Child Poverty Measurement:
An assessment of methods and an application to Bangladesh *

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Work in progress, comments are welcome

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Abstract:
This paper applies Alkire and Foster's (2007) methodology to the measurement of multidimensional child poverty using the 2006 Bangladesh Multiple Indicator Cluster Survey. It examines how this methodology can complement other measures of child poverty by particularly proposing a headcount ratio adjusted by breadth of deprivation of multidimensional poverty based on the traditional FGT measures of poverty. The final measure satisfies a series of properties including decomposability, and can be applied to cardinal and ordinal variables in microdata sets. The paper also illustrates how the specification of the dual cutoff method in the methodology allows carrying out sensitivity analyses according to different cutoff decisions. The paper illustrates the contribution of the methodology and implications for policy makers by measuring child poverty among children under five years of age in Bangladesh.

JEL Classification: I31, I32, J13

Keywords: *Poverty measurement, Multidimensional poverty, Child poverty, Decomposability, Bangladesh, MDGs*

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1. INTRODUCTION

There has been a growing interest in developing child specific multidimensional poverty measures to monitor progress on international commitments on child poverty reduction and child rights in general[1]. To this end, the United Nations Children's Fund (UNICEF) has assisted countries in filling the gap on information through its international household survey initiative the Multiple Indicator Cluster Surveys (MICS). In parallel, a major study that measures child poverty in developing countries, with national household surveys, has produced the first international comparable results (Gordon et al. 2003b; Gordon et al. 2001; also published in: UNICEF 2004; and as a short report in: Gordon et al. 2003a). While this has been a very important contribution, the methodology applied by this study – referred in this paper as the Bristol approach - can still be subject to important improvements. The measure proposed by the Bristol approach is still a crude, or partial, index of poverty that does not take into account the breadth, the depth, nor the severity of multidimensional poverty (Delamonica and Minujin 2007). To deal with some of these critiques, this paper applies Alkire and Foster's (2007) methodology to the measurement of multidimensional child poverty.

The paper examines how Alkire and Foster's (2007) methodology can enhance the Bristol approach (Gordon et al. 2003b) by adjusting the headcount ration by breadth of multidimensional child poverty based on the traditional FGT measures of poverty (cf. Foster et al. 1984). The final measure satisfies a series of properties including decomposability and can be applied to cardinal and ordinal variables in household surveys. Similarly, the methodology allows carrying out sensitivity analyses according to different cutoff decisions. The benefits of the methodology are assessed by measuring multidimensional poverty among children under five years of age with the 2006 Bangladesh Multiple Indicator Cluster Survey.

The remaining of the paper is divided as follows. It starts by reviewing the context of composite measures of child poverty and explaining the strengths and weaknesses of the Bristol approach. The next section explains in detail the methodology applied in the paper: the data and unit of analysis, the measurement method (Alkire and Foster 2007), and the choice of dimensions, indicators, cut-offs and weights. Following, the results and analyses

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[1] Important international commitments were agreed at world summits and conventions such as: the 1989 Convention on the Rights of the Child (CRC) (United Nations 1989), the World Summit for Children in 1990 (United Nations 1990), the 1995 World Summit for Social Development (United Nations 1995), the 2000 Millennium Summit (United Nations 2000), and the declaration 'A World Fit for Children' (WFFC) (United Nations 2002).

are presented in detail while examining the contributions of this alternative methodology. The paper compares different measures, presents a series of decomposition exercises and a sensitivity analysis of different cutoff decisions. The final section discusses policy implications and draws conclusions about the contributions of the methodology.

2. COMPOSITE MEASURES ON CHILD POVERTY AND WELL-BEING

Issues of multidimensionality have received special attention in the recent literature on poverty and inequality. The seminal works of Amartya Sen (1980, 1985, 1987, 1992) have particularly contributed to this debate with a systematic critique of the income and utility focus of neoclassical economics[2]. Interestingly, while multidimensional studies were – and perhaps still are – scare in welfare economics, the debate concerning child well being has predominantly followed a multidimensional perspective. Not surprisingly, the influential work carried out during the eighties by Cornia, Jolly and Stewart (1987) was promoted by the United Nations Children's Fund (UNICEF)[3]. The interest in multidimensionality has been particularly boosted by the publications of the Human Development Reports and companion indices since the early nineties, and later by the Millennium Development Goals indicators, and a series of international comparable data and household surveys.

One of the effects of the 1989 Convention on the Rights of the Child (CRC) (United Nations 1989) and the World Summit for Children (WSC) in 1990 (United Nations 1990) was to generate the international awareness that additional and more reliable data to monitor progress in children rights was necessary. As a result, the governments of countries that ratified the CRC agreed to dedicate particular efforts to producing the necessary data for monitoring purposes. A review of the progress since the WSC took place at the Special Session on Children in 2002 (United Nations 2002). In this session a more extensive declaration - 'A World Fit for Children' (WFFC) - was agreed with a new agenda, including 21 specific goals and targets for the next decade. Since then, there has been a substantial increase of international comparable data to measure and monitor children's rights. This has been particularly boosted by UNICEF international household survey initiative the Multiple Indicator Cluster Surveys (MICS)[4]. While more needs to be done to have a comprehensive

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[2] Notice that Sen's approach is more than a simple multidimensional approach to human well being, it emphasises human agency and the substantial freedom that people have to achieve valuable beings and doings in life.

[3] This seminal work ('Adjustment with a human face') discusses the negative effect of the Structural Adjustment Policies (SAP) in health and education performance. The SAPs have now largely been replaced by the Poverty Reduction Strategy Paper (PRSP) process.

[4] The Multiple Indicator Cluster Survey (MICS) is a household survey programme developed by UNICEF to assist countries in filling data gaps for monitoring human development in general and the situation of children and

set of indicators to monitor the CHC and WFFC, there is an extensive amount of available data at the present time.

The advantage of having such a varied amount of data comes with a draw back; it is difficult to interpret the information and get a synthetic picture of the overall progress and priorities. A set of indicators provides plenty of information, facilitates sectoral approaches, and can be used to monitor sectoral targets. While they frequently provide the opportunity for more comprehensive or holistic analyses, they only produce partial rankings and often supply redundant information. In contrast, the composite indices summarise a broad range of information in a single measure that can be used for complete ranking comparisons. A suitable composite measure for supporting decision makers would inform them if the overall situation is improving or worsening, and allow them to identify where it is changing (i.e. in which dimension, in which particular subgroup of the population). These are precisely the reasons that have motivated the development of composite measures of child poverty[5].

The Young Lives study is a good example of the advantages of a comprehensive or holistic approach that is based on microdata at a household level (cf. Boyden 2006). This is an international collaborative study founded by the UK Department for International Development (DFID) oriented to investigate the changing nature of child poverty. It is a long term project that aims to collect information on child well being for different cohorts over a period of 15 years in four countries (Ethiopia, Peru, Vietnam, and India)[6]. While this study provides a resourceful set of information that allows understanding the factor associated with child poverty, it does not attempt to offer a final synthetic evaluation of the child poverty in each country.

There is far from a consensus of which would be the best composite measure for international or national comparisons on child poverty. Instead, there is a range of different efforts that have been developed for various purposes (for some non-comprehensive review see: Gordon et al. 2003b; Minujin et al. 2006; Roelen and Gassmann 2008). These measures can be broadly classified between those that are based on macro data and those that are based on micro data - the choice among them normally depends on the available data set at hand or the purpose of the study. Composite measures that are based on macro data normally use indicators that have been previously computed at an aggregated geographical level (e.g. country, region), or for a specific social group category (e.g. gender,

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women in particular. A range of dissemination materials and results can be found in ChildInfo (Monitoring the Situation of Children and Women) at: http://www.childinfo.org/index.html.

[5] See EC/JRC and OECD (2008: 13-14) to expand on the pros and cons of composite indicators.

[6] The first and second rounds data sets of the study are available in the UK-Data Archive: http://www.data-archive.ac.uk/findingData/snDescription.asp?sn=5307.

ethnic group, age group)[7]. It is only after computing or obtaining the indicator for each dimension, that they are aggregated across dimensions.

A good example of this type of measures is the Child Development Index (CDI) launched by the international NGO Save the Children (2008). This index has been computed for a total of 37 countries for ranking comparison. The index follows a similar scaling and ranking methodology implemented for the Human Development Index (HDI) and the Human Poverty Index (HPI) published by UNDP (see the origin in: Anand and Sen 1994; Sen 2006; and current technical notes in: UNDP 2007). The CDI uses three child specific indicators: the mortality rate of children who are under five years of age, the percentage of school-age who are not enrolled in primary school, and the percentage of children under five year of age who are underweight - all MDG indicators. Each indicator is standardized following a lineal function by defining a maximum and a minimum value, obtaining a normalised indicator that range from 0 to 100[8]. Then, the indicators are combined together with equal weights to form the composite measure. As a result, countries can be ranked and their performance assessed either for each dimension or with regard to the aggregated indicator.

The CDI has similar strengths and weaknesses than the UNDP family of indices (cf. Chiappero-Martinetti and Roche 2009). The methodology is a particularly useful solution for the aggregation of indicators with different units of measurement, generally at the macro level. While the standardisation procedure solves the problem of the lack of a common unit of measurement, the final measure also has a straightforward interpretation. However, at a technical level, the definition of maximum and minimum limits can be contested. An important weakness is that the methodology requires continuous variables which are not always common in multidimensional analysis, particularly at the micro level. As a result, this methodology is not entirely suitable for interpersonal comparisons. Similar to the HDI, the CDI is calculated by a simple unweighted arithmetic average of standardized indicators. This solution avoids allocating arbitrary weights, but allows substitutability between dimensions (Kuklys 2005) and a certain redundancy between components (cf. Ivanova et al. 1999; McGillivray and White 1993; McGillivray 2005). Finally, there might be disagreement with regard to the indicators chosen and the way in which the technique handles issues of measurement error. The technique works based on the assumption that the best indicators

[7] At an international level, this is typically the harmonized time-series provided by United Nations, World Bank, UNDP, UNESCO, UNICEF, among many others.

[8] The standardisation is done as follow: $\tilde{x}_i^k = \left(x_i - m_i / M_i - m_i\right) \times 100$; where the maximum and minimum limits, M_i and m_i respectively, are considered goalposts for each dimension i . The standardized indicators $\tilde{x}_i^k$ are a linear projection of the original indicator on a scale between 0 and 100. This becomes a common unit of measurement suitable for aggregation. Notice that the indicators are expressed in deprivation form which refers to the lack of basic human capabilities.

for measuring each dimension have been chosen and there is not redundancy among the indicators[9].

Other composite measures of this type might be obtained by actually computing the indicator for each geographic unit directly from the microdata. The South African Index of Multiple Deprivation for Children (SAIMDC) is a good example of this type (Barnes et al. 2009; Barnes et al. 2007). In this case aggregated indices for 14 indicators are computed at the level of municipality directly from the Census microdata. These initial 14 indicators are then aggregated into five domains: income and material deprivation, employment deprivation, education deprivation, living environment deprivation, and adequate care deprivation. The aggregation by domain is carried out –in all cases except the dimension of education deprivation- by simply computing the proportion of children experiencing at least one of the deprivations in the original indicators[10]. For the case of the domain of education, the indicators are aggregated with a weighted index because there were different denominators for the two indicators involves. Following, the domain indices are standardised by ranking and then transformed to an exponential distribution. Finally, the standardised domain indices are combined together with equal weights. As a result each municipality can be compared on the basis of a set of five domains measures and one overall index of deprivation.

One of the strengths of this methodology is that it deals with issues of measurement error systematically by measuring each dimension with multiple indicators[11]. Similarly, the method of standardisation has a series of clear advantages[12]. Clearly, the main weaknesses are that the methodology is more complex and the final measure does not have an easy interpretation (except as a ranking of the municipalities). Besides the selection of the indicators – that can also be a matter of disagreements-, the methodology contains a number of appraisal decisions that can vary the results. One is concern with the number of indicators considered to measure each domain. While some domains are measured with only one indicator (i.e. employment), other domains are measure with up to six indicators (i.e. living

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[9] Other techniques, such as Structural Equation Model (SEM), deals better with issues of measurement error and maximise redundancy among indicators. This technique has been applied for the study of child well being by Di Tommaso (2007).

[10] As will be seen, this is analogous to choose a cutoff $k = 1$ in Alkire and Foster's (2007) methodology. We shall discuss this issue in the following sections.

[11] This is analogous to applications in the capability approach that are based on Structural Equation Models (cf. Di Tommaso 2007; Krishnakumar 2007; Kuklys 2005). Nonetheless, in Structural Equation Models when computing the latent variables, each indicator is explicitly considered to contain a certain degree of measurement error, contributing only partially to each latent variable. Roche (2008) is another example of an application in the capability approach literature where multiples indicators are aggregated to generate a final indicator reducing the measurement error.

[12] The exponential distribution for the standardisation satisfies a number of properties, including that *'when the domain are combined into a single index, there is no implicit weighting as a result of the underlying distribution; the exponential distribution is not affected by the size of the municipality's population; and it effectively spreads out the most deprived part of the distribution'* (Barnes et al. 2009: online source).

environment). The problem is that the chances to be deprived in the final domain indices increase according to the number of indicators considered[13]. Another less problematic weakness is that the results could vary if the authors had chosen as a cutoff for deprivation during the aggregation process another number of deprivations (e.g. deprived in at least two indicators). As will be seen shortly, Alkire and Foster's (2007) methodology proposes a dual cutoff method that allows carrying out sensitivity analysis of these decisions.

A common problem with all these previous composite measures is that they aggregate by dimension first at a geographical level or group of population, and then aggregate across dimension. The problem with this is that the final measure cannot be decomposed or use for interpersonal comparisons. To this end, new measures would need to be computed for each subgroup of population making the computation difficult when not simply unfeasible[14]. Other interesting experiences with micro data have particularly been implemented with the purpose of allowing interpersonal comparisons.

The best example of this type, and precisely the measure that we are more interested in, is the Bristol Approach. This methodology has been developed by a research team from the Townsend Centre for International Poverty Research, at the University of Bristol[15]. It was applied to child poverty in developing countries during a research project on child poverty and child rights funded by the United Nation Children's Fund (UNICEF) (Gordon et al. 2003b; Gordon et al. 2001). The results were later published as part of the UNICEF's world report 'the State of the World's Children 2005' (UNICEF 2004) and also in the form of a short summary of the project report (Gordon et al. 2003a).

The study is particularly attractive because it is the first measurement of the incidence of child poverty in all the developing regions of the world (Delamonica and Minujin 2007). It is conceptually appealing because the authors define child poverty according to the right based approach and international consensus[16]. While this makes the final measure suitable for the monitoring of child rights according to CRC and WFFC, the rights based approach has also important concurrences with Amartya Sen's human development and capability approach (cf. Sen 2005; Nussbaum 2003; Fukuda-Parr 2003; Osmani 2005; Vizard 2005). At a more methodological level, the study is attractive because it is based on the Demographic and

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[13] This particularly the case because the aggregation across dimensions considers a union approach (see later discussion).

[14] In fact, only Barnes et al. (2007) can produce this measures for other subgroups because they compute the indicators directly from the Census micro data.

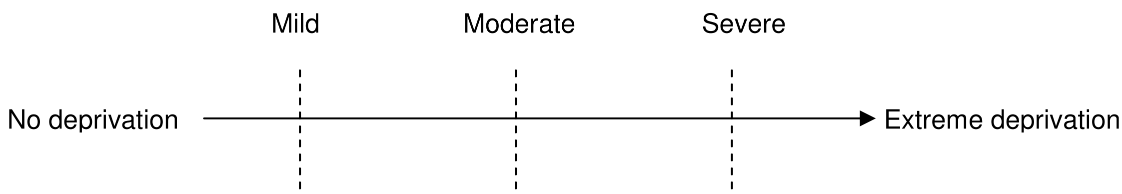
[15] Dissemination materials and other project reports can be found in the research centre website: http://www.bristol.ac.uk/poverty/.

[16] International conventions and summits, particularly the Copenhagen 1995 World Social Summit.

Health Survey (DHS) and can be replicated with the MICS[17]. Finally, the methodology is easy to be computed and the final measure has a straight forward interpretation.

The methodology is divided in four fundamental steps: i) definitions of the list of dimensions, ii) definition of the threshold by dimension to identify deprivations, iii) definition of poverty according to a threshold across dimensions, iv) computation of a multidimensional head count ration[18]. In relation to i), the approach bases the decision on the definition of poverty agreed in the 1995 World Summit for Social Development (United Nations 1995). Accordingly, eight dimensions are chosen: food, safe drinking water, sanitation facilities, health, shelter, education, information, and access to services[19]. The threshold for each dimension is defined according to a continuum of deprivation as in figure 1:

Figure 1 Continuum of deprivation



It assumes that deprivations can occur in different degrees from no deprivation at all to a situation of extreme deprivation. It is worth noting that this observation is similar to the idea of vagueness in fuzzy set theory (cf. Chiappero-Martinetti 2008; Qizilbash 2003, 2006) methodology that has been applied in several measurement applications in the capability approach (e.g. Berenger and Verdier-Chouchane 2007; Chiappero-Martinetti 2000; Lelli 2001; Qizilbash and Clark 2005; Roche 2008). The difference is that Gordon et al. (2003c) choose at the end a sharp cutoff in what they theoretically define as the situation of sever deprivation of basic human need in each dimension[20].

[17] The first figures were initially computed with a merged data file with the Demographic and Health Survey (DHS) of 46 developing countries. The DHS is an international survey program funded by the United States Agency for International Development (USAID).
[18] As will be seen this is very similar to Alkire and Foster's (2007) methodology.
[19] Choosing the dimensions is a sensitive topic in the capability approach. In empirical applications the list is frequently defined in relation to data availability and conventions from other research on well-being. This might be a pragmatic solution but, in the best case, it only leads to a second-best list (Robeyns 2003). The ideal list can be defined based on a variety of other methods (see: Alkire 2007). It can be based on theoretical assumptions such as in Nussbaum's list (2003). It can be based on public consensus such as the human rights framework (e.g. Vizard and Burchardt 2007). It can be based on ongoing deliberative participatory processes such as Narayan et al. (2000), Alkire (2002) or Apsan-Frediani (2003). Finally, some lists are based on empirical evidence regarding people's values such as in Qizilbash and Clark (2005) or Biggeri et al. (2006). This last one particularly applied to a list of capabilities for children.
[20] For example, instead of 'going hungry on occasion' they choose 'malnutrition' as in 'children whose heights and weights for their age were more than -3 standard deviations below the median of the international reference population, that is, severe anthropometric failure' (Gordon et al. 2003a: 7).

After defining the within dimension cutoff, the Bristol approach define two different across dimensions cutoff to identify who is in sever deprivation and who is in absolute poverty. Sever deprivation is define as those children experiencing one or more sever deprivation of basic human need. Children in absolute poverty are who suffer from two or more different types of severe deprivation of basic human need. According to (Gordon et al. 2003c: 44):

> *'The reason for using a multiple deprivation threshold to measure absolute poverty, rather than equating absolute poverty with a single deprivation, is that in rare cases single severe deprivations can result from causes other than a lack of command of sufficient resources over time e.g. severe anthropometric failure can result from ill health rather than from lack of income. Similarly, severe education deprivation could result from discrimination (particularly against girls) rather than from the lack of a teacher or a school in the village. However, it is very unlikely that two or more different severe deprivations would be caused by any reason other than a lack of sufficient resources'*

While the authors explain that other studies have demonstrated that poverty is better measured based on multiple deprivations, they do not carry out any sensitivity analysis with their set of indicators. As will be seen later, the dual specification in Alkire and Foster's (2007) allows performing these analyses.

The Bristol approach finally measure poverty and sever deprivation with the multidimensional headcount ratio of those children in the specific situation (i.e. poverty or sever deprivation). This measure is theoretically relevant, easy and clear to compute, and straight forward to interpret - being analogous to the traditional income headcount ratio. However, as Foster and Alkire (2007) argue, the draw back of the multidimensional headcount ratio measure is that it does not account for the breadth, the depth and the severity of deprivation as the traditional FGT measures in income poverty (Foster et al. 1984). Delamonica and Minujin (2007) have particularly identified that this is one of the weaknesses of the Bristol approach[21]. Breadth of deprivation is related to how many deprivations suffer the poor on average which varies considerably among regions or subgroups of population. Depth of deprivation refers to how far from the within dimension cutoff are the poor on average - Delamonica and Minujin (2007) do not refer to this particular issue-. The severity of deprivation refers to how poor are the poorest of the poor. Delamonica and Minujin (2007) do not refer to this issue either, but they refer to the severity of poverty in relation to the breadth of poverty which is instead overlooked by Foster and Alkire (2007).

[21] Notice that Delamonica and Minujin (2007) use a different terminology. They call depth of child poverty what Alkire and Foster (2007) refers as breadth: *'the fact that many children suffer from multiple deprivations* [while other from only few]' (Delamonica and Minujin 2007: 364). This paper follows Alkire and Foster (2007) terminology.

In order to account for the breadth of multidamentional poverty, Delamonica and Minujin (2007) advise to also analyse the average of deprivation. This is similar to Alkire and Foster's (2007) suggestion, though they propose to calculate it only among those who are multidimensionally poor, and then incorporate it to an adjusted headcount ratio. We shall explain this methodology in the following section, and illustrate it later with some empirical data[22]. As will be seen this have the advantage that the final measure satisfy decomposability and poverty focus.

3. METHODOLOGY

3.1 Data, response rate, unit of analysis

The analysis is based on the 2006 Bangladesh Multiple Indicator Cluster Survey conducted by the Bangladesh Bureau of Statistics (BBS 2006) with support of UNICEF. The 2006 Bangladesh Multiple Indicator Cluster Survey corresponds to the third rounds of MICS which particularly focuses on '*providing a monitoring tool for the Millennium Development Goals (MDGs), the World Fit for Children (WFFC), as well as for other major international commitments, such as the United Nations General Assembly Special Session (UNGASS) on HIV/AIDS and the Abuja targets for malaria*' (Croft and James 2008: 1). The survey is constituted by three questionnaires: 1) a household questionnaire, 2) a questionnaire for individual women aged 15-49, and 3) a questionnaire for children under five years old.

The survey sampling was designed to provide estimates at the national level for urban and rural areas, and for all six divisions in Bangladesh: Barisal, Chittagong, Dhaka, Khulna, Rajshahi and Sylhet (see graph 1 in the appendix). First, a number of households were selected for questionnaire 1. Then individual women aged 15-49 were selected within those households for questionnaire 2. Finally children under five were selected for questionnaire 3. The final sample corresponds to 62,463 households, 69,860 women (aged 15-49), and 31,566 children under five. Overall, the under-five questionnaire had a response rate of 84.1 percent[23].

The analysis in this paper specifically focuses on under-five child poverty, in order to provide policy-relevant information about the incidence and breadth of multidimensional

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[22] As will be seen, the nature of the indicators does not allow illustrating other aspects of the methodology, such as the measurement of the depth and severity of deprivation. We shall come back to this point in the section about the measurement method.

[23] This figure combines the household response rate (92.5%), and the under-five response rate (90.9%).

poverty among this age group. While poverty can be measured jointly for all age groups, in order to provide a general evaluation of child and youth poverty (e.g. Gordon et al. 2003a), age group specific measures allow identifying areas for particular interventions. Naturally, child rights and needs are age specific and public policies should be designed accordingly. The measurement of under-five child poverty is of particular relevance, not only for its association to under-five child mortality[24], but also because of the future consequences that poverty at this early age has on long term individual well-being[25]. The analysis in this paper takes full advantage of the MICS design and the broad information regarding the situation of under-five children. Hence, the under-five children are considered as the unit of analysis for identifying the poor. The values of the indicators of dwelling are ascribed to the children while all the rest are under-five children specific indicators contained in questionnaire 3. Let us first explain the measurement method before explaining in detail the criteria for selecting the indicators.

3.2 Measurement method

The paper applies Alkire and Foster's (2007) methodology to the measurement of multidimensional poverty among children under five years old[26]. It particularly illustrates how this methodology can enhance the Bristol approach by offering a clear specification of the dual cutoff method and by taking into account the breadth of multidimensional poverty. First, the notation is defined before moving on to explain the methodology in more detail. We adapt the methodology to the case of children instead of to all the individuals as in the original version.

Let $y = [y_{ij}]$ denote the $n \times d$ matrix of achievements, where n represents the number of children, d is the number of dimensions, and $y_{ij} \geq 0$ is the achievement of child $i = 1,2,...,n$ in dimension $j = 1,2,...,d$. Each row vector $y_i = y_{i1}, y_{i2},..., y_{id}$ lists child i´s achievements, while each column vector $y_{\circ j} = y_{1j}, y_{2j},..., y_{nj}$ gives the distribution of dimension j achievements across the set of children. Let $z_j > 0$ denotes the cutoff below which a child is considered to be deprived in dimension j, and let z be the row vector of

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[24] Access to safe drinking water, access to improved sanitations facilities, and appropriate immunization, among other indicators are highly associated to under-five child mortality.
[25] Malnutrition, lack of vitamin A, iodine deficiency, lack of immunization, slow brain development at an early age, among other incidences of child poverty, can have sever consequences on the children's life course driving them to chronic poverty.
[26] Naturally, the methodology can be applied to poverty measurement among other age groups, or to national population (e.g.: Alkire and Foster 2007; Alkire and Suman 2008; Batana 2008; Santos and Ura 2008)

dimension specific cutoff. The expression $|v|$ denotes the sum all the elements of any vector or matrix v, and $\mu(v)$ represents the mean of $|v|$, or $|v|$ divided by the total number of elements in v.

For a give matrix of achievements y, it is possible to define a matrix of deprivation $g^0 = [g_{ij}^0]$ whose typical element g_{ij}^0 is defined by $g_{ij}^0 = 1$ when $y_i < z_j$, while $g_{ij}^0 = 0$ otherwise. Hence, g^0 is a $n \times d$ matrix whose ij^{th} entry is 1 when child i is deprived in dimension j, and 0 otherwise according to each dimension cutoff z_j. From this matrix, we can construct a column vector c of deprivation counts, whose i^{th} entry $c_i = |g_i^0|$ represents the number of deprivations suffered by child i. Notice that the matrix g^0 and vector c can be defined for any ordinal and cardinal variable from the matrix of achievements y [27].

3.2.1 Identification method

Following Alkire and Foster (2007), the vector c of deprivation counts is compared against a cutoff k to identify the poor, where $k = 1,...,d$. Hence, the identification method ρ_k is defined as $\rho_k(y_i; z) = 1$ whenever $c_i \geq k$, and $\rho_k(y_i; z) = 0$ whenever $c_i < k$. Finally, the set of children who are multidimensionally poor is defined as $Z_k = \{i : \rho_k(y_i; z)\}$. In other words, the method identifies as poor any child whose number of the dimensions in which it is deprived falls below the cutoff value k. Alkire and Foster (2007) refers to ρ_k as a dual cutoff method because it first applies the within dimension cutoff z_j to determine who is deprived in each dimension, and then the across dimension cutoff k to determine the minimum number of deprivations for a child to be considered multidimensionally poor.

Notice that the Bristol approach applies a similar method (Gordon et al. 2003a). They first define the within dimension cutoff for each of the eight dimensions considered in their study[28]. Then, they identify as in *absolute poverty* those children who suffer from at least two or more deprivations (equivalent to $k = 2$), and as in *sever deprivation* those who suffer from at least one deprivation (equivalent to $k = 1$). Naturally, the decision regarding the across

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[27] This allows measuring the headcount ratio and the adjusted headcount ratio by the breadth of deprivation. As will be explained later, the headcount ratio adjusted by the depth or severity of deprivation can be only applied to cardinal variables.

[28] They refer this as sever deprivations, in contrast to moderate or mild deprivation (cf. Gordon et al. 2003a: 8; table 2.1)

dimension cutoff depends on various factors including the number and type of indicators involved in the analysis. Alkire and Foster's (2007) method formulates more explicitly the dual cutoff method and allows us to compare the results according to different cutoff values in order to carry out sensitivity analysis[29].

3.2.2 Multidimensional poverty measure

The first measure to consider is the *headcount ratio* or the percentage of children that is poor. The headcount ratio $H = H(y;z)$ is defined by

(1) $H = q/n$

where $q = q(y;z)$ is the number of children in the set Z_k, as identified using the ρ_k dual cutoff method. This is precisely the measure used by the Bristol approach (Gordon et al. 2003a) and it is analogous to the income headcount ratio[30]. The headcount ratio has the virtue of being easy to compute and understand, but similar to the income headcount ratio, it has the disadvantage of being a crude, or partial, index of poverty (Alkire and Foster 2007). While it provides information about the proportion of children who are poor, it does not inform about the breadth, depth or severity of children in poverty. Let us concentrate next on the breadth of multidimensional poverty.

The headcount ratio is not sensitive to the breadth of multidimensional poverty because it remains unchanged if a child who is already poor becomes deprived in an additional dimension. Even though the situation has clearly worsened, the headcount ratio remains unchanged. This is what Alkire and Foster (2007) defines as 'dimensional monotonicity'[31]. As mentioned before, Delamonica and Minujin (2007) consider this one of the weakness of the Bristol approach.

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[29] The authors also examine a number of characteristics associated with the dual cutoff method including being 'poverty focused', being 'deprivation focused', and being able to be meaningful used with ordinal data (Alkire and Foster 2007: 9).

[30] In its standard definition, the income headcount ratio measures the percentage of population with income below a predefine poverty line. The poverty line is normally based on a define 'basket' of goods that are deemed to be essential.

[31] In clear reference to the traditional monotonicity axiom in the income headcount ratio which is associated with changes in the level of deprivation in a dimension in which the individual is already poor. This is the depth of poverty already considered in the FGT family measures for unidimensional poverty with cardinal variables (cf. Foster et al. 1984).

To reflect this concern, Alkire and Foster (2007) propose a headcount measure that is adjusted by the average number of deprivations experienced by the poor. To this end, a censored vector of deprivation counts $c(k)$ is defined so that if $c_i \geq k$, then $c_i(k) = c_i$; and if $c_i < k$, then $c_i(k) = 0$. This is to say that in $c(k)$ the count of deprivations is always cero for those children that are not poor according to the ρ_k dual cutoff method, while children that were identified as poor keep the original vector of deprivation counts c_i. Then, $c_i(k)/d$ represents the shared possible deprivations experienced by a poor child i, and hence the average deprivations shared across the poor is given by

(2) $A = |c(k)|/(qd)$

Notice that Delamonica and Minujin (2007) propose to measure the average deprivations across the whole population instead. As will be seen shortly, focusing on the poor allows computing a final adjusted headcount ratio that satisfies the property of decomposability and poverty focus. The (dimension) adjusted headcount ratio $M_0(y;z)$ is give by

(3) $M_0 = HA$

or simply the product of the headcount ration H and the average deprivation shared across the poor A. The (dimension) adjusted headcount ratio clearly satisfies dimensional monotonicity, since A rises when a poor becomes deprived in an additional dimension. In addition, similar to the headcount ratio H, M_0 satisfies decomposability, replication invariance, symmetry, poverty and deprivation focus, weak monotonicity, nontriviality, normalization and weak rearrangement (cf. Alkire and Foster 2007). The Bristol approach measures child poverty with the headcount ratio H which is not sensitive to the breadth of multidimensional poverty. The application in this paper illustrates how the Bristol approach can be enhanced by also analysing the average deprivations shared across the poor A, and the (dimension) adjusted headcount ratio M_0.

As will be see, an attractive property of M_0 is that it can be decomposable by population subgroups. The decomposition is obtained by:

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

where x and y are the distribution of two subgroups, (x,y) the distribution obtained by merging the two; $n(x)$ the number of children in x, $n(y)$ the number of children in y, and $n(x,y)$ the number of children in (x,y). In words, the overall poverty is the weighted average of subgroup poverty levels, where weights are subgroup population shares. This decomposition can be extended to any number of subgroups.

In addition, it is also possible to break-down the contribution of each dimension j to the overall multidimensional poverty measure. To this end, once the identification step has been completed a censored matrix of deprivations $g^0(k)$ is defined so its typical entry is given by $g_{ij}{}^0(k)=g_{ij}{}^0$ for every i satisfying $c_i \geq k$, while $g_{ij}{}^0(k)=0$ for i with $c_i < k$. Then, $M_0(y;z)$ can be break-down into dimensional groups as

(5) $$M_0(x,y)=\sum{}_j \mu\left(g^0_{\circ j}(k)\right)/d$$

consequently, $(1/d)\mu\left(g^0_{\circ j}(k)/M_0(y;z)\right)$ can be interpreted as the post-identification contribution of dimension j to overall multidimensional poverty[32].

Alkire and Foster (2007) also proposed other multidimensional poverty measures that in addition take into account information on depth deprivations among the poor and the severity of those deprivations. While these additional measures can also contribute valuable information to the analysis of child poverty, they can only be computed with cardinal data. As will be seen shortly, only one among the eight indicators considered in the application in this paper satisfies this level of measurement[33]. Consequently, the following measurement application is restricted to H and M_0. Similarly, the paper assumes equal weights between dimensions because of a lack of consensus or satisfactory justification to apply a particular

[32] Alkire and Foster (2007: 19) explains that *'technically speaking this is not fully a decomposable measure'* because the information in all the dimensions is needed to identify the poor.
[33] This is common in most multidimensional measures including the Bristol approach.

weight structure. Nonetheless, Alkire and Foster's (2007) methodology also accept different weight structures and there might be convincing arguments to apply them in future applications. The formal explanation about the additional multidimensional poverty measures and about how to incorporate weights can be found elsewhere along with various empirical illustrations (cf. Alkire and Foster 2007; Alkire and Suman 2008; Batana 2008; Santos and Ura 2008)

3.3. Indicators and cutoffs

The Multiple Indicator Cluster Surveys (MICS) have been particularly designed for the monitoring of the MDGs and other international commitments on children rights. As a result, it is possible to choose a set of indicators that are particularly suitable for monitoring child poverty. Only indicators that concern directly or indirectly to children's fundamental rights - according to CRC and WFFC- were chosen. The application focuses exclusively on indicators that refer to the current or future achievement of children under five years of age. As a result, the application measures achievements directly, and capabilities indirectly - as in term of all the potential 'beings' and 'doings' available to the child as a result of enjoying the particular achievement (i.e. receiving immunisation as the capability of being healthy and living longer, receiving supplementation of vitamin A as the capability of resisting infections and disease). Table 1 presents the eight selected indicators and the cutoff values that define the deprived situation in each particular dimension.

Four of the indicators are specific MDG indicators designed to measure progress in specific millennium development targets: access to safe drinking water, access to improved sanitation, security of tenure and eviction, and measles immunization (United Nations 2003). Access to safe drinking water and improved sanitation are socio-sanitary factors highly associated with the risk of morbidity and mortality particularly among children under five years of age[34]. The measurement and cutoff for both indicators have been defined according to the MGD indicators number 30 and 31.

The proportion of children that have received measles immunisation corresponds to the MDG indicator number 15 which is used to monitor one of the targets associated with the goal of reducing child mortality (MDG4). This indicator also provides a measure of the coverage of the child health-care system in the country (United Nations 2003)[35]. Analogous

[34] While improved sanitation is important for urban and rural population, the risk is higher in urban areas where it is more difficult to avoid contact with waste (United Nations 2003: 66).
[35] Indeed, in the MICS from Bangladesh, children who have received at least one doses of measles immunization have normally also received DPT, Polio and BGC immunization.

to the MDG indicator number 15, children between 12 and 59 months are considered deprived if they have not received at least one dose of measles immunization[36].

Access to secure tenure is associated with the MDG indicator 32 which is used to monitor target 7 referring to the improvement in the life of slum dwellers (MGD7 on environmental sustainability). In this paper, the indicator cuttoff is estimated following BSS-UNICEF's (2007a) definition so that a child is deprived if she lives in a household with lack of security of tenure (i.e. lack of formal documentation for the residence) or where household members perceive risk of eviction[37].

Table 1 Selected indicators and cutoffs values

Indicator	Goal/ Target	Indicator	MICS Quest. Num.	Cutoff (Situation of deprivation)
Drinking water	MDG7, Target 10	MDG Indicator 30	WS1, WS3	Children who only have access to surface water or unprotected wells or springs for drinking; or have access to more adequate sources of water at more than 15 minutes away (bottled water is considered inappropriate when it is also used for other purposes)
Improved sanitation	MDG7, Target 10	MDG Indicator 31	WS7, WS8	Children who do not have access to improved sanitation such as flush toilets connected to sewage systems, septic tanks or pit latrines, ventilated improved pit latrines and pit latrines with slabs, or composting toilets.
Overcrowded housing	MDG7 & UN Conf. on Human Settlements	Socio-economic common country assessment indicators	HH11, HH14, HC2, TOHL7	Children living in households whit a ratio of more than three persons per sleeping room
Tenure or eviction	MDG7, Target 11	MDG Indicator 32	HC15	Children living in households with a lack of security of tenure (i.e. lack of formal documentation for the residence) or where household members perceive risk of eviction.
Salt iodization	WSC & WFFC	-	SI1	Children living in households with not iodized salt or non salt at home
Vitamin A	WSC & WFFC	-	VA1, VA2	Children aged 9 - 59 months who have not received vitamin A supplementation in the previous 6 months
Measles Immunization	MDG4, Target 5	MDG Indicator 15	IM17	Children aged 12 - 59 months who have not received at least one dose of measles immunization
Support for learning	WSC & WFFC	MICS indicator 46	BR8	Children aged 6 - 59 months living in households in which an adult engaged in less than one activity to promote learning in the past three days

[36] Children under one year old are considered still to be protected by the antibodies received during breastfeeding. The MDG indicator estimates the proportion of children between 12 and 23 months who have received at least one dose of measles, usually based on administrative data. The MICS allows estimating the indicator for every child, so in this paper it has been measured for every child between 12 and 59 months.
[37] While this is one of the technical definitions of the indicator (United Nations 2003), there is still space for a better definition according to the criteria of the UN-HABITAD or a definition similar to the one used in the Bristol approach (Gordon et al. 2003a).

The additional four indicators are associated with the MDGs in general and correspond to indicators used to monitor other international commitments: overcrowded housing, salt iodization, vitamin A and support for learning. The overcrowded housing is associated with the 7th MDG and more precisely with the goal of adequate shelter for all, and the target provision of sufficient living space and avoidance of overcrowding (United Nations Conference on Human Settlements 1996). It corresponds to the indicator number 41 of the socio-economic common country assessment indicators (United Nations 2003). The indicator has been adjusted according to adult equivalent scales and economy of scale[38], and the cutoff defined in relation to the standards set up by BSS-UNICEF (2007a).

Salt iodization is an indicator related to the goal of virtual elimination of iodine deficiency disorders (IDD) through universal salt iodization agreed and ratified in several international conventions (UNICEF 2008). While tackling IDD require minimal financial investment, IDD is still one of the world's leading causes of preventable mental disability and impaired psychomotor development in young children, being especially damaging during the early stages of pregnancy and in early childhood (UNICEF 2008). The indicator considers deprived those children living in households with non iodized salt or no salt at home[39].

The goal of increasing vitamin A intake has been set up by the World Summit for Children (WSC) and ratified later in several international conventions[40]. Vitamin A plays a critical role in boosting the child's immune system, so decreasing the risk of preventable illness such as diarrhoea, measles and acute respiratory infections; hence, also considerably decreasing the risk of child mortality. Following the standards set up by BSS-UNICEF

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[38] The indicator (number of person per sleeping room) was adjusted by adult equivalent scales and economy of scale, in order to take into account the difference between the needs of adults and children, and the economy of scale. The final indicator is the ratio between the total of adult equivalent units (AE) in the household per sleeping room. It is based on the method proposed by the United States Census Bureau to calculate the Adult Equivalent Scale (Citro and Michael 1995). This method distinguishes the differences in needs between children and adults, and takes into account the economy of scale. The adult equivalent scale type is the following: $AE = (A + PK)^F$; "*where A is the number of adults in the family, K is the number of children, each of whom is treated as a proportion P of an adult, and F is the scale economy factor*" (Citro and Michael, 1995: 161). The United States Census Bureau recommends a P near 0.7 and an F between 0.65 and 0.75 for the United States. In this paper we assumed a value of 0.6 for P and 0.90 for F, following recommendation of Deaton and Zaidi (2002) who consider that a low P and high F should be used for developing countries. The final cutoff value is 2.69 AE per sleeping room corresponding to $(3)^{0.85}$.

[39] This is not only an indicator of current deprivation, but of possibly deprivation before birth that might have caused permanent damage already. Notice that the consumption of iodized salt in Bangladesh has increased from 19% around 1995 to 84% in 2006 (UNICEF 2008).

[40] *'One of the goals from the 1990 World Summit for Children called for the elimination of Vitamin A deficiency and its consequences, including blindness, by the year 2000. This goal was also endorsed at the Policy Conference on Ending Hidden Hunger in 1991, the 1992 International Conference on Nutrition, and the UN General Assembly's Special Session on Children in 2002. The critical role of Vitamin A for child health and immune function also makes control of its deficiency a primary component of child survival efforts and thus critical for achieving the fourth MDG: a two-thirds reduction in under-5 mortality by the year 2015'* BBS-UNICEF (2007a: 28).

(2007a), children between 9 and 59 months are considered deprived if they have not received vitamin A supplementation in the previous 6 months[41].

The final indicator 'support for learning' is the MICS indicator number 46 related to the goal that seeks enabling the children to be mentally alert, emotionally secure, socially competent and ready to learn (United Nations 2002). The indicator takes into account that rapid brain development occurs in the first three to four years of life, and that the quality of home care is the major determinant of the child's development during this period (BBS-UNICEF 2007a: 83). The MICS indicator number 46 measures the proportion of children that have been engaged with adults in at least three activities to promote learning in the past three days[42]. In the application in this paper the cutoff value has been set up to at least two activities in order to measure extreme deprivation, and has been measured for every child above six month of age[43].

Summing up, the multidimensional poverty measured in this paper is based in eight indicators all directly or indirectly concerning children's fundamental rights. They are all used either to monitor progress in specific targets related to the MDGs or to monitor progress in other international commitments in children's rights. At least four indicators are directly related with under-five child mortality (MDG4), while the others are associated with the mental, psychomotor, social and emotional development of the child, and with adequate environment and shelter. Unfortunately, it was not possible to include the prevalence of underweight children under-5 years of age. This is clearly an important MDG indicator used to monitor target 2 related to reducing the proportion of people who suffer from hunger (MDG1). However, this indicator is not measured in the third rounds of the MICS. While the list of eight indicators is not exhaustive, it does contain some of the most fundamental indicators related to under-five child poverty. It allows estimating the incidence and breadth of multidimensional poverty and suggesting policy measures to reduce under-five child poverty.

[41] Children under 9 month of age are excluded because they are expected to have received important quantities of vitamin A during breastfeeding.

[42] This includes reading books or looking at picture books, telling stories, singing songs, taking children outside the home/compound/yard, playing with children, or spending time with children naming, counting, or drawing things.

[43] The cutoff of 'at least 3 activities' might be more appropriate for children between 3 and 5 years of age.

4. RESULTS AND ANALYSIS

4.1 Incidence of deprivation and identification

Let us start by exploring the incidence of deprivation in relation to each of the selected indicators. A total of 30,918 children are included in the following analyses after excluding 2.1% of children that have missing information in any of the eight selected indicators[44]. The children are distributed 27% in urban areas and 73% in rural areas which is consistent with Bangladesh national figures for the total population.

Table 2 presents the incidence of deprivation for urban and rural areas, and for the whole of Bangladesh. It shows that for the whole country the incidence of deprivation goes from 64% of children who lack access to improved sanitation facilities, to nearly 9% of children who have not received vitamin A supplementation in the last six months, or who have not received the first doses of Measles vaccination. The incidence of deprivation varies considerably between urban and rural areas. While the incidence of deprivation in sanitation facilities is 71% in rural areas, the figure is 46% in urban areas. Similarly, 19% of children in rural areas live in households without iodized salt, while 9% suffer this deprivation in urban areas. In contrast, the lack of security in tenure and risk of eviction is higher in urban areas where 41% of children are deprived while the figure is closer to 11% in rural areas. These figures are already useful for a sectorial analysis, though limited for multidimensional poverty analysis.

Table 2 Incidence of deprivations by urban-rural area

	Area		Total
	Rural %	**Urban** %	%
Drinking Water	10.6	6.3	9.5
Sanitation facilities	71.1	46.0	64.3
Overcrowded housing	44.6	40.8	43.5
Tenure and eviction	10.7	41.0	18.9
Iodized Salt	19.4	9.0	16.6
Vitamin A	9.6	6.7	8.8
Measles vaccination	9.1	6.9	8.5
Support for learning	13.9	9.3	12.7

Note: The children are distributed 27% in urban areas and 73% in rural areas.

Table 3 Distribution of deprivation counts

Exact number of deprivations	Percentage of children
One	28.4
Two	29.6
Three	18.4
Four	7.0
Five	1.8
Six	0.4
Seven	0.1
Eight	0

[44] This decreases the response rate to 82.4% (see section about the data).

Naturally, it is not the same to suffer from only one deprivation than from multiple deprivations simultaneously. Table 3 presents the distribution of deprivation counts for the exact number of deprivations, independently of the specific area of deprivation. It shows that 28% of the children suffer from exactly one deprivation, nearly 30% from exactly two deprivations and 18% from exactly three deprivations. After three deprivations the percentage decreases considerably suggesting that the across dimension cutoff k should be defined somewhere in between one and three. Let us move on to identify the poor according to the methodology.

Table 4 presents the comparison of different multidimensional child poverty measures according to different cutoffs k. Column 1 shows the headcount ratio H corresponding to equation 1. When the cutoff k is set up as 1, the headcount ratio is close to 86%, while if the cutoff k is set up as 2, the headcount ratio is 57%. Clearly, the more suitable cutoff for our analysis seems to be somewhere between $k=1$ and $k=3$ since the headcount ratio decreases to 9% when the cutoff k is set up as 4.

Although the methodology used was different, it seems worth comparing these results with the headcount ratio for Bangladesh obtained by other studies. Interestingly, the results are very similar. In their most recent estimations, the Bristol approach identifies a total of 92% of children as in 'severe deprivation', corresponding to $k=1$ (Gordon et al. 2003c). Similarly, they identify as in 'absolute poverty', corresponding to $k=2$, a total of 54% of children (Gordon et al. 2003c). On the other hand, the headcount ratio for the income poverty line was 49.8% for 2000 (World Bank 2002). While a number of aspects in the methodology are different, the figures are surprisingly similar.

Table 4 Comparison of different multidimensional child poverty measures for different cutoffs

	1	2	3	4
Cutoff (k)	**Headcount (H)**	**Adjusted Headcount (Mo = HA)**	**Average deprivation share (A)**	**Average deprivations among the poor**
1	0.857	0.228	0.27	2.13
2	0.573	0.193	0.34	2.69
3	0.277	0.119	0.43	3.44
4	0.093	0.050	0.54	4.31
5	0.023	0.015	0.65	5.23
6	0.005	0.004	0.77	6.14
7	0.001	0.001	0.88	7.02
8	0	0.000	0	0

Column 2 of Table 4 presents the results of the identification for the adjusted headcount ratio by breadth of multidimensional poverty M_0 according to equation 3. This is the product of the headcount ratio (column 1) and the average deprivation share (column 3). The average deprivation share A is measured according to equation 2. Let us move now to compare the different poverty measures and assess the value added of the adjusted headcount ratio.

4.2 Decomposition by geographical location

As explained in previous sections, one of the interesting features of the adjusted headcount ratio M_0 is that it can be decomposable by subgroups of population as in equation 4. Table 5 presents the decomposition of the different measures of child poverty by regions and by urban-rural areas for a cutoff $k = 2$. Column 1 and 2 present the sample of children in the survey and the contribution in percentage of each region/area to the total of Bangladesh. Among the regions, Dhaka has the largest share with 32%, followed by Rajshahi and Chittagong with 23% and 22% respectively. The least populated areas are Barisal with only 6% of the national population, followed by Sylhet 8% and Khulna 10%. As previously mentioned, 73% of the children live in rural areas while 27% in urban areas.

Since the MICS round 3 does not measure income it is not possible to compute the income headcount ratio. The best alternative is to use the Wealth Index Score (WI) which is a variable constructed for analysis by the producer of the data (BBS 2006). The WI measures the socio-economic status of households based on variables concerned with wealth or assets owned by the household (i.e. car, refrigerator, television, computer, AC, washing machine, among others). The index is calculated using principal component analysis after dichotomizing the variables. Finally, it uses the wealth score (first component in the analysis) to create household wealth quintiles. The first quintile corresponds to the 20% of households with lower WI or poorest in the country. Since our unit of analysis is focused on under-five children, we have recalculated the quintiles for the distribution of children instead. This is the poorest quintile corresponds to the 20% of poorest children in terms of WI.

Column 3 presents the distribution of the share of the poorer quintile in WI for each region and urban-rural area. Naturally, the share for Bangladesh is 0.200. The higher share is in the rural areas with 0.244 while only 0.082 in the urban areas[45]. Among the regions,

[45] The WI might be urban biased since it recodes assets that are more common for an urban life style.

Rajshashi is the poorest region in term of income with a WI of 0.306, followed by Dhaka with 0.210. The least income poor is Chittagong with 0.119. The WI will allow us to compare the multidimensional measures with an income or commodity based measure. We will come back to this point when carrying out ranking comparisons.

The contribution of each region/area to the total of income poor (or poorer quintile in WI), is given in column 4. Columns 5 and 7 present the share for the multidimensional measures H and M_0, while column 6 and 8 the respective contribution of each region to the total of multidimensional poor according to each measure. Clearly, the income poverty measure differs significantly with the multidimensional measures. For example, Rajshashi has the highest income poverty but only the third position in the multidimensional measures. Hence, while this region contributes the most to income poverty with 35%, it contributes less than Dhaka in the multidimensional measures with around 23%. Similarly, Sylhet moves from the third position according to income poverty (WI), to the first position according to the multidimensional poverty measures (H/M_0). This means that if the different regions were to receive more attention or resources depending on these results, the output would be considerably different if we use WI or H/M_0. At this point, there is only a small adjustment in the results by applying M_0 instead of H as observed when comparing column 6 and column 8. Some regions decrease their contribution slightly (i.e. Rajshashi) while others increase their contribution (i.e. Sylhet and Chittagong).

Let us move now to observe how the ranking changes depending on the different measures. Since the urban and rural areas are significantly different in the incidence of poverty, it might be worth comparing regional differences jointly with urban and rural differences. Table 6 presents the ranking comparison for the combination between regions and urban/rural area, which are compared in columns 11 to 13. Naturally, the highest differences in ranking can be observed between WI and M_0. Some cases are particularly significant. Urban Rajshahi falls six places in the ranking when M_0 is considered instead of WI. In practical terms, that means that urban Rajshahi is considerable less poor in terms of multidimensional poverty, than it is in terms of the wealth index. Clearly, a multidimensional measure is more appropriate for analysing child-poverty.

Interestingly, while the first four positions remain invariant in the ranking according to H and M_0 (column 13), there are important rearrangements in the rankings among the rest of the regions when the headcount ratio is adjusted by the average of deprivation among the poor. For example, rural Khulna drops one place when ranked by H instead of WI (column 12), and then an additional two places when adjusted by the breadth of multidimensional

Table 5 Decomposition of child poverty by region and urban-rural area (Equal weights and k = 2)

	1	2	3	4	5	6	7	8	9	10
	Total Sample	**% Contribution**	**WI**	**% Contribution**	**H**	**% Contribution**	**Mo (HA)**	**% Contribution**	**A**	**Average deprivations among the poor**
Regions										
Barisal	1,821	5.9	0.153	4.5	0.519	5.3	0.179	5.5	0.35	2.76
Chittagong	6,654	21.5	0.119	12.8	0.529	19.9	0.185	20.6	0.35	2.79
Dhaka	9,748	31.5	0.210	33.2	0.618	34.0	0.208	34.0	0.34	2.70
Khulna	3,106	10.0	0.136	6.8	0.514	9.0	0.158	8.2	0.31	2.46
Rajshahi	7,105	23.0	0.306	35.2	0.573	23.0	0.188	22.4	0.33	2.63
Sylhet	2,484	8.0	0.185	7.4	0.625	8.8	0.223	9.3	0.36	2.85
Area										
Rural	22,555	73.0	0.244	88.9	0.596	75.9	0.201	76.1	0.34	2.70
Urban	8,363	27.0	0.082	11.1	0.511	24.1	0.170	23.9	0.33	2.67
Total	30,918	100	0.200	100	0.573	100	0.193	100	0.34	2.69

Note: Table A2, A3, and A4 in the appendix shows the decomposition of poverty by area within regions for different k cutoffs.

Table 6 Ranking comparison between regions and urban-rural areas for different multidimensional child poverty measures (Equal weights and k = 2)

	1	2	3	4	5	6	9	10	11	12	13
Regions / Urban-Rural	**WI**	Ranking WI	**H**	Ranking H	**Mo (HA)**	Ranking Mo	**A**	**Average deprivations among the poor**	Dif. in rank order WI-Mo	Dif. in rank order WI-H	Dif. in rank order H-Mo
Rural Rajshahi	0.344	1	0.601	3	0.198	3	0.33	2.63	-2	-2	0
Rural Dhaka	0.279	2	0.639	2	0.216	2	0.34	2.71	0	0	0
Rural Sylhet	0.216	3	0.662	1	0.239	1	0.36	2.89	2	2	0
Urban Rajshahi	0.174	4	0.474	10	0.155	10	0.33	2.61	-6	-6	0
Rural Barisal	0.173	5	0.554	5	0.192	4	0.35	2.77	1	0	1
Rural Khulna	0.161	6	0.528	7	0.161	9	0.31	2.44	-3	-1	-2
Rural Chittagong	0.149	7	0.546	6	0.192	5	0.35	2.81	2	1	1
Urban Barisal	0.090	8	0.406	12	0.138	12	0.34	2.72	-4	-4	0
Urban Sylhet	0.085	9	0.506	8	0.171	7	0.34	2.70	2	1	1
Urban Dhaka	0.060	10	0.571	4	0.191	6	0.33	2.67	4	6	-2
Urban Khulna	0.058	11	0.472	11	0.147	11	0.31	2.49	0	0	0
Urban Chittagong	0.047	12	0.488	9	0.168	8	0.34	2.75	4	3	1

Table 7 Ranking comparison between regions for WI and Mo according to different k cutoffs

	1	2	3	4	5	6	7	8	9	10	11
Regions	WI	Ranking WI	Mo (K=2)	Ranking Mo (K=2)	Mo (K=1)	Ranking Mo (K=1)	Mo (K=3)	Ranking Mo (K=3)	Dif. in rank order WI-Mo (k=2)	Dif. in rank order Mo (k=2) - (k=1)	Dif. in rank order Mo (k=2) - (k=3)
Bangladesh											
Rajshahi	0.306	1	0.188	3	0.163	3	0.109	5	-2	0	-2
Dhaka	0.210	2	0.208	2	0.184	2	0.130	2	0	0	0
Sylhet	0.185	3	0.223	1	0.192	1	0.152	1	2	0	0
Barisal	0.153	4	0.179	5	0.147	5	0.115	4	-1	0	1
Khulna	0.136	5	0.158	6	0.132	6	0.077	6	-1	0	0
Chittagong	0.119	6	0.185	4	0.153	4	0.121	3	2	0	1
Total	0.200		0.193		0.165		0.119				

Note: Table A5 and A6 presents the ranking comparisons for the combination of region and area for Mo and H.

poverty M_0 (column 13). Rural Chittagong is the opposite case, it moves up in the ranking because it has a higher breadth of multidimensional poverty. Notice that Urban Dhaka moves up six places when ranked by H instead of WI (column 12), but it then moves down two places when adjusted by breadth of multidimensional poverty M_0 (column 13). Adjusting the headcount ratio by breadth of deprivation is clearly a value added to the measure provided by the Bristol approach (Gordon et al. 2003a).

In addition, a sensitivity analysis can be carried out based on the specification of the dual cutoff. While up to this point the analysis is based on a cutoff $k = 2$, we could now assess if different decisions for the cutoffs k affect the results. Table 7 compares the ranking comparison of the different regions in Bangladesh for M_0 according to three different cutoffs $k = 2$, $k = 1$, and $k = 3$ [1]. As explained previously, there are significant differences in the ranking produced by WI and the one produce by M_0 (column 9). Interestingly, as seen in column 10, a cutoff $k = 2$ or a cutoff $k = 1$ produce the same rankings, which suggests the results are quite robust independently of the decision of cutoffs k at this level. The same cannot be said when generating the rankings for the combination of region and urban/rural areas as can be seen in table A5 in the appendix. Finally, the ranking order would vary significantly if the cutoff k were to be defined as $k = 3$ (column 11). Clearly, in some cases the conclusions would be sensitive to the decision of the across dimension cutoff k. The dual cutoff specification seems to allow making this sensitivity analysis, which gives also space for interpreting these differences in relation to the detailed figures in table annex A2, A3, and A4.

4.3 Decomposition by dimension

In addition to the previous analysis, the adjusted headcount ratio M_0 can also be broken down by dimension according to equation 5. Table 8 and the corresponding graph 1 present these results[2]. Clearly, priorities vary depending on the region or urban/rural area.

For example, nearly 16% of child poverty in Barisal can be attributed to deprivation in access to drinking water. In contrast, the same only contributes with less than 3% in Dhaka and Rajshahi. Lack of improved sanitation is clearly a national problem, accounting for more

[1] Table A5 and A6 in the appendix present the ranking comparisons for the combination of region and area for Mo and H.
[2] The joint analysis of region and urban/rural area is also presented in tables A7 and A8 in the appendix.

than 25% of child poverty in all regions. Deprivation in salt iodization accounts for 15% of total child poverty in Chittagong, and also has an important contribution to child poverty in Rajshahi (11%), and Dhaka (9%). As expected, deprivation in tenure is a significant urban problem, contributing to more than 20% of child poverty in this area. These are only a few examples to illustrate how the decomposition of the indices by groups can also help to identify priorities, in this case associated with indicators to monitor international commitments in the reduction of child poverty.

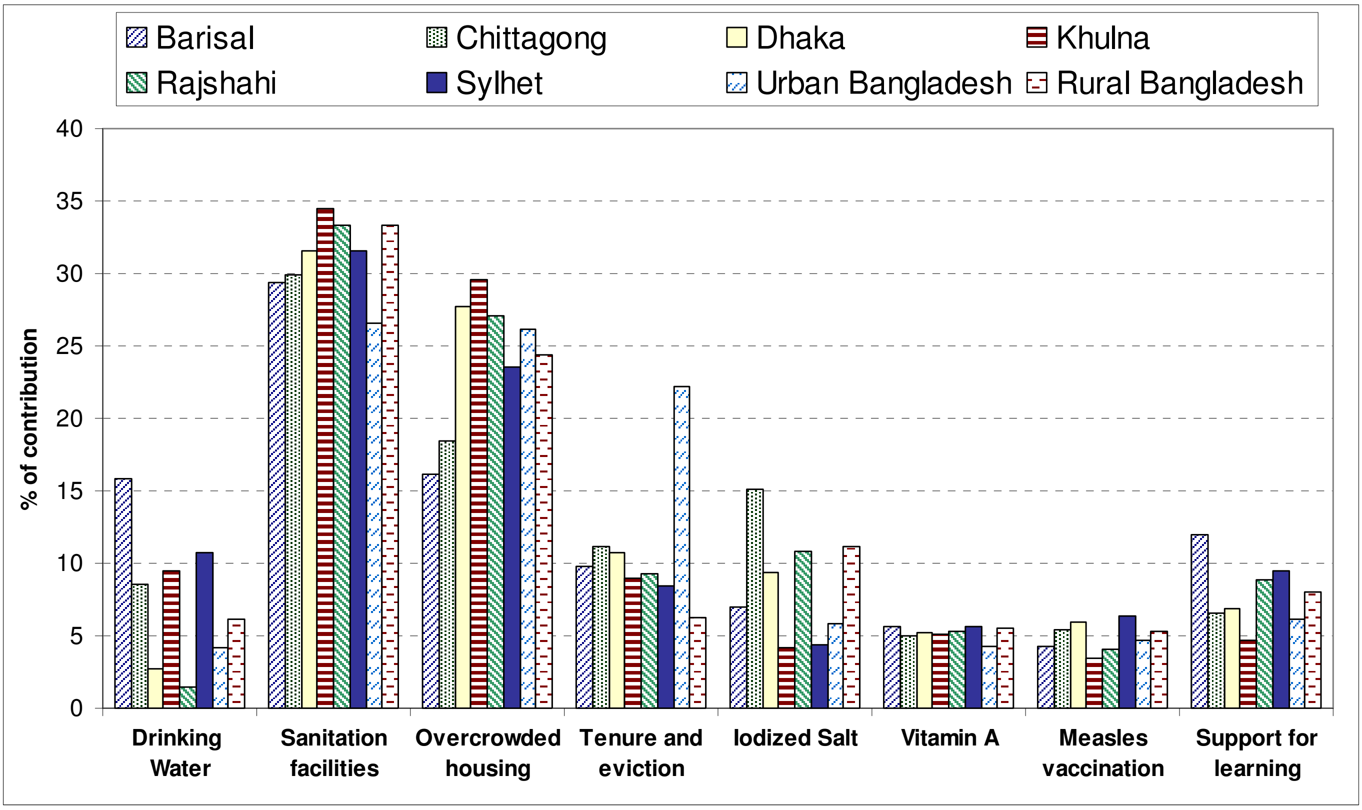
Up to this point, we have illustrated the benefits of decomposing the adjusted headcount ration M_0 by geographical regions and urban-rural areas. Naturally, similar decomposition exercises can be carried out by other groups either for targeting purposes or simply to understand the determinants of poverty. For example, it might be attractive to decompose poverty by gender, ethnicity, religious groups, disabled groups, and types of household, among others. Let us now decompose the adjusted headcount ratio by the mother's level of education to reveal the cycle of poverty.

Table 8 Share of the respective population that is both poor and deprived in each dimension, and percentage of contribution of the dimension to the respective population level of Mo
(Equal weights and k = 2)

	1	2	3	4	5	6	7	8	9
	Drinking Water	**Sanitation facilities**	**Overcrowded housing**	**Tenure and eviction**	**Iodized Salt**	**Vitamin A**	**Measles vaccination**	**Support for learning**	**Mo**
Regions									
Barisal	0.226	0.421	0.231	0.141	0.100	0.081	0.061	0.172	0.179
% contribution	15.8	29.4	16.1	9.8	7.0	5.7	4.3	12.0	100
Chittagong	0.126	0.443	0.273	0.164	0.223	0.073	0.080	0.097	0.185
% contribution	8.5	29.9	18.5	11.1	15.1	5.0	5.4	6.5	100
Dhaka	0.046	0.525	0.461	0.178	0.156	0.087	0.099	0.114	0.208
% contribution	2.7	31.5	27.7	10.7	9.4	5.2	5.9	6.9	100
Khulna	0.119	0.436	0.374	0.113	0.053	0.064	0.044	0.060	0.158
% contribution	9.4	34.5	29.6	9.0	4.2	5.1	3.5	4.7	100
Rajshahi	0.022	0.502	0.408	0.139	0.162	0.079	0.061	0.133	0.188
% contribution	1.4	33.3	27.1	9.2	10.8	5.3	4.0	8.8	100
Sylhet	0.191	0.561	0.419	0.149	0.077	0.099	0.113	0.169	0.223
% contribution	10.7	31.5	23.6	8.4	4.3	5.6	6.4	9.5	100
Area									
Rural	0.098	0.537	0.392	0.101	0.179	0.089	0.085	0.130	0.201
% contribution	6.1	33.3	24.4	6.2	11.1	5.5	5.3	8.1	100
Urban	0.056	0.363	0.357	0.302	0.079	0.058	0.065	0.083	0.170
% contribution	4.1	26.6	26.2	22.2	5.8	4.3	4.7	6.1	100
Total	0.087	0.490	0.383	0.155	0.152	0.081	0.079	0.117	0.193
% contribution	5.6	31.7	24.8	10.0	9.8	5.2	5.1	7.6	100

Note: Table A7 and A8 shows analogous results for the combination of region and area.

Graph 1 Percentage of contribution of the dimension to the respective population level of Mo
(Equal weights and k = 2)



4.4 Decomposition by mother's level of education

The effect of poverty and deprivation during early childhood has quite severe consequences on the future well-being of the child. Appropriate measures are required in order to break this cycle and help children escape from chronic poverty. The relation between child poverty and the mother's level of education is a good illustration of the cycle of poverty. The mother's level of education is highly associated with children's chances of suffering deprivation that can cause permanent damage. Let us explore this relation by focusing exclusively on rural Rajshahi in order to isolate any effect related to differences in services among regions or urban-rural areas[3].

Table 9 presents this decomposition. The final column 9 shows the intensity of child poverty according to the mother's level of education. When the mother has no level of education the adjusted headcount ratio is 0.257 which decreases to 0.054 when the mother has completed secondary or a higher level of education. While these results are somehow expected, the decomposition by dimensions provides additional insights. What this analysis

[3] Naturally, a regression approach could also be implemented but it goes beyond the scope of the paper.

shows is that the differences are considerable in relation to the *share* of the respective population by dimension. However, they are only minor in relation to the *percentage of contribution of the dimension* to the respective population which are more associated with regional or urban-rural differences.

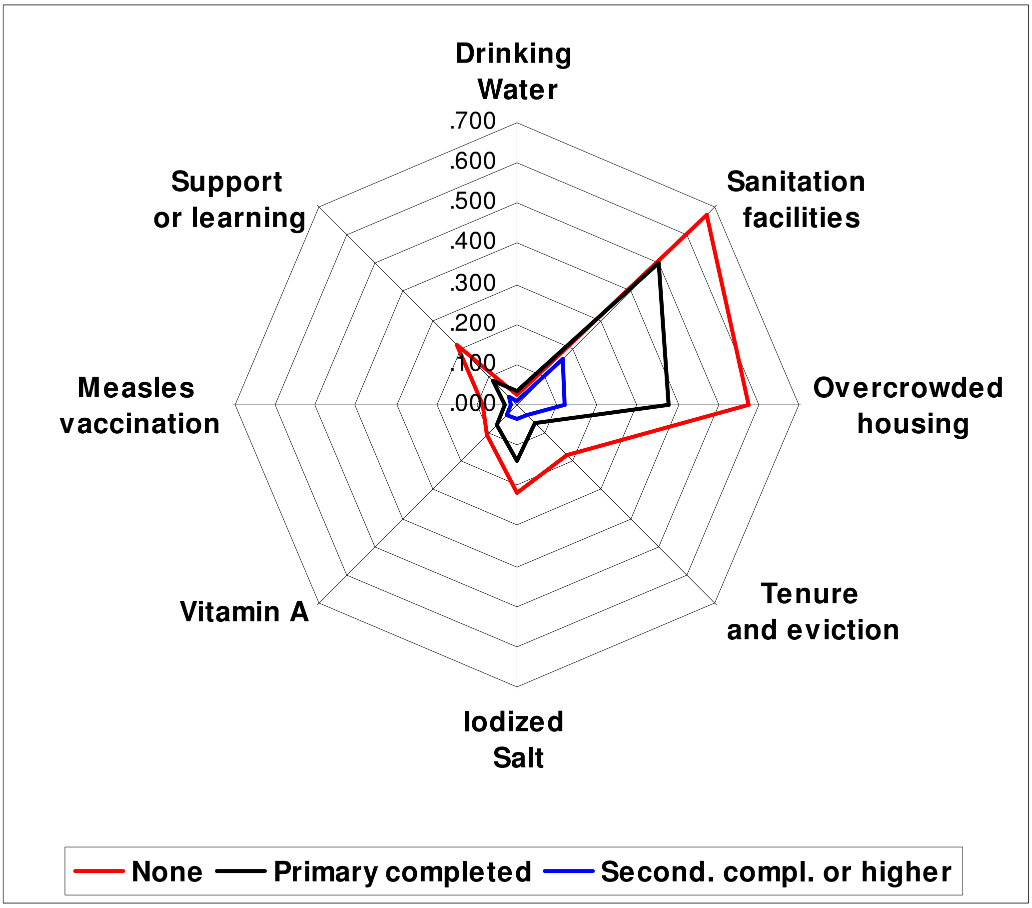
The share of each level of education in every dimension is shown in table 9 from column 1 to column 8, and also in a more illustrative way in graph 2. It shows how the share of children in deprivation in each dimension varies significantly according to the mother’s level of education. For example in column 2, the share of deprivation in sanitation facilities for children with mothers without education is 0.665, while the same is 0.161 for children with mothers with secondary or higher level completed. This is a significant gap, considering that the overall share in rural Rajshahi is 0.545. The same occurs, to a different degree, in every dimension except in access to drinking water, because rural Rajshahi has nearly full coverage of the service. There is an obvious relation between the mother’s level of education and the share of child deprivation in each dimension. Naturally, it is not only a matter of targeting programs by geographical areas but also of reaching the most deprived in each region, and identifying the determinants of child poverty.

Table 9 Share of the respective population that is both poor and deprived in each dimension and percentage of contribution of the dimension to the respective population level of Mo
(Equal weights and k = 2)

	1	2	3	4	5	6	7	8	9
	Drinking Water	Sanitation facilities	Overcrowded housing	Tenure and eviction	Iodized Salt	Vitamin A	Measles vaccination	Support or learning	Mo
Mother's education									
None	0.022	0.665	0.572	0.180	0.217	0.103	0.083	0.214	0.257
% contribution	1.1	32.4	27.8	8.7	10.6	5.0	4.0	10.4	100
Primary incomplete	0.021	0.637	0.465	0.126	0.210	0.090	0.067	0.155	0.221
% contribution	1.2	35.9	26.3	7.1	11.9	5.1	3.8	8.7	100
Primary completed	0.034	0.495	0.375	0.066	0.139	0.071	0.032	0.085	0.162
% contribution	2.6	38.2	28.9	5.1	10.7	5.5	2.4	6.6	100
Secondary incomplete	0.018	0.403	0.267	0.060	0.151	0.072	0.051	0.075	0.137
% contribution	1.7	36.7	24.3	5.5	13.8	6.6	4.7	6.8	100
Second. compl. or higher	0.008	0.161	0.120	0.034	0.035	0.034	0.016	0.026	0.054
% contribution	1.8	37.2	27.6	7.8	8.1	7.9	3.6	6.1	100
Non-standard curriculum	0.000	0.848	0.599	0.267	0.228	0.087	0.052	0.389	0.309
% contribution	0.0	34.3	24.2	10.8	9.2	3.5	2.1	15.7	100
Total	0.021	0.545	0.427	0.119	0.179	0.085	0.062	0.144	0.198
% contribution	1.3	34.5	27.0	7.5	11.3	5.4	3.9	9.1	100

Note: The decomposition for other poverty measures is presented in table A9.

Graph 2 Radar graph comparing the share of different levels of mother's education for Rural Rajshahi (Equal weights and k = 2)



5. CONCLUSIONS AND POLICY IMPLICATIONS

This paper has assessed the contributions of applying Alkire and Foster's (2007) methodology to the measurement of multidimensional child poverty. It has argued that this methodology can enhance the Bristol approach in three particular ways. First, it proposes a way to adjust the headcount ratio by breadth of multidimensional poverty based on the traditional FGT measures of poverty. The adjusted headcount ratio M_0 is easy to compute and interpret, and can be decomposed and broken down by dimension giving rise to enlightening comparisons. Second, the methodology proposes a clear specification of the dual cutoff method that allows carrying out sensitivity analysis of the results, according to different decisions concerning the across dimensions cutoff k. Third, the methodology is flexible where the list of indicators and poverty lines can be adapted to different contexts or specificities of a particular age group, while simultaneously allowing the use of weights.

These methodological contributions have been examined systematically throughout the measurement of multidimensional poverty among children under five years of age with the 2006 Bangladesh Multiple Indicator Cluster Survey.

The measurement application has provided a series of interesting insights. It clearly confirmed that results based on income or commodity measures are considerably different to those obtained with multidimensional poverty measures. Naturally, if the aim is to produce policy-relevant information to tackle child poverty, a multidimensional poverty measure with analogous indicators to those considered in this paper would be more appropriate than an income measure. The application has also shown that adjusting the headcount ratio by the breadth of deprivation is likely to produce different outputs particularly in the ranking order and in the contribution of each subgroup to the overall share of poverty. This conclusion particularly challenges the Bristol approach because the adjusted measure is expected to provide different suggestions for targeting or for policy purposes. The application in this paper has also illustrated how the methodology allows carrying out sensitivity analysis of different decisions on cutoff k. This analysis showed that the ranking between regions in Bangladesh was robust for $k = 2$ and $k = 1$, but it changes considerably for $k = 3$. Naturally, the possibility of assessing the robustness of the results is convenient in order to reach better informed decisions. Finally, the measurement application has illustrated the benefits of being able to decompose the adjusted headcount ratio in order to help identify priority areas for attention which is an attractive feature for policy makers.

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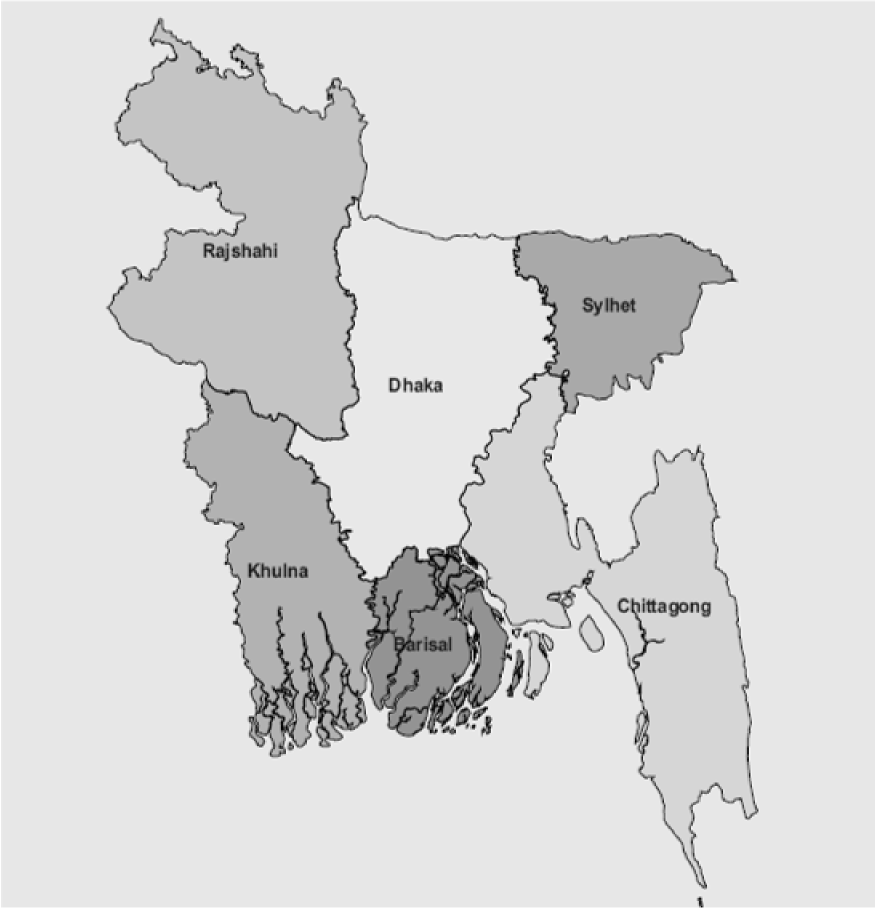
APPENDIX

Graph A1 Regional division of Bangladesh



Source: BBS-UNICEF (2007b)

Table A1 Spearman rank correlations among selected indicators

	Drinking Water	Sanitation facilities	Overcrowded housing	Tenure and eviction	Iodized Salt	Vitamin A	Measles vaccination	Support for learning
Drinking Water	1	-0.005	-.093**	.034*	-0.019	-0.023	0.008	-.038*
Sanitation facilities	-0.005	1	-.052**	-.076**	-0.015	-.085**	-.090**	-.124**
Overcrowded	-.093**	-.052**	1	-.084**	-.218**	-.102**	-.066**	-.071**
Tenure and eviction	.034*	-.076**	-.084**	1	-.066**	0.022	0.001	-0.031
Iodized Salt	-0.019	-0.015	-.218**	-.066**	1	-.073**	-.044**	-.113**
Vitamin A	-0.023	-.085**	-.102**	0.022	-.073**	1	.034*	0.008
Measles vaccination	0.008	-.090**	-.066**	0.001	-.044**	.034*	1	-0.002
Support for learning	-.038*	-.124**	-.071**	-0.031	-.113**	0.008	-0.002	1

Note: ** Correlation is significant at the 0.01 level (2-tailed) *. Correlation is significant at the 0.05 level (2-tailed).

Table A2 Decomposition of child poverty by the combination of urban – rural area and regions (Equal weights and k = 2)

	1	2	3	4	5	6	7	8	9	10
Regions / Urban-Rural	**Total Sample**	**% Contribution**	**WI**	**% Contribution**	**H**	**% Contribution**	**Mo (HA)**	**% Contribution**	**A**	**Average deprivations among the poor**
Rural										
Barisal	1,388	4.5	0.173	3.9	0.554	4.3	0.192	4.5	0.35	2.77
Chittagong	4,727	15.3	0.149	11.4	0.546	14.6	0.192	15.2	0.35	2.81
Dhaka	6,703	21.7	0.279	30.2	0.639	24.2	0.216	24.3	0.34	2.71
Khulna	2,333	7.5	0.161	6.1	0.528	7.0	0.161	6.3	0.31	2.44
Rajshahi	5,508	17.8	0.344	30.7	0.601	18.7	0.198	18.3	0.33	2.63
Sylhet	1,896	6.1	0.216	6.6	0.662	7.1	0.239	7.6	0.36	2.89
Total	22,555	73.0	0.244	88.9	0.596	75.9	0.201	76.1	0.34	2.70
Urban										
Barisal	433	1.4	0.090	0.6	0.406	1.0	0.138	1.0	0.34	2.72
Chittagong	1,925	6.2	0.047	1.5	0.488	5.3	0.168	5.4	0.34	2.75
Dhaka	3,046	9.9	0.060	3.0	0.571	9.8	0.191	9.7	0.33	2.67
Khulna	772	2.5	0.058	0.7	0.472	2.1	0.147	1.9	0.31	2.49
Rajshahi	1,596	5.2	0.174	4.5	0.474	4.3	0.155	4.1	0.33	2.61
Sylhet	589	1.9	0.085	0.8	0.506	1.7	0.171	1.7	0.34	2.70
Total	8,363	27.0	0.082	11.1	0.511	24.1	0.170	23.9	0.33	2.67
Bangladesh										
Barisal	1,822	5.9	0.153	4.5	0.519	5.3	0.179	5.5	0.35	2.76
Chittagong	6,652	21.5	0.119	12.8	0.529	19.9	0.185	20.6	0.35	2.79
Dhaka	9,749	31.5	0.210	33.2	0.618	34.0	0.208	34.0	0.34	2.70
Khulna	3,106	10.0	0.136	6.8	0.514	9.0	0.158	8.2	0.31	2.46
Rajshahi	7,105	23.0	0.306	35.2	0.573	23.0	0.188	22.4	0.33	2.63
Sylhet	2,485	8.0	0.185	7.4	0.625	8.8	0.223	9.3	0.36	2.85
Total	30,918	100	0.200	100	0.573	100	0.193	100	0.34	2.69

Note: WI = Welfare index fifth quintile; H = Headcount; M_o = Adjusted headcount; A = Average deprivation shared

Table A3 Decomposition of child poverty by the combination of urban – rural area and regions

(Equal weights and k = 1)

	1	2	3	4	5	6	7	8	9	10
Regions / Urban-Rural	**Total Sample**	**% Contribution**	**WI**	**% Contribution**	**H**	**% Contribution**	**Mo (HA)**	**% Contribution**	**A**	**Average deprivations among the poor**
Rural										
Barisal	1,388	4.5	0.173	3.9	0.846	4.4	0.162	4.4	0.19	1.83
Chittagong	4,727	15.3	0.149	11.4	0.837	14.9	0.160	14.8	0.19	1.82
Dhaka	6,703	21.7	0.279	30.2	0.896	22.7	0.194	25.4	0.22	1.99
Khulna	2,333	7.5	0.161	6.1	0.860	7.6	0.139	6.3	0.16	1.62
Rajshahi	5,508	17.8	0.344	30.7	0.888	18.5	0.176	18.9	0.20	1.87
Sylhet	1,896	6.1	0.216	6.6	0.889	6.4	0.212	7.9	0.24	2.14
Total	22,555	73.0	0.244	88.9	0.874	74.5	0.176	77.7	0.20	1.89
Urban										
Barisal	433	1.4	0.090	0.6	0.736	1.2	0.102	0.9	0.14	1.43
Chittagong	1,925	6.2	0.047	1.5	0.800	5.8	0.134	5.1	0.17	1.66
Dhaka	3,046	9.9	0.060	3.0	0.855	9.8	0.163	9.7	0.19	1.81
Khulna	772	2.5	0.058	0.7	0.769	2.2	0.113	1.7	0.15	1.47
Rajshahi	1,596	5.2	0.174	4.5	0.783	4.7	0.121	3.8	0.15	1.55
Sylhet	589	1.9	0.085	0.8	0.774	1.7	0.132	1.5	0.17	1.63
Total	8,363	27.0	0.082	11.1	0.809	25.5	0.138	22.6	0.17	1.66
Bangladesh										
Barisal	1,822	5.9	0.153	4.5	0.819	5.6	0.147	5.2	0.18	1.73
Chittagong	6,652	21.5	0.119	12.8	0.827	20.8	0.153	19.9	0.18	1.78
Dhaka	9,749	31.5	0.210	33.2	0.883	32.5	0.184	35.1	0.21	1.93
Khulna	3,106	10.0	0.136	6.8	0.837	9.8	0.132	8.0	0.16	1.59
Rajshahi	7,105	23.0	0.306	35.2	0.865	23.2	0.163	22.6	0.19	1.80
Sylhet	2,485	8.0	0.185	7.4	0.862	8.1	0.192	9.3	0.22	2.02
Total	30,918	100	0.200	100	0.857	100	0.165	100	0.19	1.83

Note: WI = Welfare index fifth quintile; H = Headcount; M_o = Adjusted headcount; A = Average deprivation shared

Table A4 Decomposition of child poverty by the combination of urban – rural area and regions

(Equal weights and k = 3)

	1	2	3	4	5	6	7	8	9	10
Regions / Urban-Rural	**Total Sample**	**% Contribution**	**WI**	**% Contribution**	**H**	**% Contribution**	**Mo (HA)**	**% Contribution**	**A**	**Average deprivations among the poor**
Rural										
Barisal	1,388	4.5	0.173	3.9	0.284	4.6	0.125	4.7	0.44	3.50
Chittagong	4,727	15.3	0.149	11.4	0.289	16.0	0.127	16.4	0.44	3.52
Dhaka	6,703	21.7	0.279	30.2	0.321	25.1	0.137	24.9	0.43	3.41
Khulna	2,333	7.5	0.161	6.1	0.189	5.2	0.077	4.9	0.41	3.24
Rajshahi	5,508	17.8	0.344	30.7	0.271	17.5	0.115	17.3	0.42	3.40
Sylhet	1,896	6.1	0.216	6.6	0.371	8.2	0.166	8.6	0.45	3.58
Total	22,555	73.0	0.244	88.9	0.290	76.6	0.125	76.7	0.43	3.44
Urban										
Barisal	433	1.4	0.090	0.6	0.190	1.0	0.084	1.0	0.44	3.54
Chittagong	1,925	6.2	0.047	1.5	0.237	5.3	0.105	5.5	0.44	3.55
Dhaka	3,046	9.9	0.060	3.0	0.275	9.8	0.117	9.7	0.42	3.39
Khulna	772	2.5	0.058	0.7	0.190	1.7	0.077	1.6	0.40	3.22
Rajshahi	1,596	5.2	0.174	4.5	0.208	3.9	0.088	3.8	0.42	3.39
Sylhet	589	1.9	0.085	0.8	0.246	1.7	0.106	1.7	0.43	3.43
Total	8,363	27.0	0.082	11.1	0.240	23.4	0.103	23.3	0.43	3.42
Bangladesh										
Barisal	1,822	5.9	0.153	4.5	0.262	5.6	0.115	5.7	0.44	3.51
Chittagong	6,652	21.5	0.119	12.8	0.274	21.3	0.121	21.9	0.44	3.53
Dhaka	9,749	31.5	0.210	33.2	0.307	34.9	0.130	34.6	0.43	3.40
Khulna	3,106	10.0	0.136	6.8	0.190	6.9	0.077	6.5	0.40	3.24
Rajshahi	7,105	23.0	0.306	35.2	0.257	21.4	0.109	21.1	0.42	3.40
Sylhet	2,485	8.0	0.185	7.4	0.342	9.9	0.152	10.3	0.44	3.55
Total	30,918	100	0.200	100	0.277	100	0.119	100	0.43	3.44

Table A5 Ranking comparison between regions and urban-rural areas for Mo by different k cutoffs

	1	2	3	4	5	6	9	10
Regions / Urban-Rural	**Mo (k=2)**	Ranking Mo (k=2)	**Mo (k=1)**	Ranking Mo (k=1)	**Mo (k=3)**	Ranking Mo (k=3)	Dif. in rank order (k=2) - (k=1)	Dif. in rank order (k=2) - (k=3)
Rural Sylhet	0.239	1	0.212	1	0.166	1	0	0
Rural Dhaka	0.216	2	0.194	2	0.137	2	0	0
Rural Rajshahi	0.198	3	0.176	3	0.115	6	0	-3
Rural Barisal	0.192	4	0.162	5	0.125	4	-1	0
Rural Chittagong	0.192	5	0.160	6	0.127	3	-1	2
Urban Dhaka	0.191	6	0.163	4	0.117	5	2	1
Urban Sylhet	0.171	7	0.132	9	0.106	7	-2	0
Urban Chittagong	0.168	8	0.134	8	0.105	8	0	0
Rural Khulna	0.161	9	0.139	7	0.077	11	2	-2
Urban Rajshahi	0.155	10	0.121	10	0.088	9	0	1
Urban Khulna	0.147	11	0.113	11	0.077	12	0	-1
Urban Barisal	0.138	12	0.102	12	0.084	10	0	2

Table A6 Ranking comparison between regions and urban-rural areas for H by different k cutoffs

	1	2	3	4	5	6	9	10
Regions / Urban-Rural	**H (k=2)**	Ranking H (k=2)	**H (k=1)**	Ranking H (k=1)	**H (k=3)**	Ranking H (k=3)	Dif. in rank order (k=2) - (k=1)	Dif. in rank order (k=2) - (k=3)
Rural Sylhet	0.662	1	0.889	2	0.371	1	-1	0
Rural Dhaka	0.639	2	0.896	1	0.321	2	1	0
Rural Rajshahi	0.601	3	0.888	3	0.271	6	0	-3
Urban Dhaka	0.571	4	0.855	5	0.275	5	-1	-1
Rural Barisal	0.554	5	0.846	6	0.284	4	-1	1
Rural Chittagong	0.546	6	0.837	7	0.289	3	-1	3
Rural Khulna	0.528	7	0.860	4	0.189	13	3	-6
Urban Sylhet	0.506	8	0.774	10	0.246	7	-2	1
Urban Chittagong	0.488	9	0.800	8	0.237	8	1	1
Urban Rajshahi	0.474	10	0.783	9	0.208	9	1	1
Urban Khulna	0.472	11	0.769	11	0.190	10	0	1
Urban Barisal	0.406	12	0.736	12	0.190	12	0	0

Table A7 Share of the respective region/area that is both poor and deprived in each dimension (Equal weights and k = 2)

	1	2	3	4	5	6	7	8	9
	Drinking Water	**Sanitation facilities**	**Overcrowded housing**	**Tenure and eviction**	**Iodized Salt**	**Vitamin A**	**Measles vaccination**	**Support for learning**	**Mo**
Rural									
Barisal	0.265	0.464	0.233	0.119	0.121	0.089	0.069	0.177	0.192
Chittagong	0.143	0.480	0.268	0.108	0.258	0.077	0.089	0.109	0.192
Dhaka	0.048	0.585	0.476	0.086	0.201	0.101	0.106	0.127	0.216
Khulna	0.138	0.464	0.379	0.062	0.064	0.070	0.046	0.069	0.161
Rajshahi	0.021	0.545	0.427	0.119	0.179	0.085	0.062	0.144	0.198
Sylhet	0.218	0.625	0.438	0.112	0.088	0.111	0.125	0.191	0.239
Total	0.098	0.537	0.392	0.101	0.179	0.089	0.085	0.130	0.201
Urban									
Barisal	0.102	0.283	0.226	0.212	0.031	0.056	0.037	0.157	0.138
Chittagong	0.083	0.350	0.285	0.301	0.137	0.064	0.057	0.067	0.168
Dhaka	0.041	0.392	0.428	0.380	0.059	0.056	0.083	0.087	0.191
Khulna	0.061	0.350	0.359	0.268	0.019	0.049	0.039	0.032	0.147
Rajshahi	0.022	0.353	0.342	0.207	0.104	0.060	0.056	0.095	0.155
Sylhet	0.104	0.357	0.359	0.269	0.041	0.062	0.074	0.099	0.171
Total	0.056	0.363	0.357	0.302	0.079	0.058	0.065	0.083	0.170
Bangladesh									
Barisal	0.226	0.421	0.231	0.141	0.100	0.081	0.061	0.172	0.179
Chittagong	0.126	0.443	0.273	0.164	0.223	0.073	0.080	0.097	0.185
Dhaka	0.046	0.525	0.461	0.178	0.156	0.087	0.099	0.114	0.208
Khulna	0.119	0.436	0.374	0.113	0.053	0.064	0.044	0.060	0.158
Rajshahi	0.022	0.502	0.408	0.139	0.162	0.079	0.061	0.133	0.188
Sylhet	0.191	0.561	0.419	0.149	0.077	0.099	0.113	0.169	0.223
Total	0.087	0.490	0.383	0.155	0.152	0.081	0.079	0.117	0.193

Table A8 Percentage of contribution of the dimension to the respective population level of Mo (Equal weights and k = 2)

	1	2	3	4	5	6	7	8	9
	Drinking Water	**Sanitation facilities**	**Overcrowded housing**	**Tenure and eviction**	**Iodized Salt**	**Vitamin A**	**Measles vaccination**	**Support for learning**	**Mo**
Rural									
Barisal	17.3	30.2	15.1	7.7	7.9	5.8	4.5	11.5	100
Chittagong	9.3	31.3	17.5	7.1	16.8	5.0	5.8	7.1	100
Dhaka	2.8	33.8	27.5	5.0	11.6	5.8	6.1	7.3	100
Khulna	10.7	35.9	29.4	4.8	4.9	5.4	3.5	5.3	100
Rajshahi	1.3	34.5	27.0	7.5	11.3	5.4	3.9	9.1	100
Sylhet	11.4	32.7	23.0	5.9	4.6	5.8	6.6	10.0	100
Total	6.1	33.3	24.4	6.2	11.1	5.5	5.3	8.1	100
Urban									
Barisal	9.2	25.7	20.5	19.2	2.8	5.1	3.3	14.2	100
Chittagong	6.2	26.0	21.2	22.4	10.2	4.8	4.3	5.0	100
Dhaka	2.7	25.7	28.1	24.9	3.8	3.7	5.4	5.7	100
Khulna	5.2	29.7	30.5	22.8	1.6	4.2	3.3	2.7	100
Rajshahi	1.8	28.5	27.6	16.7	8.4	4.9	4.5	7.7	100
Sylhet	7.6	26.1	26.3	19.7	3.0	4.5	5.4	7.3	100
Total	4.1	26.6	26.2	22.2	5.8	4.3	4.7	6.1	100
Bangladesh									
Barisal	15.8	29.4	16.1	9.8	7.0	5.7	4.3	12.0	100
Chittagong	8.5	29.9	18.5	11.1	15.1	5.0	5.4	6.5	100
Dhaka	2.7	31.5	27.7	10.7	9.4	5.2	5.9	6.9	100
Khulna	9.4	34.5	29.6	9.0	4.2	5.1	3.5	4.7	100
Rajshahi	1.4	33.3	27.1	9.2	10.8	5.3	4.0	8.8	100
Sylhet	10.7	31.5	23.6	8.4	4.3	5.6	6.4	9.5	100
Total	5.6	31.7	24.8	10.0	9.8	5.2	5.1	7.6	100

Table A9 Decomposition of child poverty by mother's education for Rural Rajshahi (Equal weights and k = 2)

	1	2	3	4	5	6	7	8	9	10
	Total Sample	% Contribution	WI	% Contribution	H	% Contribution	Mo (HA)	% Contribution	A	Average deprivations among the poor
Mother's education										
None	2,171	39.4	0.530	60.7	0.744	48.7	0.257	51.2	0.35	2.76
Primary incomplete	939	17.0	0.365	18.1	0.671	19.0	0.221	19.1	0.33	2.64
Primary completed	625	11.4	0.284	9.4	0.535	10.1	0.162	9.3	0.30	2.42
Secondary incomplete	1,397	25.4	0.146	10.8	0.454	19.1	0.137	17.6	0.30	2.42
Second. compl. or higher	336	6.1	0.025	0.4	0.192	1.9	0.054	1.7	0.28	2.26
Non-standard curriculum	39	0.7	0.327	0.7	0.884	1.1	0.309	1.1	0.35	2.80
Total	5,508	100	0.344	100	0.601	100	0.198	100	0.33	2.63