81 % of the population lived in rural areas. This decreased to 73 % in 2007.

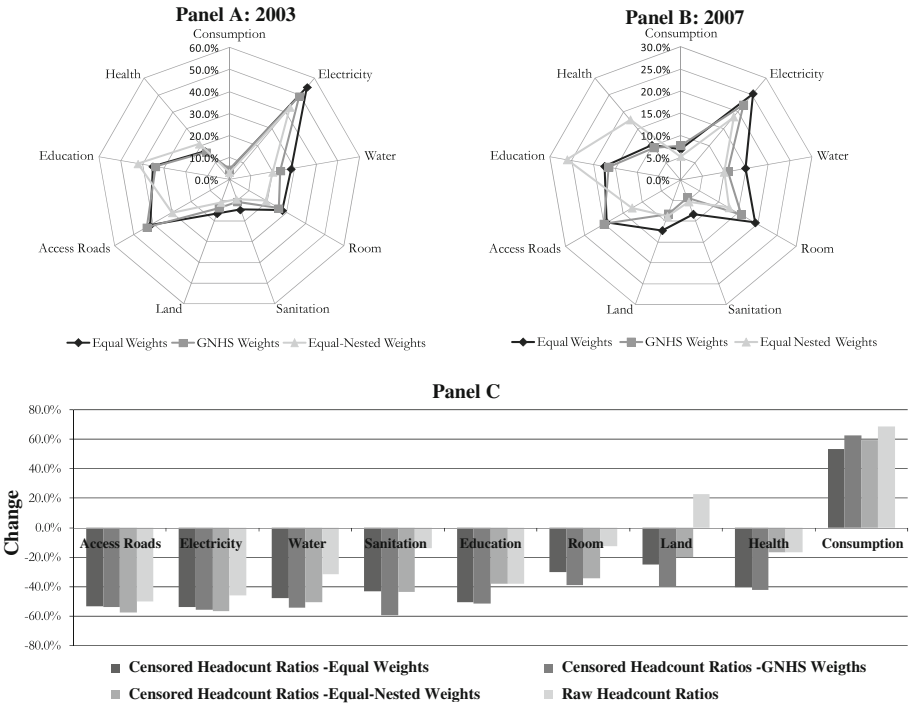

Fig. 10 Composition of poverty. Rural areas. Various weighting structures. 30 % poverty cutoff

electricity, water, sanitation and education were reduced in 40–60 %, and deprivations in room, land and health were reduced in 20–40 %, depending on the weighting structure. Deprivation in consumption expenditure is the only one that registered an increase, but this might be due to differences in data collection between the two surveys.

Given the different percent reductions of indicators across weights in 2007 the pattern of deprivations varies a bit more across weights. With equal-nested weights, education, electricity and health are at the top, followed by roads and room, and then water, land, sanitation and consumption. With equal and GNHS weights, deprivation in education is lower, while deprivation in roads and room are higher.

Panel C of Fig. 10 also allows comparing the percent change in the censored headcount ratios (with the various weighting structures) with the percent change in the raw headcount ratios, namely those discussed in Sect. 2.4. Interestingly, the graph suggests that the reduction in deprivation in water, sanitation, room per person, roads and electricity were higher among the poor than in the population in general. Also, the increase in deprivation in consumption expenditure seems to have affected less the multidimensionally poor than the general population. The improvements in health and education were with equal-nested weights- exactly the same as in the population in general, but higher with equal and GNHS weights. Finally, while deprivation in land ownership exhibited an increase in the overall population, it was reduced among the poor. These more pronounced improvements of the censored headcount ratios as compared to the raw ones suggest that policies towards the MDGs have been well targeted to those experiencing multidimensional deprivations; in other words, they seem to have been *pro-poor*.

These results are robust across the different specifications of the measures. When the set of more demanding poverty cutoffs is used, the main difference is that sanitation appears as the indicator with the highest proportion of people being poor and deprived in it, which is due to the highly demanding cutoff used. Also, in terms of reductions in the deprivations, the percent changes are more moderate.

All in all, we may highlight three points. First, that although improvements have been greatest in extending access to roads, electricity, water, sanitation, and education, there seems to have been a relatively balanced improvement across indicators rather than a reduction in poverty led by reduction in one or two particular deprivations. Second, these improvements are consistent with Bhutan's coordinated and planned investments towards specific goals such as those specified in the guidelines for Farm Roads Development, the Rural Electrification Master Plan and the Rural Water Supply Scheme, to mention some examples. Thirdly, these planned investments seem to have been successful in reaching the multidimensionally poor. However, there is still need for much more development in the country, as evidenced by the still considerably high censored headcount ratios in certain indicators, namely education, access to roads, electricity and room per person.

3.7 District Rankings

When tracking poverty at the country level, it is natural to compare how regions or other subgroups perform compared to each other. This informs policy design and may guide prioritization of certain regions over others. The 2003 BLSS does not allow estimates representative at the district level, but the 2007 BLSS does. Figure 11 presents the M_0 estimates in 2007 for the 20 districts using the measure with seven indicators, the baseline set of cutoffs, equal-nested weights, and the 30 % cutoff. It presents the point estimate and the bootstrapped confidence interval at the 95 % level. A district can be said to have an unambiguously lower M_0 if the upper bound M_0 estimate is strictly lower than the lower bound M_0 estimate of another, in other words, if their confidence intervals do not overlap.

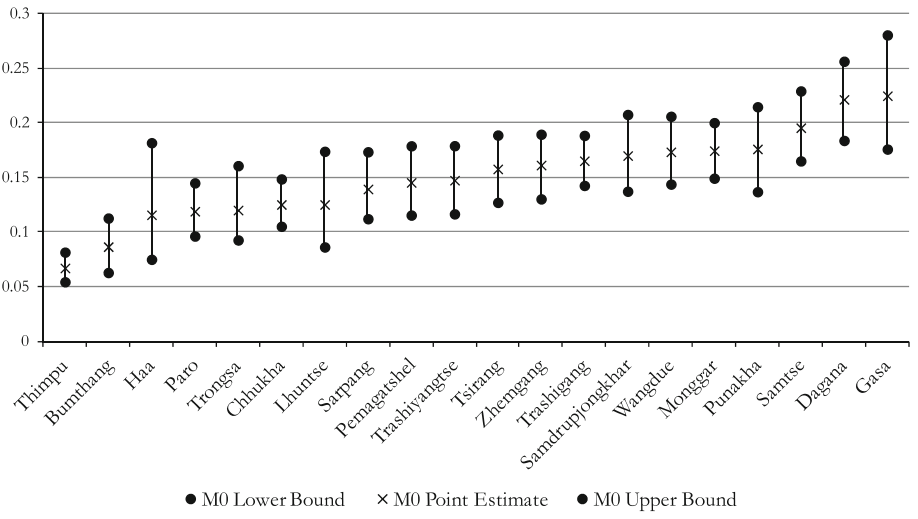

Fig. 11 Bootstrapped confidence intervals (95 % confidence) of M_0 by district urban and rural areas—baseline set of deprivation cutoffs—equal-nested weights—30 % poverty cutoff

In the figure it can be seen that many of the confidence intervals overlap with each other suggesting that the ranking is not unambiguous. However, there are a few robust comparisons. For example, Thimpu is unambiguously less poor than the rest of the districts except for Bhumtang and Haa. Bhumtang is unambiguously less poor than all the districts that rank as Pemagatshel or higher. Trashiyangtse is unambiguously less poor than Dagana; Chhukha is unambiguously less poor than Monggar, Samtse, Dagana and Gasa while Pemagatshel is unambiguously less poor than Dagana. Thus although the whole ranking is not robust, some comparisons are. Similar findings are obtained comparing the confidence intervals of the M_0 estimates of the other specifications. We also considered for each measure whether the pair wise comparisons were robust to changes in the poverty cutoff k, going from 20 to 40 %. We found that this varies. When the baseline set of deprivation cutoffs are used, we find that the pair wise comparisons are not very robust, consistent with the previous analysis. Still the proportion of robust pairs varies with the measures. In particular, of the 190 possible pair wise comparisons, only 20 pairs (10 %) are robust using the specification of 9 indicators and equal-nested weights, but 69 pairs (36 %) are robust to changes in the k value when the specification of 7 indicators with equal weights are used. When the higher deprivation cutoffs are used, the proportion of robust pairs is higher across the different measures with a maximum of 109 robust pair wise comparisons when the measure with 7 indicators and equal weights is used.

Is the fact that the district ranking is not highly robust a matter of using a multidimensional measure? Apparently not. We bootstrapped the income poverty headcount ratio by district and found that the confidence intervals of the different districts also overlap in many cases. This is depicted in Fig. 12. Thus, the lack of robustness seems to be either due to small sample sizes for each district or to the fact that districts are actually not so different rather than to a particular selection of variables.

Despite the fact that rankings by multidimensional poverty and income are not robust for the whole range, it is interesting to compare the change of rankings in certain cases where there is some robustness. For example, Gasa is a district with very low income

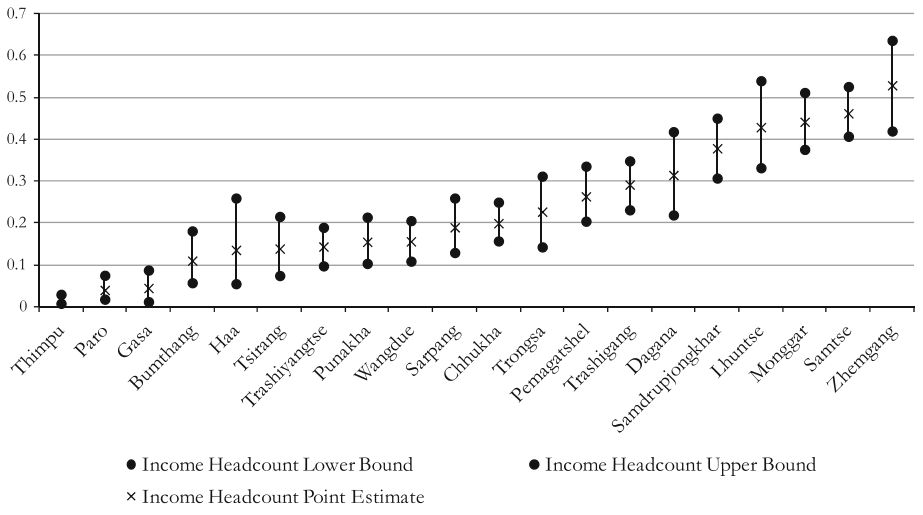

Fig. 12 Bootstrapped confidence intervals (95 % confidence) of income poverty headcount ratio by district (total poverty line)

poverty: it is the third least poor with only 4 % of income poor people and 1 % subsistence poor. On the other hand, Chhukha has 20 % of poor people and 4 % of subsistence poor. Looking at Fig. 12 it can be verified that Chhukha is unambiguously poorer than Gasa in income terms. However, Chhukha is unambiguously less poor than Gasa when using a multidimensional poverty measure as it can be seen in Fig. 11; in fact, using the measure with 7 indicators, equal-nested weights and 30 % cutoff Chhukha has 16.5 % of multidimensionally poor people whereas in Gasa this is 49.8 %. This significant divergence between income poverty and multidimensional poverty between these two districts is because, even if not highly deprived in income, significant parts of the population in Gasa are deprived in the other considered dimensions, whereas the opposite occurs in Chhukha. For example, using the measure of 7 indicators, with equal-nested weights, the baseline set of deprivation cutoffs and a 30 % poverty cutoff, we find that while only 1 % of the population is poor and deprived in income (subsistence poor) (versus 3 % in Chhukha), 38 % are poor and live in poor households which are deprived in education (versus 20 % in Chhukha), 28 % are poor and do not have access to electricity (versus 11 % in Chhukha) and 28 % are poor and do not have access to water (versus 7 % in Chhukha). Additionally, 10 % are poor and deprived in room per person and 5 % are poor and deprived in sanitation, although these censored headcount ratios are similar to those found in the case of Chhukha (9 and 6 % correspondingly). The divergence between income poverty and multidimensional poverty can also be seen with the magnitude of the mismatches between the two criteria. Using the same multidimensional measure specified above, 26 % of people are multidimensionally poor but not income poor (exclusion error) in Chhukha, whereas this is much higher in the case of Gasa: 49 %. Inclusion error on the other hand is 0 in Gasa and 1.8 % in Chhukha.

4 Concluding Remarks

In this paper we have estimated multidimensional poverty in Bhutan for two points in time—2003 and 2007 using the M_0 measure of Alkire and Foster (2011) method, which is the headcount ratio adjusted by poverty intensity. We have estimated a variety of specifications in terms of indicators, deprivation cutoffs, weights and poverty cutoffs. In particular we estimate one set of measures with seven indicators considering consumption expenditure, household literacy and child attendance to school, health status and access to electricity, safe drinking water, improved sanitation and enough room per person in household. For estimates in rural areas only, we add access to roads and land ownership. We consider two set of deprivation cutoffs, a baseline one which follows international standards and a set of more demanding thresholds. We also consider three alternative weighting structures. One is an equal-nested weights approach, following the MPI, where indicators are grouped by dimension and weights are equally divided between dimensions and within them. Another is an equal weights approach, where each indicator weights the same. A third is a Gross National Happiness weights approach, where each indicator is weighted with the (normalised) proportion of people who have identified that indicator (or a closely related one) as a source of happiness. Twelve measures are estimated in total to test the robustness of our results.

We find that there has been an unambiguous reduction in multidimensional poverty over the considered period regardless of weights, deprivation cutoffs, poverty cutoffs and number of considered indicators. This reduction was mainly led by a reduction in the proportion of the poor, which decreased in about a third when we consider as poor those

deprived in 30 % or more of the weighted indicators. The reduction was bigger when other weighting structures are used as well as if one focuses on the poorest poor. The reduction in poverty incidence was accompanied by a reduction in the intensity of poverty among those who are identified as poor with 10, 20 and 30 % of the weighted indicators. Intensity was reduced across all poverty cutoffs when higher deprivation cutoffs are used for each indicator. Also, in line with Bhutan's holistic approach to development, we find that the reduction in poverty was accomplished through a reduction in several deprivations, namely access to roads, electricity, water, sanitation, and education, rather than through a major reduction in just one indicator. Moreover, when one compares the reduction in deprivations in the total population (raw headcount ratios) with the reduction among the poor (censored headcount ratios), these have been greater among the poor, suggesting that policies have been pro-poor. All these are development achievements which are worth highlighting.

However, a lot remains to be done. Poverty is still widespread in the country, mainly in rural areas. About a third of people are identified as poor using the measure with seven indicators, the baseline set of cutoffs, equal-nested weights and a 30 % poverty cutoff. In rural areas, where 73 % of the population live, using the measure with nine indicators and similar specifications otherwise, 38 % of the people are poor. The proportion of the poor is naturally higher if one requires a lower share of joint deprivations or if one uses more demanding deprivation cutoffs. Moreover, the intensity of poverty remains high, with the average poor person in the country being deprived in 44 % of the weighted indicators (as identified with the measure specified above) and with the poorest poor having experienced no significant reduction in the intensity of their poverty between 2003 and 2007.

When comparing multidimensional poverty with income poverty we find that while most of the income poor are also multidimensionally poor, the converse does not hold. If one intends to target the multidimensionally poor using income alone, exclusion error is likely to be high. This is consistent with Bhutan being a country at the outset of its development path, where many needs cannot be satisfied through markets. In fact, looking at the district level, Gasa constitutes an interesting example of how a district that is among the richest in income terms, still needs investment in other fundamental dimensions such as education, electricity, room in the dwellings and even access to drinking water.

Thus, while the country has done remarkable progress, challenges remain in both continue reducing poverty incidence as well as in reaching the poorest poor. For that purpose, a multidimensional measure as outlined in this paper, which allows identifying those with different degrees of simultaneous deprivations and which allows dimensional break-downs, can be a valuable tool for targeting poverty reduction programmes (also see Azevedo and Robles 2013, and Alkire and Seth 2013, this volume). Such a measure can also be of use for monitoring poverty reduction, scrutinizing areas and groups of success as well as pending areas for improvement. While the measure itself cannot indicate the most-effective sequence of investments to be made (as no measure alone can), it constitutes a toolkit for prioritizing groups and evaluating upon investment.

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Appendix

See Table 5 and 6.

Table 5 Sample size of each survey by district and by rural and urban areas

District	BLSS 2003				BLSS 2007			
	Rural	Urban	Total	Weighted sample	Rural	Urban	Total	Weighted sample
Bumthang	302	140	442	12,063	1,051	286	1,337	16,033
Chhukha	725	1,517	2,242	48,730	2,930	2,088	5,018	67,606
Dagana	750	140	890	26,269	1,362	104	1,466	18,867
Gasa	72	33	105	2,131	1,076	48	1,124	3,749
Haa	173	90	263	8,357	1,079	138	1,217	12,511
Lhuntse	219	206	425	17,838	1,206	81	1,287	15,705
Monggar	652	186	838	41,556	2,529	436	2,965	38,187
Paro	381	122	503	22,238	2,615	175	2,790	35,475
Pemagatshel	289	197	486	23,815	1,649	184	1,833	23,646
Punakha	313	190	503	14,075	1,879	134	2,013	25,346
Samdrup Jongkhar	0	993	993	4,697	2,027	679	2,706	34,940
Samtse	1,196	526	1,722	59,694	3,490	717	4,207	55,727
Sarpang	0	1,184	1,184	6,524	2,119	802	2,921	40,182
Thimpu	395	2,476	2,871	63,915	662	5,482	6,144	86,717
Trashingang	918	617	1,535	68,039	3,301	388	3,689	47,704
Trashi Yangtse	415	203	618	29,820.40	1,274	175	1,449	18,216
Trongsa	467	127	594	18,512.42	1,097	176	1,273	14,585
Tsirang	647	208	855	26,791.03	1,385	121	1,506	18,970
Wangdue	894	664	1,558	32,901.33	2,223	564	2,787	35,890
Zhemgang	418	203	621	19,203.86	1,257	176	1,433	19,606
Bhutan	9,226	10,022	19,248	547,178	36,211	12,954	49,165	629,662

Table 6 Maximum inclusion and exclusion errors

Years	Number of indicators	Deprivation cutoffs	Weights	Maximum inclusion error (intersection approach) (%)	Maximum exclusion error (union approach) (%)
2003	7 (urban and rural areas)	Baseline	Equal-nested	3.6	49.0
			GNHS	3.8	70.6
			Equal	3.6	78.6
		High	Equal-nested	28.8	43.3
			GNHS	31.7	49.8
			Equal	28.8	59.2
	9 (rural areas only)	Baseline	Equal-nested	4.7	68.5
			GNHS	4.7	78.8
			Equal	4.7	89.6
		High	Equal-nested	37.3	53.6
			GNHS	38.2	55.0
			Equal	37.3	60.8

Table 6 continued

Years	Number of indicators	Deprivation cutoffs	Weights	Maximum inclusion error (intersection approach) (%)	Maximum exclusion error (union approach) (%)
2007	7 (urban and rural areas)	Baseline	Equal-nested	5.9	30.8
			GNHS	5.9	45.9
			Equal	5.9	60.8
		High	Equal-nested	22.3	38.0
			GNHS	23.2	44.5
			Equal	22.3	60.3
	9 (rural areas only)	Baseline	Equal-nested	8.0	49.2
			GNHS	8.0	55.0
			Equal	8.0	77.4
		High	Equal-nested	30.7	51.2
			GNHS	30.9	50.7
			Equal	30.7	66.1

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