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Assessing Deprivation with Ordinal Variables: Depth Sensitivity and Poverty Aversion

Around four decades ago, in an influential article titled Poverty: An Ordinal Approach to Measurement, Nobel laureate Amartya Sen proposed an axiomatically derived poverty measure to avoid some shortcomings of the traditionally used headcount ratio (Sen, 1976). Sen's approach was ordinal in the sense that his poverty measures assigned an ordinal-rank weight to each poor person's income, an otherwise cardinal variable. Since then, this seminal article has influenced a well-developed literature on poverty measurement involving cardinal variables within an axiomatic framework (Thon, 1979; Clark et al., 1981; Chakravarty, 1983; Foster et al., 1984; Foster and Shorrocks, 1988a,b; Ravallion, 1994; Shorrocks, 1995).

Distances between the values of cardinally measurable variables are meaningful. By contrast, ordinal variables merely consist of ordered categories and cardinal distances between these categories are hard to interpret when numerals are assigned to them, respecting their order or rank. And yet, the practice of using ordinal variables has been on the rise due to the recent surge in interest toward studying deprivation in non-monetary indicators, which are often ordinal in nature (e.g. type of access to basic facilities). In fact, the Commission on Global Poverty (World Bank, 2017) have acknowledged the need for assessing, monitoring, and alleviating poverty in multiple dimensions, besides the monetary dimension. In practice, most non-income dimensions are assessed by ordinal variables. There may also be instances where ordinal categories of an otherwise cardinally measurable variable may have more policy relevance. For example, it may be of more interest to focus on ordered categories of income, nutritional status, or years of education completed, than the cardinal values of these indicators themselves.

How should poverty be meaningfully assessed with ordinal variables? One straightforward way may be to dichotomise the population into a group of deprived and a group of non-deprived people, and then use the headcount ratio. However, this index is widely accused of ignoring the depth of deprivations (Foster and Sen, 1997). For instance, we observe that in Sylhet province of Bangladesh between 2007 and 2011, the proportion of population with inadequate sanitation facilities went down from around 70% to nearly 63%; whereas, during the same period, the proportion of people with the worst form of sanitation deprivation ('open defecation') increased significantly, from around 2% to more than 12%.

How can the depth of deprivations be reasonably captured in the case of ordinal variables? The challenges associated with measuring well-being and inequality using an ordinal variable in an

axiomatic framework have received due attention during the last few decades (e.g., Mendelson, 1987; Allison and Foster, 2004; Apouey, 2007; Abul Naga and Yalcin, 2008; Zheng, 2011; Kobus and Milos, 2012; Permanyer and D'Ambrosio, 2015; Kobus, 2015; Lazar and Silber, 2013; Yalonetzky, 2013; Gravel et al., 2015). Yet in the assessment of poverty such efforts have not been sufficiently thorough. The first attempt, by Bennett and Hatzimasoura (2011), showed that indeed we can measure poverty with ordinal variables sensibly, but implicitly ruled out entire classes of well-suited measures (as shown by Yalonetzky, 2012). Moreover, their assessment of depth-sensitivity was restricted to the ordinal version of Pigou-Dalton transfers, thereby missing many other options including the burgeoning use of Hammond transfers (e.g. see Gravel et al., 2015).

Our paper contributes theoretically to the poverty measurement literature in the following ways.

First, we axiomatically characterise a class of ordinal poverty measures under a minimal set of well-motivated and desirable properties. Our class consists of measures that are weighted sums of population proportions in deprivation categories, where these weights are referred to as ordering weights because their values depend on the order of the categories. The characterised measures are sensitive to the depth of deprivations (unlike the headcount ratio), are additively decomposable, and are bounded between zero and one. These features make them amenable to a broad range of empirical applications.

Second, an adequately designed poverty measure should also ensure that policy makers have additional incentive to provide precedence to those poorer among the poor in the design of poverty alleviation policies so that the poorest are not left behind. In a novel attempt, we operationalise the concept of precedence to poorer people by incorporating a new form of degree of poverty aversion in the ordinal context. This new form of poverty aversion encompasses, as limiting cases, both previous attempts at sensitising ordinal poverty indices to the depth of deprivations (e.g., Bennett and Hatzimasoura, 2011; Yalonetzky, 2012) as well as current burgeoning approaches to distributional sensitivity in ordinal frameworks based on Hammond transfers (Hammond, 1976; Gravel et al., 2015). We define a range of properties based on this new form of degree of poverty aversion and characterise the corresponding sub-classes of ordinal poverty measures. Within our framework, different degrees of poverty aversion merely require setting different restrictions on the ordering weights, preserving the measures' additive decomposability.

To demonstrate the efficacy of our approach, we first present an empirical illustration studying the evolution of sanitation deprivation in Bangladesh. For our analysis, we use the nationally

representative Demographic Health Survey (DHS) datasets of Bangladesh for years 2007, 2011 and 2014. One target of the United Nations' sixth Sustainable Development Goal is: "by 2030, [to] achieve access to adequate and equitable sanitation and hygiene for all and end open defecation." To achieve the target, the Joint Monitoring Programme (JMP) of the World Health Organisation and the UNICEF proposes using "a service ladder approach to benchmark and track progress across countries at different stages of development," building on the existing datasets. We pursue this service ladder approach and apply our ordinal poverty measures to study the improvement in sanitation deprivation in Bangladesh. Interestingly, our measures are able to discern the instances where the improvements in overall sanitation deprivation did not necessarily include the poorest.