ORIGINAL RESEARCH

How Poor is Poor? A novel look at multidimensional poverty in the UK

Deniz Sevinc[1]

Abstract
The integrated nature of well-being produces difficulty in evaluating poverty levels and one issue is the neglected of human life aspects, multiple feedback loops, and an over-emphasis on income. In the light of current structural changes a multidimensional poverty measure (MPI), which includes some of those missing dimensions, closely related to the well-being of individuals, is constructed in this paper. Using data from the EU Statistics on Income and Living Conditions Survey, this paper provides a fresh insight into the analysis of multidimensional poverty in the United Kingdom. One of the distinctive feature of the study is the use of polychoric factor loadings to estimate dimensional weights of the MPI, in addition to more arbitrary weighting schemes. This technique consists of a coherent hierarchy of principles, to verify which of the many acknowledged dimensions of poverty hold both theoretical and practical importance. Findings indicate that, the MPI is highly consistent with the conventional measures of poverty and multidimensional poverty has decreased over the period of examination.

1 Introduction

With the increasing awareness of the limitations of relying on income to evaluate poverty, the measurement of poverty is undergoing a multidimensional turn (Alkire and Foster 2011; Bourguignon and Chakravarty 2019; Alkire et al. 2018; Samuel et al. 2018; Santos and Villatoro 2018) departing from the income-centric or unidimensional forms to integrating insights from multiple life dimensions. As Sen puts it, *the role of income and wealth has to be integrated into a fuller picture of success and deprivation* (Sen 1976). One of the core elements of Sen's capability approach is the functioning of life that consists of many elements, providing a rationale for the development of a multidimensional

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✉ Deniz Sevinc
d.sevinc@bham.ac.uk

[1] City Region Economic and Development Institute, Birmingham Business School, University of Birmingham, Birmingham, UK

approach to poverty (Sen 1982). With this in mind, in an attempt to demonstrate how the non-monetary dimensions can advance the evaluation of poverty in the United Kingdom, this study sets up a poverty analysis incorporating Sen's view of poverty as capability deprivation and builds on the multidimensional poverty measure (MPI) introduced by Alkire and Foster (AF) (2011). The United Kingdom has seen a significant rise in material deprivation rates amongst households since 2009, from 3 to 8%. In 2012, the UK had a higher poverty rate than most advanced EU member states. Between 2008 and 2011, almost 33% of Britons experienced poverty at least once (Office for National Statistics 2015). There are few studies that have focused on measuring measuring poverty in the UK using multidimensional perspectives, nevertheless, they either use a national average (e.g., Whelan et al. 2014; Alkire et al. 2014) or restrict their analysis to measuring multiple deprivations (e.g., Noble et al. 2006; Whelan et al. 2002) with an emphasis on health outcomes (e.g., Jordan et al. 2004; Adams and White 2006; Walsh 2014). However, determining who the most deprived social groups are and in which life domains they are experiencing deprivation is crucial for generating an effective, holistic poverty reduction initiatives combined with intervention prioritization (Alkire and Foster 2011). With this in mind, as highlighted by Alkire and Foster (2011) in an attempt to shift the focus of societal development from an income-oriented to a people-centric approach, this paper makes three contributions to poverty analysis in the United Kingdom.

First, the paper focuses on examining the level of multidimensional poverty in the UK by incorporating a socio-economic dimension into poverty measurement. This multidimensional perspective provides a more precise image of the experience of poverty as well as possibly influencing the categorization of being poor, which is instrumental for policy makers to advance the distribution of scarce human and economic assets and prioritise social protection intervention programmes as a result (Alkire and Foster 2011). This study, to the best of our knowledge, is the first to estimate multidimensional poverty in the United Kingdom by applying the Alkire–Foster methodology to the EU-Statistics on Income and Living Conditions (EU-SILC) that provides a detailed reflection of various socio-demographic characteristics of the households living in the UK. The study develops on the flexible, policy focused methodology proposed by Alkire and Santos (2010) in an effort to work with a directly applicable framework, seeking to explain MPI by socio-economic characteristics which accommodates different indicators, weights, and cut-offs (Alkire and Santos 2010). As Ravallion (1998) noted, "a credible measure of poverty can be a powerful instrument for focusing the attention of policy-makers on the living conditions of the poor". Therefore, the study provides a more detailed portrayal of poverty both in terms of measurement and characteristics of deprivation in the UK by making the case for an anti-poverty agenda that gradually works towards multidimensionality of well-being.

Secondly, in addition to equal and nested equal weights, the study employs a data-driven approach, using polychoric factor loadings to estimate dimensional weights for the MPI is preferable to the common practice of using more arbitrary (e.g., equal or nested equal) weights. As will be explained in Sect. 3.2, it is necessary to explicitly recognize the constraints of an equal weighting scheme, its choices about the substitutability, and specific trade-offs between the dimensions. There are several arguments in favour of the polychoric weighting approach. First, it combines the strengths of both data driven and normative approaches by using information on value judgements combined with information on the actual distribution of the achievement vectors (Kolenikov and Angeles 2004). Second, this technique consists of a coherent hierarchy of principles, to verify which of the many acknowledged dimensions of deprivation hold both theoretical and practical importance, and distinguish which are of only marginal significance (Kolenikov and Angeles 2004).

Thirdly, the study analyses the potential advantages of a multidimensional approach to poverty measurement relative to a unidimensional point of view and to the EU's material deprivation measure, and the extent to which the multi-dimensionality of poverty is captured by these traditional measures. The divergence between unidimensional poverty and multidimensional notions of poverty has been noted by several authors (e.g., Costa 2003; Hulme and McKay 2007). Although multidimensional measures provide a more holistic view of poverty, both unidimensional and multidimensional perspectives provide beneficial insights to the poverty measurement and evaluation, neither of which can be said to be categorically right or wrong. Therefore, the key aims that such an exercise would like to address are the extent of overlap between these measures as well as a comparison of multidimensional and objective methods of measuring poverty.

This paper is divided into the following six sections: The subsequent section outlines the current situation in the United Kingdom, and provides a detailed presentation on the set of indicators and data that are used to reflect dimensions of multidimensional deprivation. Section 3 explains: (1) Alkire and Foster's (2011) MPI methodology (2) the methods used to find numerical weights for dimensions of poverty and discusses how polychoric weights can enhance existing methodologies by offering a clear specification of the weighting scheme through reflecting the intensity of multidimensional deprivation. Overlaps with EU material deprivation and unidimensional poverty are presented in Sect. 4.1. Section 4.2 presents the headcount poverty ratios to provide a stark picture of multidimensional poverty in the UK. Section 4.3 reports the results of an empirical application in the United Kingdom that seeks to explain multidimensional poverty by socio-demographic characteristics. Finally, concluding comments and policy implications are given in Sect. 5.

2 Selecting Dimensions, Indicators: Data and the United Kingdom Context

The first step of the multidimensional approach begins with the selection of various dimensions. Plausible dimensions that are a measure of multiple deprivations are quite abundant and should include empowerment, health, education, standard of living, work, environment, safety from violence, social relationships, and culture (Alkire and Santos 2010). Formulating a multifaceted phenomenon encompassing deprivations among multiple life domains clashes with disagreement as there is no consensus yet on exactly how to adequately capture the extent of deprivation (Alkire and Santos 2010). To identify the set of indicators and dimensions which would be best suited for the UK as a first cut, the study utilizes existing evidence to guide the preliminary choice of indicators.

There is a growing empirical literature, which seeks to explore the multidimensionality of poverty, with a particular focus on British (see among others: Whelan et al. 2014; Halleröd and Larsson 2008; Nolan and Whelan 2011; Burchardt et al. 2002) and European studies (see among others: Coromaldi and Zoli 2007; Notten and Roelen 2010). The indicators in the existing literature broadly relate to the dimensions of material deprivation, living standards, health, and housing. Whelan et al. (2001) show that income is highly correlated with material deprivation, accompanied with secondary deprivation in multiple life domains. Similar findings have been noted amongst EU member states by Coromaldi and Zoli (2007) and Notten and Roelen (2010). Similarly, Halleröd and Larsson (2008) show that materially deprived households' probability of experiencing deprivation in multiple life domains such as poor environment, being unemployed, crime and vandalism in

the neighbourhood is higher than those who are income poor. Existing studies can suggest a broad list of dimensions, yet it is both theoretically and empirically challenging to focus sufficient attention on the numerous variables (Alkire and Santos 2010).[1] For instance, Nussbaum (2000)'s approach provides an informative account of the capability approach and argues for ten core capabilities that should be supported by all democracies, however, they may not be pertinent across different contexts (Robeyns 2003; Trani et al. 2016). Using a participatory process to identify an informed decision on what constitutes the dimensions of poverty is another option (Notten and Roelen 2012; Narayan 2000) but it is also not uncontentious (Kapteyn et al. 1988; Ravallion and Lokshin 2001). In fact, as outlined by Alkire and Santos (2010) the selection of multiple life domains for any well-being measure should be considered as a value judgement rather than mechanical exercise that can be formulated based on international consensus, human rights, or empirical evidence (Alkire and Santos 2010; Alkire et al. 2015). This paper does not intend to describe a list of indicators that should constitute a multidimensional well-being measure. The aim is much more modest in that respect, yet, there are several arguments in favour of the chosen dimensions based on the authoritative work in the field of multidimensional poverty by Alkire and Santos (2010).[2]

The empirical analysis presented in this study is based on data from the 2008/9 wave of the European Union Statistics on Income and Living Conditions Survey (EU-SILC), a household survey, aimed at collecting timely and comparable cross-sectional and longitudinal multidimensional microdata on income, poverty, social exclusion and living conditions (EUROSTAT 2018). The EU-SILC was selected as the relevant dataset because of the comparative wealth of material it covers on multiple dimensions of deprivation, as well as on low income and material deprivation. A headline poverty target of reducing by 20 million in 2020 the number of people under poverty and social exclusion has been defined based on the EU-SILC instrument, and the dataset is being used for monitoring the poverty and social inclusion in the EU. Thus, the factors of its origin, comparability, and frequency, qualify it as a natural source of data for this measurement work. The findings are based on a completed case analysis of respondents between the ages of 16 and 65.[3]

MPI consists of thirteen indicators taken from the EU-SILC, which combined, represent the multidimensional deprivation of households living in the UK and dimensions are based on a definition of deprivation in multiple life domains as a result of low living conditions. Sen's arguments on the framing of dimensions and weights associated with them are highly dependent on public debate and critical observation (Sen 2004). So how can these be identified in a robust manner? This paper particularly focuses on three overlapping methods following Alkire and Foster (2011) as a step towards choosing life domains and dimensions as a first cut: normative assumptions; data availability and builds upon the structured evidence-based literature -namely empirical evidence- regarding multi-faceted and inter-linked nature of deprivation in the UK. A second cut is to measure the importance of validity and reliability of the selected indicators and dimensions -namely internal

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[1] See, for example, Alkire (2002), Alkire and Foster (2011), and Andrews and Stephen (2012) for a detailed review on social indicators of well-being.

[2] Further work with major contributions on the indicators that a well-being measure should take into consideration, see among others: Eid and Larsen (2008), Alkire and Santos (2010), and Alkire et al. (2014).

[3] It is worth noting that, the same methodology can be adapted to analyse multidimensional poverty for different countries. From 2005 onwards EU-SILC data are available for all EU25 Member States. Turkey, Romania, Bulgaria have also launched EU-SILC in 2006.

Table 1 Deprivation in each indicator

Indicator	2008	2009
Capacity to afford a meal with meat, chicken, fish every second day	5.28	4.92
Ability to keep home adequately warm	6.87	6.78
Leaking roof, damp walls/floors/foundation, or rot in window frames or floor	14.00	13.74
Capacity to afford paying for one week annual holiday away from home	22.42	24.84
Pollution, grime or other environmental problems	12.38	12.08
Crime violence or vandalism in the area	24.45	24.70
Capacity to face unexpected financial expenses	27.00	28.00
Arrears on hire purchase instalments or other loan payments	5.95	6.75
Ability to make ends meet	43.54	42.32
Unmet need for medical examination or treatment	4.30	4.32
Unmet need for dental examination or treatment	6.03	6.69
Arrears on mortgage or rent payments	5.55	7.34
Financial burden of the total housing cost	73.30	70.02

consistency- with Cronbach's alpha. Selected dimensions are characterized by high levels of the Cronbach's alpha reliability index based on the average correlation between the component items. The results indicate high reliability as well as internal consistency.[4] The four dimensions of multidimensional poverty available in the EU-SILC, which correspond to the concept of poverty as outlined in the study are:(1) general health, (2) living standards, (3) housing deprivation, and (4) financial deprivation; three indicators for income, two indicators each for housing and health, and six indicators for living standards (see Appendix, Table 7).

The first set of indicators deals with *living standards* and draws on five indicators reflecting the capabilities of possessing adequate resources across the life course to enjoy a decent standard of living. These needs are: consumption of meat or proteins at least every other day, ability to provide adequate heating of dwelling, ability to spend a week long holiday away from home at least once a year, quality of the environment and problems with the dwelling. Dietary requirements are taken as the first indicator within the living standards dimension. Table 1 examines the deprivation ratio in each dimension and shows that a minimally acceptable diet is a normal element for many households. The next indicator in the same dimension is *leisure activities* while the other set (6th and 7th) of indicators draws on top necessities relating to whether the respondent's accommodation has: adequate heating; and adequate housing conditions (i.e. leaking roofs; damp walls or floors; and wet/dry rot). In terms of leisure activities, as far as economically weak households are concerned, many of them *could not afford a one-week holiday away from home* in 2008. The third and fourth set of items are related to multiple exposures to risk factors in the neighbourhood, with the assumption that households wish to avoid: a) *crime, and vandalism* and b) *pollution, grime or other environmental problems.* As shown in Table 1, crime and environmental pollution are identified as one of the most serious problems associated with respondents' neighbourhood.

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[4] See Cronbach (1951) and Appendix, Table 6 for further details.

Financial deprivation, being central for almost every form of subjective poverty, is included as a dimension itself.[5] Three main indicators are taken as component proxies of functionings and jointly provide a holistic assessment of capabilities that have been the prime deprivational concern of UK society: capability to face unexpected expenses (i.e. a required expense could be surgery, funeral, major repair in the house, or replacement of durables), arrears on hire purchase instalments or other loan payments (i.e. whether the household has been in arrears in the last 12 months that is, unable to meet scheduled hire purchase or other non-housing repayments. Other loans include all types of commercial credits and ability to make ends meet (the objective is to assess the respondent's feeling about the level of difficulty experienced by the household in making ends meet). This deprivation segment is conceived as a proxy for one's ability to control many other resources by facilitating the core functionings of well-being (Whelan et al. 2001). An equally important fact within the same dimension shows that the household sample is less able to cope with unexpected expenses. The next set reflects the household's capability for paying rent, mortgage repayments, other loans and utility bills and these are linked to financial stress of the housing facilities: *financial burden of the total housing cost* and *arrears on mortgage or rent payments*. As shown in Table 1, housing cost was generally the most progressively growing category in this deprivation segment.

The competency to lead a healthy lifestyle is an indispensable for most of human well-being, therefore, health constitutes the final dimension.[6] The large literature on this topic falls roughly into two distinct facets in terms of measurement of inequalities in health care systems (Wagstaff and Van Doorslaer 2000). One aspect being proper nutrition that is acknowledged as a crucial dimension of human capabilities (Le Grand 1987). Other studies focus on the household's access to healthcare services and analyse the correlation between their socio-economic position and access to crucial medical services towards their health maintenance (Kim 2011). To be more precise, the health dimension consists of two indicators, reflecting a more holistic picture of health outcomes: two each for presenting a balanced assessment of *access to health services* in the household.

3 Methods

3.1 Alkire–Foster Multidimensional Poverty Measures

The multidimensional poverty approach has been extensively researched (see among others, Alkire and Santos 2010; Alkire and Foster 2011; Alkire et al. 2015; Trani et al. 2016; Mitra et al. 2013; Mitra 2016). There are several arguments in favour of the Alkire and Foster (AF) methodology. Firstly, the AF approach identifies multiple life domains in which poor people are deprived and allows the identification of the domains that play the biggest role in experiencing poverty. Secondly, its flexibility in terms of deciding upon important decisions such as the selection of dimensions, cut-offs, dimensional weights that reflect the relative importance of each dimension, and indicators. Thirdly, MPI can be broken down to subgroupings around individual and demographic characteristics that capture age, ethnicity, gender and so forth to target and prioritise the

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[5] instead of an indicator in the broad standard of living dimension, as in the MPI

[6] One of the core elements of Sen's theory is the functioning of life.

most deprived (Alkire et al. 2015). Finally, the AF approach successfully deals with the two shortcomings encountered by other multidimensional measures as highlighted by Trani et al. (2016): (1) other conventional measures call for cardinal data for each life dimension (Chakravarty and D'Ambrosio 2006; Bourguignon and Chakravarty 2003). (2) existing approaches either do not offer a straightforward technique to identify the deprived, particularly beyond two dimensions (Alkire and Foster 2011; Alkire et al. 2015), or they consider only those deprived in all life dimensions as poor (Bourguignon and Chakravarty 2003; Tsui 2002).

A single measure constructed to illustrate the multidimensional nature of poverty has limitations that require attention. Numerous reviews and a multitude of studies have discussed the challenges of employing a dual cut-off method as well as the weighing scheme within selected dimensions (Ravallion 2011, 2012), and criticisms on the accounts of its negligence concerning the inequality facet within the chosen dimensions and population groups (Silber 2011; Chakravarty and D'Ambrosio 2006; Jayaraj and Subramanian 2010; Rippin 2010, 2011), or the necessity to modify the dimensions consistent with average well-being, to illustrate the weakly comparative facet of well-being and income (Ravallion and Chen 2011). Although it is possible to discuss in further detail the conceptual issues that can be revealed by a composite measure of multidimensional well-being, it is, however, not the aspiration of this paper to do so.

The rest of this section utilises and comes from the properties presented in Alkire and Foster (2011) in an attempt to build MPI for the UK.

$\Delta(Y) : M^n \longrightarrow \mathfrak{R}^j_+$ is a real valued function that comprises a categorical selection of dimensions, indicators, and weights that compute deprivation in d dimensions among n individuals. Consider a population of n individuals, indexed by $i = 1, \ldots, n$ with $n \geq 2$. Each individual is allotted with j strictly positive attributes of well-being whose quantities are measured in a mutual comparable way. All the possible distributions of attributes can be associated with j-dimensional deprivation index that belongs to the set $\mathfrak{R}_+$ of real numbers greater than or equal to zero (Alkire and Foster 2011).

Let $y = [y_{ij}]_{n \times d}$ present the non-negative attainments for individual i across j dimensions, and let $y_i = [y_{i1}, \ldots, y_{ij}]$ summarize these attainments where $y_i \in \mathfrak{R}_+$. Thus, each row vector $y_i = [y_{i1}, \ldots, y_{id}]$ corresponds to individual i's attainment given the entire attributes of well-being. Whereas, each column vector $y_j = [y_{1j}, y_{2j}, \ldots, y_{nj}]$ collects distributions of attainments in dimension j of the n individuals in the society. Achievement vectors across n individuals are collected by the distribution matrix Y with M^n the set of all $n \times j$ matrices with strictly positive elements (Alkire and Foster 2011).

$$Y := \begin{bmatrix} y_{11} & y_{12} & y_{13} & \cdots y_{1j} \\ y_{21} & y_{22} & y_{23} & \cdots y_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ y_{n1} & y_{n2} & y_{n3} & \cdots y_{nj} \end{bmatrix}_{i \times j} \quad \in M^n$$

Individual achievements are then combined through a social welfare function that assigns a welfare level for each distribution of attributes across individuals. Particularly, M_0, j dimensional poverty index, corresponds to a real valued function $W(Y) : M^n \to \mathfrak{R}_+$ underlying the derivation of $\Delta(Y)$, and it allows for weighting each dimension of well-being differently (Alkire and Foster 2011). Let $w^0 = W(Y)$, be the level of welfare attained by Y, then if W(.) satisfies the standard axioms of anonymity, continuity, monotonicity and equity preference, a weighting vector w can be defined such that w_j is the weight applied to dimension j (Alkire and Foster 2011).

3.2 Weighting Dimensions: Equal and Polychoric Weighting Schemes

Several challenges are encountered when constructing a composite measure to account for the multidimensional nature of poverty: the choice of dimensions and indicators; the selection for appropriate weights to aggregate the dimensions; and the justification of the final measure. In this section, the study surveys and compares a wide range of procedures to set up appropriate weights (Decancq and Lugo 2013). Normative weights are determined on value judgements of a specific panel of res, which is often considered as the most important challenge as they display important value judgements about the concept of well-being and play a critical role in the imposed trade-offs among the dimensions (Stiglitz et al. 2009; Decancq and Lugo 2012). A plethora of weighting approaches have been discussed in the literature with respect to the selection of weights for multidimensional measure of poverty or well-being to examine the significance of each dimension and whether how to aggregate them (e.g., Deutsch and Silber 2005; Krishnakumar 2007; Decancq and Lugo 2013; Maasoumi and Xu 2015). Decancq and Lugo (2012) provide an overview of three different methodologies, which are also employed within literature to set the weights in empirical applications of multidimensional measures of poverty and each is more convenient for a particular purpose: (1) normative (2) data driven and (3) hybrid. The most commonly used approach to weighting in multidimensional measures of well-being is to assume an equal value for each dimension, in which the relevant dimensions are weighted equally (Decancq and Lugo 2012). Well known examples of such a weighting scheme include leading aggregate indices like UNDP's Human Development Index (HDI) (Anand and Sen 1997), the Human Poverty Index and the Gender-related Development Index (UNDP 2014). However, this approach has often been defended for its agnostic viewpoint (Decancq and Lugo 2012), attributed to its simplicity or from the acknowledgement that every indicator is just as equally important. Similarly, Alkire and Foster (2011) assume perfect substitutability between the transformed achievements in MPI. Regardless of its common use, the equally weighted linear aggregation approach is far from uncontroversial (Decancq and Lugo 2012). In a paper on the HDI, Ravallion refers to equal weighting as the value judgements underlying the trade-offs built into the HDI's equally weighted dimensions are not made explicit, and they are questionable (Ravallion 1997). Chowdhury and Squire take this criticism further, and refer to equal weighting as *obviously convenient, but also universally considered to be wrong* (Chowdhury and Squire 2006). However, there is a significant difference between the indicators within a dimension as they do not have the same explanatory scope. An example can further clarify this. Consider a case where the living standards dimension consists of only two indicators: 'consumption of meat or relevant proteins at least every other day' and 'ability to spend a week long holiday away from home'. An economically weak respondent is likely to judge *a decent meal* to be more important than a *holiday*. Thus, it is necessary to explicitly recognize the constraints or trade offs within equal weighting scheme; its choices about the transformation and substitutability; and specific trade-offs between dimensions (Acar 2014). Another way to set the weights, based on data, is to adopt more complex and mathematically advanced approaches such as regression analysis, factor analysis for categorical data or fuzzy set theory (e.g., Krishnakumar 2007; Di Tommaso 2006). In addition to these approaches, Yalonetzky (2013) discusses the possibility of uniform rankings in several dimensions to be non-continuous and shows the utility of stochastic dominance tests in drawing robust conclusions about multidimensional poverty as regards the choice of dimensions. These probabilistic models, however, are relatively complex to interpret (Bartholomew et al. 2008) and accordingly they may

lack lucidity in terms of promoting a precise understanding of issues for policy-makers (Decancq and Lugo 2008). After surveying existing tools and methodologies, it can be inferred that a data-driven approach, polychoric PCA that improves on PCA, to estimate dimensional weights for the MPI is preferable to the common practice of using more arbitrary (e.g., equal or nested equal) weights. In consideration of such important criticisms, this study develops on the work of Alkire and Foster (2011) by using polychoric weighting approach in addition to the common practice of equal/nested equal weights. Here, it is noteworthy to mention that, Alkire and Foster utilize equal weights in the empirical illustration of their measure; however the measure they propose in the theoretical part of the paper is much more flexible than this and does not necessarily require equal weights, which enables the application of polychoric PCA weights (Alkire and Foster 2011). In addition, in a recent paper, Alkire et al. (2015) reflect on the robustness of MPI rankings in the particular selection of weights and poverty cutoffs (Alkire et al. 2015).

One of the questions addressed in this paper, therefore, is whether there is an intermediate approach in terms of determining data-driven weights. Polychoric correlations that improve on regular PCA are introduced with appropriate references to the existing literature, which demonstrate their statistical properties, and are particularly formulated for categorical variables (Kolenikov and Angeles 2008).[7] For generating the data-driven weights, polychoric principal component analysis is applied to the raw dataset and the factor loadings of the first component are subsequently used to estimate the score for each individual within the household sample. More specifically, first, the set of initial indicators within each dimension of well-being is transformed into an equal number of mutually uncorrelated linear combinations of indicators. Then, the proportion of the variance as explained by each of these linear combinations is computed, and the weights are obtained from the linear combination that explains the largest proportion of the variance (Kolenikov and Angeles 2008).[8] Another significant advantage comes from its use of ordinal data, which becomes even clearer when moving from theory to practice. For instance, as far as the economically weak households are concerned, researches are likely to judge 'accessing daily basic needs' to be more important than 'going for a holiday'. The polychoric technique offers a solution to such problems by assigning each the value of a discrete variable, thereby ensuring that the coefficients of an ordinal variable follow the order of the values (Acar 2014). This further explains that, in addition to its ability to predict coefficients more accurately, it uses ordinal data without any violation of identification assumptions (Kolenikov and Angeles 2004). Another important advantage of the polychoric approach is that it computes the coefficients of both owning and not owning an asset (Kolenikov and Angeles 2004). This is particularly important whilst reflecting the depth of deprivation in each well-being dimension, because not owning a particular asset often conveys more qualitative information than owning it (Kolenikov and Angeles 2004). Results of the computations based on polychoric and equal weighting schemes are shown in Table 2.

However, before applying polychoric analysis, the appropriateness of this method should be checked in relation to the data (Acar 2014). Cronbach's alpha is a commonly used analysis of internal consistency that measures the suitability of the indicators included in the composite index to answer the question of multidimensional well-being

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[7] For further work with major contributions, see Pearson and Pearson (1922) and Olsson (1979) who introduced the concepts of polychoric and polyserial correlations.

[8] See Kolenikov and Angeles (2008) for further details on socioeconomic status measurement with discrete proxy variables.

Table 2 Dimensions and weights

Indicator	Nested qual weights	Polychoric weights
Capacity to afford a meal with meat, chicken, fish every second day	0.04	0.3892
Ability to keep home adequately warm	0.04	0.3451
Leaking roof, damp walls/floors/foundation, or rot in window frames or floor	0.04	0.2966
Capacity to afford paying for one week annual holiday away from home	0.04	0.3671
Pollution, grime or other environmental problems	0.04	0.4138
Crime violence or vandalism in the area	0.04	0.3826
Capacity to face unexpected financial expenses	0.08	0.3785
Arrears on hire purchase instalments or other loan payments	0.08	0.3174
Ability to make ends meet	0.08	0.3509
Unmet need for medical examination or treatment	0.125	0.5036
Unmet need for dental examination or treatment	0.125	0.4795
Arrears on mortgage or rent payments	0.125	0.3145
Financial burden of the total housing cost	0.125	0.3461

and capabilities (Cronbach 1951). The maximum possible value of the coefficient is one, and a Cronbach's alpha of 0.6 or higher is accepted as sufficient enough to justify the application of polychoric PCA (Nguefack Tsague et al. 2011). Test results suggest that internal consistency ranges between 0.72 and 0.78. As it is, the procedure output has an overall raw alpha of .78 (rounded from .7817 from the test scale) which is good considering that Nunnally (1967), the most authoritative work of its kind, has indicated 0.7 to be an acceptable reliability coefficient.

Polychoric weighting approach consists of a maximum likelihood estimation to derive factor loadings from polychoric analysis. Let the reported attainment of well-being y_i is ordinal with categories $1,...,d_j$, then it is assumed that they are calculated by discretizing the underlying y_{ij}^* according to the set of thresholds $\alpha_{i1}, \ldots, \alpha_{i,dj-1}$.

$$Y_i = r \qquad if \qquad \alpha_{i,r-1} < Y_i^* < \alpha_{i,r} \qquad (3.1)$$

where

$$\alpha_{i,0} = -\infty, \qquad \alpha_{i,0} = \infty \qquad (3.2)$$

As outlined in Kolenikov and Angeles (2009), derivation of factor loadings from polychoric analysis consist of maximum likelihood estimation, and it is possible to recover the correlation between the starred variables. Thus, according to the set of thresholds these properties come from Kolenikov and Angeles (2009) and $\alpha_{i1}, \ldots, \alpha_{i,dj-1}$ the study calculates the underlying reported attainment of well-being y_{ij}^*. Define two variables, y_{11}^*, y_{12}^* with distribution:

$$\begin{pmatrix} y_{11}^* \\ y_{12}^* \end{pmatrix} \sim N\left(0, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right), -1 \le p \le 1 \qquad (3.3)$$

Thresholds for the variables are obtained by:

$$\alpha_{1,0} = -\infty < \alpha_{1,1} < \cdots < \alpha_{1,d_1-1} < \alpha_1, d_1 = \infty \tag{3.4}$$

$$\alpha_{2,0} = -\infty < \alpha_{2,1} < \cdots < \alpha_{2,d_2-1} < \alpha_2, d_2 = \infty \tag{3.5}$$

Maximizing over ρ and α, we obtain the polychoric correlation of y_{11} and y_{21}. The maximum likelihood estimate of ρ is obtained by maximizing: (See Kolenikov and Angeles (2009) for a detailed mathematical derivation of polychoric estimates.)

$$logL(\rho, \alpha; y) = \Sigma_{i=1}^{n} log\Pi(y_{11}, y_{12}; \rho, \alpha) \tag{3.6}$$

3.3 Dual Cut-Off Method: Classifying Who is Deprived

The next stage consists of a two-step procedure *(dual cut-off method)* which uses two different types of cut-offs that come from Alkire and Santos (2014) to determine who is deprived among the households (Alkire and Santos 2014). Households who are deprived in any well-being dimension are identified in the first step. Let z be the vector of deprivation lines for each of well-being dimensions, such that $z_j > 0$ represents the deprivation cut-off in dimension j. A matrix of deprivations $g^0 = [g_{ij}^0]$ is then defined, where a typical element is g_{ij}^0 defined by $g_{ij}^0 = w_j$ when $z_j > y_{ij}$ (Alkire and Santos 2014). That is, *ij*th entry of the matrix is equivalent to the dimensional weight, w_j when person i is deprived in dimension j (Alkire and Santos 2014). Vice versa, if individuals i's achievement in dimension j is greater then the deprivation cut off in dimension j, that person is not considered as deprived and *ij*th element takes the value of zero (Alkire and Santos 2014):

$$g_{ij}^0 = w_j \qquad if \quad z_j > y_{ij} \tag{3.7}$$

$$g_{ij}^0 = 0 \qquad if \quad y_{ij} > z_j \tag{3.8}$$

A multidimensional poverty index reflects the total number of deprivations as well as deprived household's experiences. But, what qualifies a household as multidimensionally poor? One could consider a household deprived in any of the thirteen indicators yet, one deprivation may not represent overall poverty (Alkire and Foster 2011). Therefore, the next step identifies which households should be considered as multidimensionally poor. From the matrix of deprivations, g^0, a column vector c that represents the deprivation counts is constructed whose *i*th entry $c_i = \Sigma_{j=1}^{d} g_{ij}^0$ represents the sum of weighted deprivations suffered by person i (Alkire and Foster 2011).

$$c = \begin{bmatrix} c_1 \\ c_2 \\ . \\ . \\ . \\ c_n \end{bmatrix} \tag{3.9}$$

Cross dimensional cut-off, represented by $k > 0$ is the sum of weighted indicators in which a household must be deprived to be identified as multidimensionally poor, and is applied across this column vector $c.k$, in other words, is a policy variable that governs the range of

simultaneous deprivations, each deprived household necessarily must have. As k goes up, the number of households who will be considered as deprived goes down, while the intensity of deprivations goes up. In a more conventional notation (Alkire and Foster 2011):

Let ρ_k, $\rho : \mathfrak{R}_+^d \times \mathfrak{R}_{++}^d \to (0, 1)$ be the identification function that maps from person i's achievement vector $y_i \in R_{++}^d$ and cut off vector z in $\mathfrak{R}_{++}^d$ to an indicator variable. Note that, $\rho_k(y_i, z)$ takes a value of 1 (if individual's weighted deprivation count is greater than or equal to k) or 0 depending on the vectors of achievements and deprivation cut-offs to finalize the identification process of the deprived households by counting the number of indicators a person is deprived in (Alkire and Foster 2011, p. 478).

$$\rho_k(y_i, z) = 1 \qquad c_i \geq k \tag{3.10}$$

$$\rho_k(y_i, z) = 0 \qquad c_i < k \tag{3.11}$$

Finally, the information about deprived individuals are aggregated into the population-wide measure MPI by censoring their deprivations. For this, a censored matrix that counts zero deprivations for those which are not identified as multidimensionally poor is used. In other words, a censored matrix counts $c(k) \to c_i(k) = c_i\rho(y_i, z)$ for $i = 1, \ldots, n$.[9] Thus, the average deprivation share across the deprived households can now be written as (Alkire and Santos 2014):

$$A = \Sigma_{i=1}^n \frac{c_i(k)}{dq} \tag{3.12}$$

The average of this fraction among those who are deprived (q), is precisely A; the intensity of multidimensional deprivation. H, on the other hand, represents the incidence of multidimensional poverty such that $H = \frac{q}{n}$ is the fraction of number of deprived people (q) and the population. Moreover, MPI, M_0 can also be expressed as the product of these two intuitive measures, $H \times A$. As a consequence, M_0 not only provides information on the incidence of deprivation, but also provides further insight in terms of the intensity of deprivation. This is indeed a very important advantage over any headcount ratio, since they generally do not reflect the intensity of deprivation.[10]

4 Results

4.1 Synergies Among Monetary, Multidimensional and Material Poverty: Investigating Overlap of Poverty Indicators

EU-SILC is chosen over household surveys such as the Understanding Society to enable an analysis of a direct comparison of the poverty incidence based on relative income poverty, material deprivation and that based on the multidimensional index. One of the principal questions that such an analysis would like to point out is the overlap between the three

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[9] Note that, c_i/d is the share of deprivations experienced by a deprived person i and represents the fraction of weighted indicators in which the poor person i is deprived.

[10] For a more detailed mathematical derivation, see Alkire and Foster (2011).

Table 3 Degree of overlap between measures (percentage, in total sample)

Weighting scheme	Cut-offs	EU material deprivation	Relative income poverty
Equal weights	5 indicators	88.11	79.04
	6 indicators	86.70	80.91
	7 indicators	85.48	81.63
	8 indicators	84.76	81.22
	9 indicators	84.46	81.22
Nested equal weights	(40%)	86.64	78.65
	(50%)	85.11	80.75
	(60%)	87.74	81.17
Polychoric weights	(50%)	87.95	76.02
	(60%)	87.54	79.04

measures.[11] Considering the households recognised as deprived by the three measures to be identical, the study's multidimensional measure can be considered as a good proxy for capturing overall well-being. Besides, such comparison on the basis of the degrees of overlap, not only provides meaningful insights in terms of consistency for the selected indicators to capture the actual level of well-being, but also ensures compatibility, and accordingly explores how well the novel measure matches the existing well-being measures over the entire panel (Acar 2014).

For the purpose of this analysis, relative income poverty is calculated for the entire sample in comparable terms that varies one-for-one with the standard of living; also the relative poverty threshold is defined as 60% of the median equivalised disposable income of the entire sample. The material deprivation measure is on a nine-item deprivation index referring to a state of economic strain and durables, defined as the enforced inability (rather than the choice not to do so) to pay unexpected expenses, afford a one-week annual holiday away from home, a meal involving meat, chicken or fish every second day, the adequate heating of a dwelling, durable goods like a washing machine, colour television, telephone or car, being confronted with payment arrears (mortgage or rent, utility bills, hire purchase instalments or other loan payments) (EUROSTAT 2018). Here, the respondents have been classified as being materially deprived where they experience an enforced lack at least three deprivation items (see also Nolan and Whelan 2011), then the study calculates material deprivation ratios for the entire sample, according to Eurostat's EU-material deprivation indicator.[12] To disentangle this further, households are disaggregated by respective cut-offs for each indicator, based to a large extent on international consensus to examine the overlap degree. Once again, it is important to mention that, the study has cautiously approached the idea of entrusting mathematical algorithms with a fundamentally normative task, therefore multiple cut-offs have been used to explore the sensitivity of the overall ranking in a similar line with Acar (2014).

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[11] See Acar (2014) for a detailed application on multidimensional poverty dynamics in Turkey with a particular focus on overlapping measures

[12] See Appendix, Sect. 6.1 for the methodology applied for the computation of the statistical indicators pertinent to the subject area of EU Material deprivation within the overall domain of income and living conditions.

Table 4 Deprivation headcount rates (percentage, across the sample)

Deprivation headcount rates	2008	2009
OECD relative income poverty	18.87	17.74
EU material deprivation	18.58	16.28
Multidimensional poverty		
Equal weights		
5 indicators	9.70	9.56
6 indicators	4.56	4.03
7 indicators	1.97	1.48
8 indicators	0.68	0.43
9 indicators	0.23	0.15
Nested equal weights		
40%	10.08	9.83
50%	2.88	1.83
60%	1.09	0.50
Polychoric weights		
40%	35.81	35.19
50%	18.03	17.18
60%	7.68	7.53

An in-depth analysis of the overlapping ratios between the first weighting scheme and EU material deprivation rate, Table 3 shows that in the matched data, over 84% (ranging between 84.46% and 88.11) of those who are multi-dimensionally poor are also materially deprived. In addition, as might be expected, the degree of overlap in the second weighting scheme is similar to that observed in the first, where a significant proportion of households that are multi-dimensionally poor also have an enforced lack of three material deprivation items. The degree of overlap between the third benchmark scheme (where indicators are weighted with the factor loadings of polychoric analysis) is also highlighted in the analysis. This finding indicates that, of those who are materially deprived on this measure, around 87% are also deprived on multiple life domains.

The degree of overlap between polychoric figures and relative income poverty achieves a match ratio between 76 and 79%, given the respective cut-offs. The overlap ratio between relative income poverty and the first two benchmark schemes is indicative of high consistency and ranges between 79–82 of the sample households. This evidences the comparability of these two indices for about 76–79% of the sample, in terms of assigning a similar status to a randomly drawn household from the sample. Overall, the study results reveal that there is no significant lack of overlap between the two measures since deprived/non-deprived status match ratios range between high 0.70 s to low 0.80 s of the sample households. This is a promising picture in terms of consistency for the indicators selected to capture deprivation on multiple life domains.

4.2 Overview of Multidimensional Poverty

In addition to being a crude deprivation measure, the headcount ratio reveals a comprehensive portrait of the levels and extent of deprivation in the UK, and as the numbers span both 2008 and 2009, they allow for trends to be tracked. Deprivations originating in the

UK appear to elicit a moderate impact, and the relevant statistics for the adjusted head-count ratios, across the study sample of UK households, have been reported in Table 4.

Trends in relative income poverty show that the proportion of the households with income below the median income poverty line experienced limited change over the period of interest. Moreover, the percentage of households in poverty declined from 18.87% in 2008 to 17.74% in 2009 across the study sample. As opposed to modest changes in relative income poverty, this pattern is more pronounced for EU material deprivation rates.[13] The pattern for multidimensional poverty is rather similar over the same period, irrespective of any cut-off used.

Multidimensional poverty indicators that are weighted with the factor loadings of poly-choric analysis have declined at a faster pace than the other two weighting schemes. Additionally, with the increase in the number of considered cut-offs, the proportion of the population identified as deprived normally shows a decrease. These findings indicate a change in the poverty with the use of diverse weighting schemes. However, the weighting scheme only matters in terms of levels of the rates, so the underlying trend does not change.

4.3 Empirical Application

This section seeks to explain multidimensional poverty as well as income poverty and material deprivation by socio-economic characteristics. Within the UK context and given the data available for the selected sample the following categories have been taken into account: the gender, age and its square,[14] education level, the marital status, and employment status. Another set of variables, which is used to capture household characteristics includes, household size, the composition of the household and number of children. Different characteristics of households that are closely related to earning capabilities are accounted for, as dummy variables that indicate whether households are home owners or recipients of social transfers (both individual and household level benefits). Then, the severity of hardship conditions experienced by the UK society has also been analysed to explore, if some socio-economic categories exhibit higher risks of experiencing poverty in multiple life domains. For this analysis, a random effect probit model is estimated for any and all weighting schemes by all the measures at the possible cut-offs, where the dependent variable is equal to zero if the person is not deprived, and one otherwise. First set of weights has been derived from factor loadings of polychoric analysis, and for sensitivity analysis, alternative weighting schemes weight indicators and dimensions equally are represented in Tables 8 and 9.

The probability of deprivation is dependent on many variables. Let Y_i is a binary variable equal to 1 if the ith individual is deprived, and 0 otherwise. Hence, the outcomes are presented by a binary indicator variable Y_i as follows:

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[13] This is highly possible due to 2008 financial crisis rather than any institutional change. Further decomposition analysis (Peng and Kang 2013) on the improvement of poverty could explain this change (either the well-being increase after the shock or the psychological recovery from the shock that improves the subjective well-being of respondents in the EU-SILC).

[14] Different specifications for the education and age variables are experimented. A specification with years of education, age and age squared proved the best fit for the data.

Table 5 Polychoric weighting scheme results

Poverty indicator Respective cut-off	Polychoric MPI 0.30	Polychoric MPI 0.40	Polychoric MPI 0.50	Polychoric MPI 0.60	EU material deprivation EUROSTAT	Relative income poverty OECD
Age	0.017***	0.027***	0.046***	0.058***	0.035***	− 0.015***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)
Age^2	− 0.000***	− 0.000***	− 0.001***	− 0.001***	− 0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	0.030*	0.050***	0.050**	0.072***	0.074***	0.055***
	(0.016)	(0.016)	(0.020)	(0.025)	(0.022)	(0.018)
Marital status	− 0.194***	− 0.273***	− 0.328***	− 0.313***	− 0.288***	− 0.174***
	(0.019)	(0.020)	(0.023)	(0.029)	(0.026)	(0.022)
Depratio	0.281***	0.013	− 0.047	− 0.184**	− 0.034	0.983***
	(0.061)	(0.058)	(0.064)	(0.078)	(0.069)	(0.067)
Years of schooling	− 0.055***	− 0.058***	− 0.059***	− 0.054***	− 0.078***	− 0.086***
	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.004)
Household size	0.012	− 0.006	0.005	0.004	− 0.058***	− 0.016
	(0.010)	(0.009)	(0.011)	(0.013)	(0.012)	(0.011)
Home ownership	− 0.633***	− 0.726***	− 0.757***	− 0.688***	− 0.932***	− 0.331***
	(0.022)	(0.020)	(0.022)	(0.027)	(0.024)	(0.022)
Individual benefit recipient	0.304***	0.398***	0.418***	0.511***	0.245***	0.319***
	(0.025)	(0.025)	(0.028)	(0.033)	(0.031)	(0.027)
Household benefit recipient	0.270***	0.377***	0.369***	0.355***	0.527***	− 0.115***
	(0.024)	(0.023)	(0.025)	(0.031)	(0.028)	(0.026)
Unemployment	0.494***	0.384***	0.263***	0.157**	0.388***	1.117***
	(0.079)	(0.065)	(0.064)	(0.071)	(0.066)	(0.061)
_cons	1.014***	0.121	− 0.817***	− 1.704***	− 0.297***	0.129
	(0.080)	(0.079)	(0.092)	(0.115)	(0.101)	(0.092)
N	40,328	40,328	40,328	40,328	40,328	40,328

Standard errors in parentheses

$*p < 0.10$; $**p < 0.05$; $***p < 0.01$

$$Y_i = \begin{cases} 1 \text{ if} & Y_i^* \quad \textit{deprived in multiple life domains} \\ 0 \text{ if} & Y_i^* \quad \textit{is non-deprived} \end{cases} \tag{4.1}$$

$$Pr(Y_i = 1 | X_i) = 1 - \Phi[-X_i' \theta],$$

$$Pr(Y_i = 0 | X_i) = \Phi[-X_i' \theta], \tag{4.2}$$

where Y_i^* is the deprivation indicator, Pr denotes probability, Φ is the Cumulative Distribution Function and X_i denotes above mentioned exogenous socio-demographic characteristics in the model. Table 5 presents the results of a probit regression model, which estimates the probability of experiencing multidimensional poverty, income poverty, as well as material deprivation. The first column reports the indicators, with the first four columns present results for the respective deprivation cut-offs. The last two columns refer respectively to the relative income poverty indicator and the EU material deprivation. As evident, explanatory variables have generally a significant impact. Findings suggest that further education, home ownership, and being married are associated with lower probabilities of being deprived on multiple life domains, whilst larger households, unemployment and being female increase the probability of experiencing multidimensional poverty.

Households are categorized by the marital status of the household head to document the relationship between marital status and multidimensional poverty. As regards the marital status; being single increases, *ceteris paribus*, which is the probability of experiencing income poverty and material deprivation. The current study analysis also reveals a significant effect on multidimensional poverty, suggesting that being married is associated with lower probabilities of being deprived on multiple life domains. The majority of studies fail to measure this effect with much precision, yet the direction of the marital status effect in this paper is in alignment with Anyanwu (2014) who shows that monogamous marriage is negatively and significantly correlated with the probability of being deprived on life domains. This is corroborated by Eggebeen and Lichter (1991), in their study findings that favour the married-couple families over singles, mainly because they are found to be less deprived than female-headed single parents. In the same spirit, a recent report by the Department of Work and Pensions (2017) reveals that the probability of experiencing poverty by single households are nearly twice as those in couple families. This outcome was recognised by Waite and Gallagher (2000) who showed that marriage increases the economic well-being of the family members, including children. The results suggest that demographic momentum is associated with a high and negative rising effect of household size on material deprivation. The position this analysis takes in that debate can have implications for policy, as it does not suggest a significant linkage between household size and multidimensional poverty.

In addition, the years spent in school appears to have a significant affect on relative income poverty, as well as EU material deprivation. In fact, results provide no particular surprises in the light of earlier research (see Raffo et al. 2007; Jencks 1979; Bowles and Gintis 2002) suggesting that respondents with lower educational attainment experience greater rates of deprivation. This finding can be potentially justified by a recent contribution by Kerr and West (2010) who show that schooling can lessen the impact of deprivation in the UK significantly. Another area of interest is to examine the distributive role played by the government through the provision of public services considering that socio-economic inequalities can be remitted through a synthesis of social service provision and in-kind benefits. At least from a static point of view, the level of government transfers to households are presumably concentrated towards the bottom of the distribution and

positively associated with MPI. Nevertheless, as these benefits are targeted at poor house-holds; this analysis claim no knowledge of the counter-factual, and it is likely that multidimensional poverty would have been higher in the absence of these government transfers.[15]

Gendered dimensions have also been taken into consideration, since one of the aims of this paper is to conceptualise poverty as multidimensional with many socio-economic contributing factors, including individual characteristics. As the analysis reveals, the gender gap exerts a significant and positive impact on the probability of being income poor and materially deprived, and women have higher risks of experiencing deprivation in multiple life domains. It is likely that a higher probability can be better captured by additional explanatory variables of the female households (i.e. labour market status, highest degree etc.). While confirming results from other studies (e.g., Lucchini et al. 2007; Moghadam 2005; Chant 2003), this outcome can also be justified by the evidence on the comparative social and material hardship of female vis-à-vis male-headed counterparts in the UK. Similarly, Buvinic and Gupta (1997) report females are over-represented among the poor.

Moreover, according to the results, the interdependence of multidimensional poverty and home ownership attainment over the period of interest is statistically significant and negative. Indeed, owner occupation has been found to decrease the probability of experiencing deprivation in multiple dimensions. In contrast to this study's findings, Castles (1998) found that well-being and home ownership did not match up perfectly. However, this outcome corroborates with that concluded by Kemeny (2005), and he confirmed that socio-economic distribution and the ownership distribution map onto each other. Consistent with this study results, Siminski and Saunders (2004) argues that home ownership has a positive effect on well-being. Of course, these results are suggestive rather than definitive, but they do point towards the hypothesis that the outcomes of multidimensional poverty are at least mediated by differences in owner-occupancy statutes. In fact, evidence from the UK considerably reaffirms the current study findings, since increases in owner occupation in the UK over the period 2000–2005 led to falls in relative measures of socio-economic inequality. Cowell et al. (2012) show that increases in owner occupation during 2000–2009 in the UK have led to substantial increases in wealth, particularly median wealth holdings and this had led to subsequent falls in relative measures of wealth inequality (Cowell et al. 2012). According to the results, the interdependence of relative income poverty and material deprivation with unemployment over the period of interest is found to be statistically significant and positive. These empirical findings are congruent with theoretical expectations in each case, and direction of the unemployment effect shows that unemployment is positively and significantly correlated with the probability of being deprived on multiple life domains. For a more comprehensive review, see Harding and Sue (1998) and Brown (1999).

5 Concluding Remarks

This paper aimed to provide an in-depth analysis of poverty in the UK, through an analysis of both deprivation in several life domains and deprivation as a composite, multidimensional phenomenon by building upon the multidimensional poverty measure proposed by

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[15] For the purpose of this analysis individual level benefits consists of: unemployment, old age benefits, survivors benefits, sickness benefits, disability benefits, education related allowances. Household benefits consist of: family children related allowances, housing allowances, social exclusion not elsewhere classified (income, other cash support, migrants, drug addicts, alcoholics).

Alkire and Santos (2010). The paper has explored a variety of dimensions, which are essential for designing up to date, functional poverty reduction policies. The indices represent a development on a flexible, policy focused methodology as proposed by Alkire and Santos (2010) in an effort to develop on a directly applicable framework that can accommodate different indicators, weights, and cut-offs not only for the UK, but also for any other country (Alkire and Santos 2010). A hybrid approach is used for the selected dimensions. They include the widely used income dimension, congruently with four dimensions and thirteen indicators drawing from existing evidence in the UK: living standards, housing conditions and access to healthcare systems. A broad set of measures is estimated, ranging from raw headcount ratios by the indicator and the multidimensional headcount ratio with different deprivation cut-offs. This study contributes to the growing body of literature portraying multidimensional poverty in a range of contexts by analysing three alternative weighting schemes: (1) one in which each indicator receives the same weight that corresponds to Alkire and Foster (2011) which by assuming that dimensions are independent, allows the measure to be broken down into contributions of each dimension (once the identification has been applied) (2) a nested weighting structure where each dimension has the same weight and each variable has the same weight within each dimension (3) another set of weights derived from factor loadings of polychoric analysis. Correspondingly, the number of deprivation dimensions as well as the items to include in each of them are not determined *ex ante*, on the basis of subjective assumptions of the researcher, but are selected on the basis of the actual degree of deprivation in the data (Decancq and Lugo 2013).

According to Ravallion (2011), undertaking such an analysis enables: (1) improvements in the targeting of different deprivations and the relative burden of deprivations affecting households; (2) the targeting, coordination and flexibility of interventions to achieve better outcomes for people facing deprivation in multiple life domains (Ravallion 2011). From the analysis, it can be inferred that in the matched data, nearly 80% of those who are income poor are also multidimensionally poor. As might be expected, the degree of overlap is similar to that observed in relative income poverty, where nearly 75% of those who are materially deprived are also multi-dimensionally poor. Such systematic comparisons not only ensure compatibility, but also provide a meaningful insight in terms of consistency for the selected indicators, capturing the severity of the deprivation (Acar 2014). The outcomes of this overlapping ratio analysis are encouraging, since there is no significant lack of overlap between MPI and the existing deprivation indicators. This paper opens several lines of debate in terms of policy implications and measures to monitor well-being in the UK. The following conclusions can be drawn.

The prevalent, popular view of owner occupation is one that relates tenure with upscale households suggesting that owner occupancy is associated with lower probabilities of being deprived on multiple dimensions. This also carries along with the need to be cautious on policies to alleviate household deprivation do not, negligently, dismiss areas of home ownership. Alternatively, larger household size has a positive effect on the probability of being materially deprived. However, the direction of causality between multidimensional poverty and household size remains ambiguous, as it does not appear to be a elicit a significant affect on the probability of being deprived in multiple life domains. The findings also suggests attention need to be given to gendered dimensions, and the extent of gendered inequality should not remain under-addressed.

As far as marital status is concerned, the results suggest that, compared to married couples, singles have especially higher probabilities of being deprived in multiple life domains. Furthermore, as far as further education is concerned, less educated and non-working sample have generally a higher probability of being deprived in multiple life domains. This not

only confirms the need to focus on the education dimension but also, implies the need of an efficient anti-poverty game plan in the UK, which includes the advancement of skills and education.

Appendix

EU Material Deprivation Rate: Economic Strain and Durables Dimension

This section utilises the properties presented in Eurostat Glossary's material deprivation section (EUROSTAT 2018). The material deprivation rate is a measure in EU-SILC that demonstrates the inability to afford at least three of the nine life dimensions (k) that are considered as necessary and desirable to lead a decent lifestyle. The nine dimensions (k) of multidimensional poverty available in the EU-SILC, which correspond to the concept of material deprivation as outlined in the study are:

- to pay their rent, mortgage or utility bills;
- to keep their home adequately warm;
- to pay unexpected expenses;
- to eat a meal involving meat, chicken or fish every second day;
- to afford a one-week annual holiday away from home;
- a television set;
- a washing machine;
- a car;
- a telephone.

Here, the respondents have been classified as being materially deprived where they experience an enforced lack at least three deprivation items ((N ITEM $\leq$4). Let N be the total number of items that a person of the population, cannot afford to pay, with N ranging from 0 to 3. Thus, the weight variable used is the Adjusted Cross Sectional Weight (RB050a), and j takes the values: 0, 1, 2, 3.

Material deprivation rate broken down by each combination of dimensions (k) (DEPR TOT$_k$) is calculated as the percentage of people (or thousands of people) in each k who cannot afford to pay N ITEM of material deprivation items. In a more conventional notation:

$$DEPR \quad TOT_k = \frac{\displaystyle\sum_{\forall i \ at \ k \ where \ N \ ITEM=j} RB050a_i}{\displaystyle\sum_{\forall i \ at \ k} RB050a_i} \times 100 \tag{6.1}$$

$$DEPR \quad TOT_k = \frac{\displaystyle\sum_{\forall i \ at \ k \ where \ N \ ITEM=j} RB050a_i}{1000} \tag{6.2}$$

Reliability and Validity of the Selected Indicators: Cronbach's Alpha

See Table 6.

Table 6 Cronbach estimates

Item	Obs	Sign	Item-test correlation	Item-rest correlation	Interitem covariance	Alpha
Leaking	40,328	+	0.3893	0.2159	0.0388	0.7770
Crime	40,328	+	0.3629	0.1876	0.0413	0.7814
Pollution	40,328	+	0.3002	0.1205	0.0472	0.7918
Holiday	40,328	+	0.6627	0.5382	0.0125	0.7224
Warm	40,328	+	0.4590	0.2949	0.0319	0.7639
Meat	40,328	+	0.4565	0.2914	0.0323	0.7646
Dental care	40,328	+	0.3248	0.1500	0.0418	0.7623
Medical care	40,328	+	0.3077	0.1308	0.0431	0.7847
Ends meet	40,328	+	0.6170	0.4820	0.0168	0.7322
Arrears loans	40,328	+	0.4540	0.2998	0.0327	0.7654
Unexpected expenses	40,328	+	0.6730	0.5512	0.0155	0.7200
Arrears	40,328	+	0.4419	0.2874	0.0330	0.7659
Housing burden	40,328	+	0.4701	0.3088	0.0308	0.7617
Test scale					0.0327	0.7817

Dimensions of Deprivation

See Tables 7, 8 and 9.

Table 7 Dimensions of deprivation

Dimensions	Indicator	Deprived if ...
Ability to keep home adequately warm	Can your household afford to keep its home adequately warm?	the household cannot keep its home adequately warm
Capacity to afford a nutritious meal every other day	Can your household afford a meal with meat or vegetarian equivalent every second day?	the household cannot afford a nutritious meal every other day, regardless if the household wants it
Leaking roof, damp walls, floors or rot in window frames; the condition of the dwelling	Do you have any of the following problems with your accommodation?Leaking roof/damp walls/rot in window frames or floor	the dwelling has a problem with a leaking roof and/or damp ceilings, dampness in the walls, floors or foundation or rot in window frames and doors
Pollution, grime or other environmental problems	Are there pollution, grime or other environmental problems in the local area?	the respondent feels pollution, grime as a problem for the household
Crime, violence, vandalism in the area	Do you have crime, violence, or vandalism in the local area?	the respondent feels 'crime, violence or vandalism' to be a problem for the household
Leisure activity	Can your whole household afford to go for a week's annual holiday, away from home?	at least one household member cannot afford to go for holidays
Ability to make ends meet	Thinking of your household's total income, is your household able to make ends meet,namely, to pay for its usual necessary expenses?	the respondent's assessment of the level of difficulty experienced by the household in making ends meet is with great difficulty/ with difficulty/with some difficulty
Capacity to face unexpected financial expenses	Can your household afford an unexpected required expense and pay through its own resources?	the household cannot face itself unexpected financial expenses such as surgery, funeral, major repair in the house, or replacement of durables like washing machine, car
Arrears on hire purchase instalments or other loan payments	In the last twelve months, has the household been in arrears on hire purchase instalments or other loan payments? difficulties?	the household has been unable to pay on time repayments for hire purchase or other non-housing loans
Unmet need for medical examination or treatment when you really needed	Was there any time during the past 12 months when you really needed to consult a specialist but did not?	there was at least one occasion when the person really needed treatment but did not receive it
Unmet need for dental examination or treatment	Was there any time during the past 12 months when you really needed to consult a dentist but did not?	there was at least one occasion when the person really needed dental treatment but did not receive it
Arrears on mortgage or rent payments	In the last twelve months, has the household been in arrears?	the household has been unable to pay on time the rent and/or the mortgage payment for the main dwelling as result of lack of money
Financial burden of the total housing cost	To what extent are your housing costs including mortgage repayment or rent a financial burden to you?	housing costs are a heavy burden/slight burden/somewhat a burden

Table 8 Alternative weighting scheme 1: equally weighted dimensions

Indicator / Deprivation cut-off	MPI 5 indicators	MPI 6 indicators	MPI 7 indicators	MPI 8 indicators	MPI 9 indicators	Relative income poverty OECD	EU material deprivation EUROSTAT
Age	0.055***	0.064***	0.076***	0.077***	0.056***	0.035***	− 0.015***
	(0.004)	(0.005)	(0.007)	(0.011)	(0.016)	(0.004)	(0.003)
Age^2	− 0.001***	− 0.001***	− 0.001***	− 0.001***	− 0.001***	− 0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	0.075***	0.079***	0.052	0.089	0.253**	0.074***	0.055***
	(0.024)	(0.030)	(0.041)	(0.061)	(0.100)	(0.022)	(0.018)
Marital status	− 0.354***	− 0.320***	− 0.351***	− 0.452***	− 0.373***	− 0.288***	− 0.174***
	(0.028)	(0.036)	(0.049)	(0.075)	(0.127)	(0.026)	(0.022)
Depratio	− 0.160**	− 0.300***	− 0.342***	− 0.546***	− 0.521*	− 0.034	0.983***
	(0.074)	(0.093)	(0.124)	(0.182)	(0.289)	(0.069)	(0.067)
Years of schooling	− 0.056***	− 0.045***	− 0.026***	− 0.011	0.009	− 0.078***	− 0.086***
	(0.005)	(0.007)	(0.009)	(0.013)	(0.020)	(0.005)	(0.004)
Household size	0.022*	0.010	0.003	0.002	− 0.137***	− 0.058***	− 0.016
	(0.012)	(0.015)	(0.020)	(0.029)	(0.052)	(0.012)	(0.011)
Home ownership	− 0.700***	− 0.670***	− 0.544***	− 0.458***	− 0.359***	− 0.932***	− 0.331***
	(0.026)	(0.033)	(0.045)	(0.069)	(0.111)	(0.024)	(0.022)
Individual benefit recipient	0.451***	0.477***	0.527***	0.475***	0.539***	0.245***	0.319***
	(0.032)	(0.039)	(0.050)	(0.071)	(0.109)	(0.031)	(0.027)
Household benefit recipient	0.371***	0.345***	0.365***	0.425***	0.576***	0.527***	− 0.115***
	(0.030)	(0.038)	(0.051)	(0.077)	(0.124)	(0.028)	(0.026)
Unemployment	0.215***	0.224***	0.177*	0.130	− 0.423	0.388***	1.117***
	(0.068)	(0.077)	(0.095)	(0.131)	(0.277)	(0.066)	(0.061)
_cons	− 1.553***	− 2.202***	− 3.062***	− 3.722***	− 3.662***	− 0.297***	0.129
	(0.109)	(0.141)	(0.192)	(0.286)	(0.436)	(0.101)	(0.092)
N	40,328	40,328	40,328	40,328	40,328	40,328	40,328

Standard errors in parentheses

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

Table 9 Alternative weighting scheme 2: nested equally weighted dimensions

MPI	wdep020	wdep030	wdep040	wdep050	wdep060
Respective cut-off	0.20	0.30	0.40	0.50	0.60
Age	0.025***	0.033***	0.049***	0.060***	0.053***
	(0.003)	(0.003)	(0.004)	(0.007)	(0.010)
Age^2	− 0.000***	− 0.000***	− 0.001***	− 0.001***	− 0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	0.046***	0.042**	0.050**	0.037	0.082
	(0.016)	(0.017)	(0.024)	(0.039)	(0.059)
Marital status	− 0.217***	− 0.273***	− 0.291***	− 0.313***	− 0.372***
	(0.019)	(0.021)	(0.028)	(0.047)	(0.074)
Depratio	− 0.101*	− 0.156***	− 0.471***	− 0.516***	− 0.781***
	(0.058)	(0.060)	(0.074)	(0.116)	(0.168)
Years of schooling	− 0.067***	− 0.072***	− 0.052***	− 0.029***	− 0.019
	(0.003)	(0.004)	(0.005)	(0.009)	(0.013)
Household size	0.058***	0.043***	0.056***	0.064***	0.055**
	(0.009)	(0.010)	(0.012)	(0.018)	(0.026)
Home ownership	− 0.680***	− 0.742***	− 0.685***	− 0.617***	− 0.505***
	(0.020)	(0.020)	(0.026)	(0.043)	(0.066)
Individual benefit recipient	0.356***	0.339***	0.462***	0.387***	0.425***
	(0.025)	(0.026)	(0.032)	(0.049)	(0.070)
Household benefit recipient	0.307***	0.383***	0.404***	0.292***	0.599***
	(0.022)	(0.023)	(0.030)	(0.049)	(0.080)
Unemployment	0.490***	0.424***	0.250***	0.339***	− 0.023
	(0.068)	(0.064)	(0.068)	(0.087)	(0.136)
_cons	0.327***	− 0.158*	− 1.536***	− 2.640***	− 3.223***
	(0.078)	(0.083)	(0.108)	(0.177)	(0.262)
N	40,328	40,328	40,328	40,328	40,328

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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