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Multidimensional poverty measurement for EU-SILC (European Union Statistics on Income and Living Conditions) countries

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Abstract: This paper presents a set of experimental indices of multidimensional poverty, using cross-sectional EU-SILC data. EU-SILC is a natural source of data for this measurement work, given its provenance, frequency and comparability. The indices use the Alkire Foster (AF) methodology – a flexible methodology which can accommodate different indicators, weights and cut-offs. The AF methodology underlies the global Multidimensional Poverty Index (MPI) which is released by UNDP's *Human Development Reports* and covers over 100 countries, as well as official national measures of multidimensional poverty. In constructing the indices we review the joint distribution within and among potential indicators of multidimensional poverty such as work, income, material deprivation, health, education, and social factors. We also draw on existing comparable indicators that have been constructed with the EU-SILC data, as well as on similar recent multidimensional poverty measures. The time series data enables an analysis of multidimensional poverty dynamics, including analysis of which changes in overall poverty and in indicators are statistically significant across time. The paper also presents sensitivity and robustness tests for the cut-offs and weights, as well as comparisons with other unidimensional and multidimensional indicators currently in use.

Key words: Multidimensional Poverty, counting measures, material deprivation, multidimensional poverty dynamics

JEL classification: I3, I32, D63

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1.   Introduction

Methodologies of multidimensional poverty measurement that draw on the 'counting' approach have been used in policy applications since the 1970s (Townsend 1979; see Atkinson 2003 and the references therein), and are gaining greater momentum (Erikson 1993, Callan *et al.* 1999, Atkinson 2003, Chakravarty and D'Ambrosio 2006, Alkire and Foster 2011a). To date many studies have focused on understanding the structure among deprivations, and on identifying the normative, policy, and statistical tools that can best justify the collection of data on distinct indicators (Atkinson *et al.* 2002; Atkinson *et al.* 2005, Atkinson and Marlier 2010 and the references therein). Others have focused on statistical methods used to justify why indicators might be aggregated into a composite indicate covering one relevant dimension such as material deprivation (Guio et al 2012; OECD 2008). Drawing upon such studies, this paper will present a set of experimental indices of multidimensional poverty which use a counting-based dual-cut-off methodology M_0 (Alkire and Foster 2011a, 2011b). We show how these measures can be used to provide diverse and specific descriptive analyses, hence why they may complement existing measurement approaches.

The methodology is flexible in that different indicators, cut-offs and weights can be used, including cardinal, ratio-scale, binary, ordinal and categorical variables. Unlike the headcount ratio which has been traditionally used with counting-based measures, the AF family of measures incorporate the joint distribution of deprivation by providing a new feature of *intensity* – which shows the percentage of dimensions in which the average poor person is deprived. Incorporating intensity into the measure itself enables the multidimensional poverty measure to be broken down by indicator (after identification), to show the levels and composition of deprivations poor people experience. This is not possible with headcount ratios based on the counting approach. Where data permit, the measure and each of its consistent indicators can be further broken down by gender, age, social groups or regions. The global Multidimensional Poverty Index (MPI) which is released by UNDP's *Human Development Reports* and covers 109 countries is based on this methodology (Alkire and Santos 2010; UNDP 2010). It is also used in official national measures of multidimensional poverty, for example in Colombia and Bhutan.

Such a measure has been implemented already using the 2009 EU-SILC (European Union Statistics on Income and Living Conditions) dataset (Whelan et al 2012). This paper extends Whelan, Nolan and Maitre's work by constructing AF poverty measures across time periods 2006-2010, using, necessarily, a more limited set of indicators. In doing so, we demonstrate the analysis of the multidimensional poverty indicator in one period and across time, by headcount, intensity, and indicator. It is important to note that limitations of data availability and coverage, as well as the inability in this draft to compute standard errors or address all sample size degradation issues, mean that the value-added of this analysis is as yet not empirical. Rather, its contribution is to show the kinds of policy analyses that could be done using this methodology, were a set of dimensions and indicators to be fully justified, and were fully consistent variable definitions to be used.

The paper proceeds as follows. Section 2 briefly situations our topic in the literature; Section 3 presents the AF methodology. Section 4 introduces a set of four experimental indices of multidimensional poverty, using cross-sectional EU-SILC

data, and shows the total deprivations ('raw headcount ratios') that are generated across each country using the component indicator definitions. It also identifies the countries that are dropped due to non-response or missing time series. Section 5 presents the AF results, first showing the poverty cut-off for each decile to illustrate the likely robustness of analyses. Choosing a poverty cut-off for illustrative purposes, it then presents the overall results of the four measures in 2006, describing each and drawing attention to the advantages and disadvantages of aggregating component indicators for analyses of this class of measures. Section 5.3 then presents the findings across time, 2006-2010. The section also analyses the extent to which poverty reduction in each country occurred by reducing the percentage of people who are poor and the extent to which the intensity – or average proportion of deprivations experienced by poor people – was reduced. As the measure is on the individual level, some preliminary decompositions by gender and age are provided. Section 6 concludes.

In addition to demonstrating the kind of analyses that can be undertaken, the paper also mentions the sensitivity and robustness tests for the cut-offs and weights that could be completed. Robustness results are not presented as the standard errors have not been computed in this draft.

2.   Literature Review

Multidimensional approaches to poverty and deprivation have a long and distinguished history in conceptual and philosophical work (Sen 1992). In terms of policy, the late 1960s and early 1970s saw the entrance of policy applications, with the 1968 Swedish Level of Living Study (Johannsen 1973, Allardt and Uusitalo 1972); Jacques Delors' 1971 *Les indacateurs sociaux* and P.Ch. Ludz *Materialien zum Bericht zur Lage der Nation* (1971) each providing independent impetus in different countries and across Europe for this effort.

In more recent literature, significant attention has been paid to the relationship among deprivations, to ways of communicating these, and to methodologies to validate indicators used in composite or multidimensional indices (Nolan and Whelan 1996, 2010, Callan et al 1993; Gordon et al 2003; Atkinson *et al.* 2002; Calandrino 2003; Saunders and Adelman 2006; Layte et al 200, Whelan 2007, OECD 2008). Drawing on the 2004 EU-SILC data, Guio and Maquet (2006) proposed a multidimensional indicator of Material Deprivation, which reflected deprivations such as poor housing, lack of durable assets, and an inability to afford to meet basic needs. The indicator was designed to be comparable across time and across the EU and most member states, and to provide meaningful trend data showing improvements in material deprivation over time. Whelan (2007) used the Irish component of the 2004 EU-SILC dataset to develop an 11-item 'consistent poverty' index; and Whelan and Maître (2008) use a range of statistical methods such as correlation and factor analysis; goodness of fit tests like root mean square error of approximation; and reliability tests like Cronbach's Alpha, to identify three dimensions of material deprivation (consumption, household facilities, and neighbourhood environment) and examine their relationship to income poverty. Coromaldi and Zoli (2012) clarify the value-added of non-linear principal component analysis, NLPCA, to these techniques. Guio et al. (2012) provide a systematic exposition of an expanded range of techniques to justify a new material deprivation index using the 2009 EU-SILC dataset. An interesting set of parallel papers explores

similar questions with respect to child poverty (Bradshaw 2009, Gabos et al 2011, Guio et al 2012, and Adamson 2012). Naturally, this deep analysis of the structure of deprivations resulted in a set of empirical and policy studies on the relationship between income and other deprivations (Verbist and Lefebure 2008, Whelan and Maitre 2009, Jana et al 2012) and also gave rise to applied multidimensional measures (Whelan et al 2012).

The EU-SILC dataset has also been used by academic studies to illustrate multidimensional poverty measurement methodologies (Chakravarty and D'Ambrosio 2006; Bossert, et al 2009, among others). Brandolini (2007) explored Atkinson's (2003) counting approach using data for France, Germany and Italy and a headcount ratio associated with the minimum proportion of deprivations a person has, and comparing the various deprivation measures with income poverty measures. They drew attention to the sensitivity of cross-national comparisons to weights, and also to the sensitivity of results to the deprivation cut-off.

This paper adds to this already significant recent literature by illustrating the rich variety of analyses that can be accomplished using one particular methodology, drawing on four experimental measures which differ in the number of dimensions and indicators and in their definition and weights.

3. AF methodology
This section briefly introduces the class of M_α measures developed by Alkire and Foster (AF) that built on the FGT index, using the notation found in other works (Alkire and Foster 2011a). The four experimental measures use the M_0 methodology in this class.

Consider poverty in *d* dimensions across a population of *n* individuals. Let $y = \left[y_{ij} \right]$ denote the $n \times d$ matrix of achievements for *i* persons across *j* dimensions.

The typical entry in the achievement $y_{ij} \geq 0$ represents individual *i*'s achievement in dimension *j*. Each row vector $y_i = (y_{i1}, y_{i2}, ..., y_{id})$ gives individual *i*'s achievements in each dimension, whereas each column vector $y_{\cdot j} = (y_{1j}, y_{2j}, ..., y_{nj})$ gives the distribution of achievements in dimension *j* across individuals. To weight the dimensions, define a weighting vector *w* whose j^{th} element w_j represents the weight that is applied to dimension *j*. We set $\sum_{j=1}^{d} w_j = 1$, that is, the dimensional weights sum to one.

The M_0 measurement methodology can be summarized as follows. Let $z_j > 0$ be the deprivation cut-off in dimension *j*, and *z* be the vector of deprivation cut-offs. Define a matrix of deprivations $g^0 = [g_{ij}^0]$, whose typical element is defined by $g_{ij}^0 = w_j$ when $y_{ij} < z_j$, and $g_{ij}^0 = 0$ when $y_{ij} \geq z_j$. From the g^0 matrix construct a column vector *c* of *deprivation intensity*, whose i^{th} entry $c_i = \sum_{j=1}^{d} g_{ij}^0$ represents the sum of the entries in a given row, and represents the weighted deprivations suffered by person *i*.

Next, we identify who is multidimensionally poor. A poverty cut-off k is selected, such that $0 < k \leq 1$, and is applied across column vector c. A person is identified as poor if their weighted deprivation score $c_i \geq k$. This can be called a *dual cut-off* identification method, because it uses the *deprivation* cut-offs z_j to determine whether a person is deprived or not in each dimension, and the *poverty* cut-off k to determine who is to be considered multidimensionally poor. This identification strategy can also be represented, following Bourguignon and Chakaravarty (2003) using an *identification function* $\rho: R_+^d \times R_{++}^d \rightarrow \{0,1\}$, which maps from person i's achievement vector $y_i \in R_+^d$ and cut-off vector z in R_{++}^d to an indicator variable in such a way that $\rho(y_i; z)=1$ if person i is poor and $\rho(y_i; z)=0$ if person i is not poor.

Having identified the poor, construct a second matrix $g^0(k)$, obtained from g^0 by replacing its ith row g_i^0 with a vector of zeros whenever $c_i < k$. This matrix contains the weighted deprivations of exactly those persons who have been identified as poor and *excludes* deprivations of the non-poor. M_0 is the mean of the matrix $g^0(k)$. That is $M_0 = \mu(g^0(k))$, where μ denotes the arithmetic mean operator.

M_0 can also be expressed as the product of the (multidimensional) headcount ratio (H) and the average deprivation share among the poor (A). H is simply the proportion of people that are poor, or q/n where q is the number of poor people. A is the average of fraction of deprivations poor people experience $- A = \sum_{i=1}^{n} c_i(k)/q -$ and reflects the average *intensity* of multidimensional poverty.

M_0 satisfies a number of useful axioms, specifically: replication invariance, symmetry, poverty focus, deprivation focus, weak monotonicity, non-triviality, normalisation, dimensional monotonicity, subgroup decomposability and weak re-arrangement (Alkire and Foster 2011a). These axioms are joint restrictions on the identification and aggregation methodologies. If data are cardinal, other measures within the M_α family can be computed. These measures can reflect the depth and severity of multidimensional poverty, and satisfy other axioms related to monotonicity and transfer. However these are beyond the scope of this paper because most of the EU-SILC variables are not cardinally meaningful.

For tracking changes across time, different approaches are possible. Naturally the single-period poverty measures and their associated partial indices can be directly compared. Further, one can compute the changes over time due to changes in headcount, in intensity, and in a (usually vanishingly small) interaction term (Apablaza and Yalonetzky 2011). Shapley value decompositions can be used to show the percentage of poverty reduction which can be attributed to a reduction in headcount vs intensity, and to reveal, further, the percentage of change in national poverty that can be attributed to changes in each individual indicator (Roche 2013, Alkire and Roche 2013). Where relevant and feasible, the decomposition can include how poverty is changed due to demographic changes (including internal or external migration), for example when decomposing by geographic regions within a country.

4. Data and Indicators

As is well known, in 2001, the Laeken European Council endorsed a set of 18 indicators of social inclusion for Europe which were subsequently refined,

consolidated and extended, using normative, statistical, and policy reasoning. Atkinson et al. (2005) traces how this process led to the agreement of common social indicators related to deprivation, housing and services, which in turn gave rise to common survey instruments. The European Union Statistics on Income and Living Conditions (EU-SILC) was developed precisely to compare deprivation and social exclusion across European countries. Data are available annually from 2005. The datasets provide harmonized individual and household level information for income as well as social indicators such as labour, health, housing and the lived environment.

This paper selects an illustrative set of indicators and draws upon others' analyses of the properties of the EU-SILC variables. The illustrative measures are limited by variable definition (comparable variables must be present across time periods and must be accurate at the unit (household or individual) level rather than only on average) as well as by data availability (missing values in any variable must be low). Hence we are not able to implement the improved material deprivation index (Guio *et al.* 2012), nor to replicate Whelan *et al.* (2012) multidimensional poverty measures, because both draw on variables that are present from the 2009 dataset but not in previous periods. However we do draw upon indicators related to (but not identical to) the EU2020 multidimensional poverty indicator or its components in all measures.

4.1. Unit of Analysis: Individual

The measures that follow combine individual and household level information, and identify all individuals as multidimensionally poor or non-poor based on their own achievements in these indicators for which this information is available and household achievements otherwise.

It can be useful to signal at once that there are different units of analysis possible using the EU-SILC dataset. Here we use the individual as a unit of analysis. That is, the individual's achievements in health, education and work are used to identify their own deprivations; household level variables are used for income, material deprivations, and housing, noise, crime and pollution. This way of proceeding is very useful because the resulting measures can be disaggregated by gender and age. Furthermore, one can study the clustering of deprived people by household. However given present datasets, this approach generates a larger sample drop because of missing variables, particularly in the health domain. Furthermore, normatively it overlooks (and does not foster) intra-household sharing. For example having a chronic disability in a household which can effectively care for one is very different than having the same health condition and living alone. Some policy aims require a household focus.

It is also possible to use the household as a unit of analysis. In this case, a household would be deprived in work, education, and health indicators depending upon the joint deprivations of those household members (which could or could not include children) for whom data were available. This method – which was used for example in the global MPI – has an advantage in terms of missing data because if available data identify a household as deprived then all members can be included even if there are missing data for some members. However the household identification was not implemented in these experimental measures, in part because,

it was not clear how household definitions and comparability vary across Europe. Also, the appropriate 'cut-off' for household level indicators built with individual education and health data would require separate analysis.[2] Finally, in the EU-context, social rights tend to be individually based. For that reason, in the experimental measures the individual is taken as a unit of analysis, with the consequence of having larger sample size reductions.

4.2. Dimensions and Indicators of Deprivation

The experimental indices have three to six dimensions. The three dimensions are health, education, and living standards – dimensions which are present in nearly every treatment of poverty (Appendix 1). Drawing on the arguments provided in Whelan et al (2012) and Guio and Maquet (2006), measure B adds to these a dimension of the living environment, which includes both housing and neighbourhood considerations such as noise or safety. Finally, measure A includes these but separates out the three 'dimensions' of the EU-2020 poverty index, drawing on the claims of the distinct importance of each of these deprivations that motivate this multidimensional approach to poverty.

In this case, dimensions are seen as organising concepts which may govern the weights attached to indicators, or which may be used to communicate the results in public, but which do not enter the calculation of poverty measures directly. Once again, the discussion of the appropriate dimensions to organise the measurement of deprivation has a long history, which can inform present discussions. These measures, being experimental, do not require an extensive normative justification of the dimensions drawing on people's own values, as well as the theoretical literature, the policy purpose of the measure, and other considerations. Such an extensive justification is provided in the case of official multidimensional poverty measures. Appendix one provides a set of dimensions and in some cases indicators that have been used in the European context (see also Atkinson *et al* 2002).

The indicators of these measures are naturally data constrained. EU-SILC indicators tend to be defined in the space of resources, in the case of income, material deprivation or housing – or common proxies for functionings, such as levels of schooling and employment status. Some draw upon self-assessments – for example, evaluations of noise and safety – which may not reflect the objective risk of violence or noise vibrations in a neighbourhood. If a measure is intended to reflect deprivations in the functionings or capabilities that poor people experience (Sen 1992), then it would be necessary to examine in what way each indicator could be interpreted to proxy functionings and the anticipated accuracy of such proxies for

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[2] The options for household cut-offs are very clear, but require normative, policy, and empirical exploration to justify. They can be set based on a 'counting' approach across household members; alternatively achievements of household members can be aggregated and the average considered. Each has significant implications. For example, a household can be considered deprived in education, for example, if a) one household member has not attained a certain educational level; b) no one in the household has attained a certain educational level; c) at least one-third of household members have not attained a certain level, or d) if the average achievement level across household members is less than some threshold. Of course, households differ in kind as well as by cultural or geographical group: nuclear or extended families differ from student houses and migrant workers sharing accommodation, and the assumptions of intra-household sharing must be considered for each household type.

diverse individuals. Rather than doing so, in this case we draw upon the rich existing literature justifying the EU-SILC indicators (Atkinson and Marlier 2010).

Tables 4 to 7 provide detailed descriptions of each of the component indicators of the experimental measures and their deprivation cut-offs. Several notes may be in order. First, other measures have not necessarily included the education variable, perhaps due to country differences in the definition of levels of education. For now these measures retain it, and consider a person to be deprived if they have not completed primary school, but the accuracy and comparability of this indicator remain problematic.

The material deprivation indicator here differs from others. Recall that Guio et al. (2009) and the subsequent material deprivations had used a cut-off of three out of nine indicators. In more recent work (Guio et al. 2012, Atkinson et al 2010), both the variables and the cut-offs have been re-assessed using the 2009 EU-SILC dataset. Both authors advise some changes, including an upward revision of the cut-off to four out of nine indicators (as well as modification of those indicators). In this paper we have taken a mixed approach: we have retained the original Material Deprivation indicators to enable comparability across time, but increased the cut-off to four out of nine. This indicator thus is no longer the EU-2020 indicator.

In terms of employment, our indicator again diverges from the EU-2020 standards thus the country rates cannot be compared with the published EU-2020 rates from EU-SILC data. In each of the four measures an individual is deprived if he/she is unemployed or permanently disabled or/and unfit to work. He/she is also deprived if he/she is employed less than 30 hours due to personal illness, disability or because he or she cannot find a job(s) or work(s).

The income indicator follows the EU-2020 standards, and considers a person at risk of poverty (AROP) if their household income is less than 60% of the national median income.

4.3. Non-Response

The issue of missing values affects our selection of countries. The EU-SILC data are adjusted for non-response using sampling weights (Eurostat, 2010). In this analysis, we have adopted a rigorous approach and eliminated from the sample any individual who has any missing value in any indicator. Sample size drops are reported in Table 1, below. Because of this, we have dropped Denmark, Estonia, Finland, Iceland, the Netherlands, Norway, Sweden, and Slovenia (DK, EE, FI, IS, NL, NO, SE, and SI respectively) from all subsequent analysis.[3] We also note that we do not have all five periods of EU-SILC data for Malta, Romania, or Bulgaria thus we exclude them from the inter-temporal analyses. Our subsequent analysis is thus restricted to eighteen countries across five periods of time. Note that in the current draft, the 2008 results must be considered with caution while we are double-checking the match of individual and household level data.

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[3] In most analyses it is also necessary to test for bias analysis in the restricted versus the full sample; this is not done as our emphasis in this paper is to illustrate a measurement methodology.

Table 1: Non-Response and Missing Values across deprivation indicators

	2006	2007	2008	2009	2010
AT	1%	1%	0%	0%	0%
BE	7%	10%	5%	2%	3%
BG		21%	2%	2%	1%
CY	2%	2%	2%	2%	1%
CZ	9%	9%	12%	15%	19%
DE	5%	5%	3%	2%	2%
DK	52%	52%	51%	54%	52%
EE	0%	1%	15%	23%	26%
ES	7%	6%	7%	7%	7%
FI	59%	59%	53%	52%	52%
FR	3%	7%	3%	3%	3%
GR	4%	4%	3%	3%	3%
HU	1%	1%	4%	3%	4%
IE	2%	2%	2%	3%	3%
IS	59%	58%	59%	57%	58%
IT	0%	4%	5%	4%	4%
LT	2%	2%	19%	17%	17%
LU	3%	2%	2%	3%	4%
LV	0%	0%	0%	1%	2%
MT				2%	4%
NL	50%	50%	49%	48%	48%
NO	50%	50%	52%	51%	51%
PL	5%	6%	7%	8%	8%
PT	16%	16%	16%	15%	15%
RO		5%	2%	2%	2%
SE	56%	56%	54%	52%	54%
SI	65%	65%		64%	63%
SK	1%	1%	3%	3%	2%
UK	10%	10%	12%	12%	11%

4.4.   Non-overlapping deprivations (raw headcounts)

The descriptive percentages of deprivations in all indicators used across the four experimental measures are reported in Table 2 below. The table includes all deprivations of all individuals for whom no data on any indicator is missing.

There are several points to note. First, the income percentages roughly match those published in other sources (Nolan et al 2010, 1992).[4] Second, of the three European

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[4] We are grateful to Brian Nolan and Bernard Maitre for direction in constructing this variable

poverty measures – income, material deprivation and labour, deprivations in labour are often the highest and those in income tend to be lower, which affects the effective weights of these deprivations. Third, the nine material deprivations which are used to construct the material deprivation index have tremendous variations in incidence, with many indicators having deprivations for less than 3% of the population, and others for over 25%. The indicators that tend to have the highest incidence are perceptual data of whether ends meet, as well as the self-reported capacity to afford various expenses like holidays, heating, and eating high – protein foods. However this varies considerably across countries. The challenges inherent in the education and health indicators have been discussed sufficiently elsewhere; here we merely remind the reader again that educational deprivations depend in part upon the definition of primary school, and the duration thereof varies across the included countries. Finally, across the environmental indicators we see variation in each, and across them, but less variation overall than in many of the other indicators.

Table 2: Raw Headcounts of all deprivations, 2006 EU-SILC data

	Income	Mat Dep	Labour	EU Multi	Holiday	Meat	Expense	Car	Col. TV	Washer	Telephone	Heating	Ends Meet	Education	SR Health	Chron Health	Ltd Health	Housing	Noise	Pollution	Crime
AT	12.0%	8.1%	36.7%	46.3%	6.6%	9.1%	25.5%	4.9%	0.3%	0.6%	0.1%	3.7%	34.4%	1.1%	7.8%	21.9%	27.6%	10.2%	18.8%	7.7%	12.0%
BE	13.1%	9.1%	31.4%	42.1%	8.8%	3.4%	18.1%	5.6%	0.3%	1.6%	0.1%	12.8%	35.0%	15.0%	7.2%	23.6%	21.6%	14.0%	22.5%	15.7%	17.6%
CY	16.3%	23.5%	26.3%	45.0%	18.6%	6.5%	43.2%	2.1%	0.0%	0.8%	0.1%	34.5%	77.1%	24.9%	8.7%	28.2%	18.6%	34.9%	36.6%	25.0%	12.7%
CZ	8.7%	17.6%	29.3%	44.0%	10.0%	16.1%	39.2%	13.0%	0.4%	0.6%	1.9%	9.1%	68.1%	0.2%	13.4%	29.8%	26.2%	20.4%	18.9%	19.2%	13.8%
DE	11.8%	7.8%	32.2%	43.3%	6.7%	10.1%	36.0%	5.8%	0.6%	0.6%	0.3%	4.7%	20.1%	3.2%	9.1%	37.6%	29.8%	13.8%	26.8%	23.0%	12.0%
ES	17.7%	7.6%	26.7%	40.9%	15.1%	3.5%	28.0%	4.2%	0.1%	0.3%	0.4%	8.2%	59.1%	31.3%	10.3%	21.9%	20.5%	16.6%	27.3%	17.2%	19.9%
FR	12.4%	8.4%	32.7%	43.6%	12.2%	5.7%	31.9%	3.7%	0.3%	1.0%	0.7%	5.9%	54.0%	23.8%	9.5%	34.4%	22.5%	11.6%	19.5%	15.8%	16.1%
GR	19.7%	14.4%	36.5%	51.9%	23.6%	7.6%	30.4%	9.5%	0.2%	2.0%	0.5%	11.8%	80.3%	35.7%	8.3%	19.1%	16.2%	20.5%	20.6%	17.4%	8.5%
HU	14.0%	33.6%	29.9%	56.6%	19.7%	27.5%	51.4%	22.5%	0.8%	3.6%	2.9%	15.3%	81.5%	8.1%	20.3%	35.6%	29.6%	26.8%	17.2%	13.1%	9.9%
IE	17.3%	7.7%	27.1%	39.2%	9.0%	2.2%	35.8%	9.6%	0.2%	0.8%	0.3%	3.5%	55.4%	21.9%	3.1%	25.3%	19.2%	14.6%	14.4%	8.5%	16.1%
IT	18.7%	9.8%	38.1%	51.1%	17.8%	5.7%	26.9%	2.8%	0.4%	0.4%	1.2%	10.1%	74.7%	26.7%	10.4%	21.4%	22.8%	21.9%	25.1%	21.6%	14.9%
LT	19.3%	40.0%	25.2%	56.6%	21.3%	24.0%	57.9%	21.7%	2.0%	9.2%	4.4%	28.6%	78.1%	9.6%	16.9%	32.3%	27.5%	27.9%	20.0%	14.1%	7.8%
LU	12.4%	1.8%	32.9%	42.0%	4.4%	1.7%	16.8%	1.2%	0.1%	0.2%	0.1%	0.6%	16.7%	29.0%	7.2%	23.7%	23.3%	14.1%	23.0%	17.7%	11.5%
LV	22.5%	48.3%	27.8%	62.6%	25.4%	32.4%	69.4%	34.0%	1.7%	9.4%	3.9%	25.1%	83.8%	3.7%	19.3%	35.0%	33.7%	31.7%	20.8%	32.1%	25.8%
PL	17.8%	39.7%	23.6%	58.6%	23.0%	28.6%	57.1%	22.9%	1.1%	1.3%	3.1%	28.9%	80.4%	20.4%	17.2%	32.3%	21.1%	41.2%	19.8%	12.9%	8.8%
PT	15.3%	13.9%	23.1%	40.2%	24.7%	2.9%	13.7%	8.7%	0.3%	2.1%	2.9%	37.0%	74.4%	54.5%	14.0%	25.6%	22.6%	17.2%	26.2%	21.1%	12.7%
SK	10.7%	33.4%	26.1%	52.3%	13.6%	36.9%	48.7%	27.5%	0.9%	1.0%	2.1%	9.8%	81.5%	1.4%	18.0%	27.3%	29.4%	6.3%	19.7%	19.6%	8.2%
UK	17.7%	6.2%	30.1%	41.0%	6.7%	4.3%	25.9%	4.3%	0.1%	0.5%	0.2%	4.5%	35.9%	0.0%	6.5%	38.0%	22.1%	12.9%	21.9%	13.2%	27.4%

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This paper emphasises measurement and analysis rather than the structure of deprivations, so associations across dimensions are not studied. Simply for reference, we present below correlations across the binary deprivation indicators found in measure B in the year 2006. As is evident, these have the expected structure with higher intra-correlations among the health indicators and otherwise relatively low correlations. Similar findings pertain for measures C and D. Note however that pollution and crime have a negative correlation with education, indicating that these deprivations may be higher among those who are not educationally deprived. This may suggest the existence of adaptive preferences among the less educated, and/or a different frame of reference or higher aspirations among the more educated. As we shall see, the censoring process used to construct a poverty measure may effectively address this problem.

Table 3: Correlations across key indicators

Dimensions:		Income	Material Deprivation	Labour	Education	Self-Reported Health	Chronic Illness	Limited Activities	Housing	Noise	Pollution	Crime
EU2020	Income	1.00										
	Material Deprivation	0.28	1.00									
	Labour	0.16	0.18	1.00								
Education	Education	0.13	0.15	-0.01	1.00							
Health	Self-report	0.11	0.23	0.13	0.17	1.00						
	Chron. Illness	0.06	0.13	0.12	0.14	0.43	1.00					
	Limited Activity	0.10	0.18	0.14	0.18	0.50	0.62	1.00				
Environment	House	0.11	0.19	0.06	0.08	0.11	0.07	0.09	1.00			
	Noise	0.01	0.06	0.03	0.00	0.03	0.04	0.04	0.11	1.00		
	Pollution	0.00	0.06	0.01	-0.01	0.03	0.04	0.04	0.10	0.39	1.00	
	Crime	0.02	0.06	0.04	-0.02	0.03	0.05	0.04	0.09	0.24	0.26	1.00

4.5. Definition of Experimental Measures: Dimensions, Indicators, Cut-offs and Weights

Having described the deprivations, we now set out the experimental measures that are implemented. Four measures are constructed, called A,B,C, and D. Measures A and B are constructed to illustrate measures having larger number of, and variety of, indicators and dimensions. Measures C and D, are simpler, and share the same three dimensions and only vary in one dimension, in fact, in the sense that in measure C the three living standard indicators are entered singly, and in measure D a person who is deprived in any of them is identified as deprived in a composite measure. The four measures are computed and reported for all time periods to analyse changes across time. All four measures include the three dimensions of the

EU2020 multidimensional poverty index: income poverty (framed as being at risk of poverty); material deprivation; and long-term unemployment. All four measures also include three health indicators: self-reported health, the presence of a chronic illness, and activity limitations due to poor health. The first and second measures include an additional dimension of living environment comprising four indicators: housing, pollution, crime and noise. Tables 4-7 below specify the indicators and cut-offs.

The four experimental measures vary in the weights ascribed to the indicators, and in the degree of aggregation among the variables. In measure A, each of the 20 indicators is entered individually, illustrating fine-tuned decomposition possibilities. The weights are nested such as to give the three EU-2020 poverty indicators taken together 50% of the entire weight, and to share the remaining 50% between three dimensions: health, education, and the lived environment.

Measure B aggregates the material deprivation index following Guio et al (2009), but otherwise enters each indicator separately. It has four dimensions, each weighted at 25%: EU-2020 poverty, health, education, and environment.

Measure C drops the environment and retains three equally-weighted dimensions (EU-2020 poverty, health, and education), entering the three EU-2020 indicators in separately, as well as two health indicators and one for education, all using nested weights. Finally, measure D aggregates the EU-2020 indicators into the sub-index, and has merely four indicators: EU-2020 poverty, health, or education deprivations.

Note that across the four indicators, the relative weight on the EU-2020 indicators varies from 25% (measure B) to 50% (A), with two measures having 33% (C&D).

Table 4: Measure A

Dimension	Indicator	Cut-off: A individual/household is not deprived if...	Weight	
EU2020-income	Equivalized disposable income	Equivalized disposable income is above 60% of median income	1/6	**1/6**
EU2020-Material Deprivation	Capacity to afford one week of holidays	Capacity to afford one week of holidays	1/54	**1/6**
	Capacity to afford meal with meat, chicken, fish or vegi equivalent	Capacity to afford meal with meat, chicken, fish or vegi equivalent	1/54	
	Capacity to face unexpected expenses	Capacity to face unexpected expenses	1/54	
	the respondent has a car	the respondent has a car	1/54	
	the respondent has a colour TV	the respondent has a colour TV	1/54	
	the respondent has a washing machine	the respondent has a washing machine	1/54	
	the respondent has a telephone	the respondent has a telephone	1/54	
	Capacity to keep home adequately warm	Capacity to keep home adequately warm	1/54	
	Ability to make ends meet	Ability to make ends meet	1/54	
EU2020-Labor	Activity status	the respondent is employed, in training or fit to work	1/6	**1/6**
	Reasons for working less than 30 hours	the respondent is voluntarily laid off		
Education	Highest educational level attained	the respondent has above pre/primary education level degree	1/6	**1/6**
Health	Self-declared status	the respondent answered their health is fair or above	1/18	**1/6**
	Long-standing illness	without chronic illness	1/18	
	Limitation in daily activities	without any limitation in daily life	1/18	
Environment	Leaking roof, damp walls, rot in window frames or floor	without leaking roof, damp walls/floors/foundations and rot in window frames or floor	1/24	**1/6**
	Noise from neighbourhood or from the street	without noise from neighbourhood or street	1/24	
	Pollution, grime or other environmental problems	without pollution, grime, unpleasant smells or polluted water	1/24	
	Crime, violence or vandalism in the area	without violence or vandalism in the local area	1/24	

Table 5: Measure B

Dimension	Indicator	Cut-off: A individual/household is not deprived if...	Weight	
EU-2020	Equivalized disposable income	Equivalized disposable income is above 60% of median income	1/12	**1/4**
	Material Deprivation 3 out of 9	the respondent is deprived in less than 3 out of 9 indicators	1/12	
	Activity status	the respondent is employed, in training or fit to work	1/12	
	Reasons for working less than 30 hours	the respondent is voluntarily laid off		
Education	Highest educational level attained	the respondent has above pre/primary education level degree	1/4	**1/4**
Health	Self-declared status	the respondent answered as fair or above	1/12	**1/4**
	Long-standing illness	without chronic illness	1/12	
	Limitation in daily activities	without any limitation in daily life	1/12	
Environment	Housing	without leaking roof, damp, walls/floors, foundations and rot in window frames or floor	1/16	**1/4**
	Noise	without noise from neighbourhood or street	1/16	
	Pollution	without pollution, grime, unpleasant smells or polluted water	1/16	
	Crime	without violence or vandalism in the local area	1/16	

Table 6: Measure C

Dimension	Indicator	Cut-off: A individual/household is not deprived if...	Weight
EU2020-income	Equivalized disposable income	Equivalized disposable income is above 60% of median income	**1/9**
EU2020-Material Deprivation	Capacity to afford one week of holidays		**1/9**
	Capacity to afford meal with meat, chicken, fish or vegi equivalent		
	Capacity to face unexpected expenses		
	the respondent has a car	the respondent answered deprived less than 3 out of 9 dimensions	
	the respondent has a colour TV		
	the respondent has a washing machine		
	the respondent has a telephone		
	Capacity to keep home adequately warm		
	Ability to make ends meet		
EU2020-Labor	Activity status	the respondent is employed, in training or fit to work	**1/9**
	Reasons for working less than 30 hours	the respondent is voluntarily laid off	
Education	Highest educational level attained	the respondent has above pre/primary education level degree	**1/3**
Health	Self-declared status	the respondent answered as fair or above	**1/9**
	Long-standing illness	without chronic illness	**1/9**
	Limitation in daily activities	without any limitation in daily life	**1/9**

Table 7: Measure D

| Dimension	Indicator	Cut-off: A individual/household is not deprived if...	Weight
EU2020	Equivalized disposable income above 60% median level	the respondent is not deprived in any of the three dimensions	1/3
	Having less than 3 out of 9 material deprivation		
	Employed or fit to work		
Education	Highest educational level attained	the respondent has above pre/primary education level degree	1/3
Health	Self-declared status	the respondent answered as fair or above	1/9
	Long-standing illness	without chronic illness	1/9
	Limitation in daily activities	without any limitation in daily life	1/9

5. Results

This section presents the results for four measures across five periods. The comprehensive tables underlying this analysis are not attached to this paper due to space limitations, but relevant tables could be appended.

5.1. *Identification of multidimensional poverty*

The first step to construct results is to identify who is poor. AF dual-cut-off methodology identifies a person to be poor if the weighted sum of deprivations is greater than or equal to the poverty cut-off. It censors the deprivations of the non-poor, in order to focus attention strictly on the poor. Information on the total deprivations (raw headcounts) is retained and can be considered later, for inter-temporal analyses in particular. Having identified the poor, the methodology then aggregates information regarding the poor into an overall poverty measures.

In this experimental index, we first calculate the poverty measuring using all range of poverty cut-offs from 1% to 100%, for all measures in all periods. We display the results, for example, using ten such cut-offs, from 10% to 100% for Measure A in the year 2010. Without the standard errors we cannot assess first order dominance, but we can see clearly that in the relevant range of poverty cut-offs – for example from 30% to 50% in measures A, C, and D (20-50% in measure B) – there are some pairwise comparisons of country ranking which are clearly either not robust or are very close and likely to be indistinguishable with standard errors. Thus it is likely to be useful to group the EU-SILC countries into several groups and assess robustness to different country groups (see for example Ura, Alkire, Wangdi and Zangmo 2012).

Figure 1: Measure A Adjusted Headcount Ratio (M_0) per country by poverty cut-off in 2010
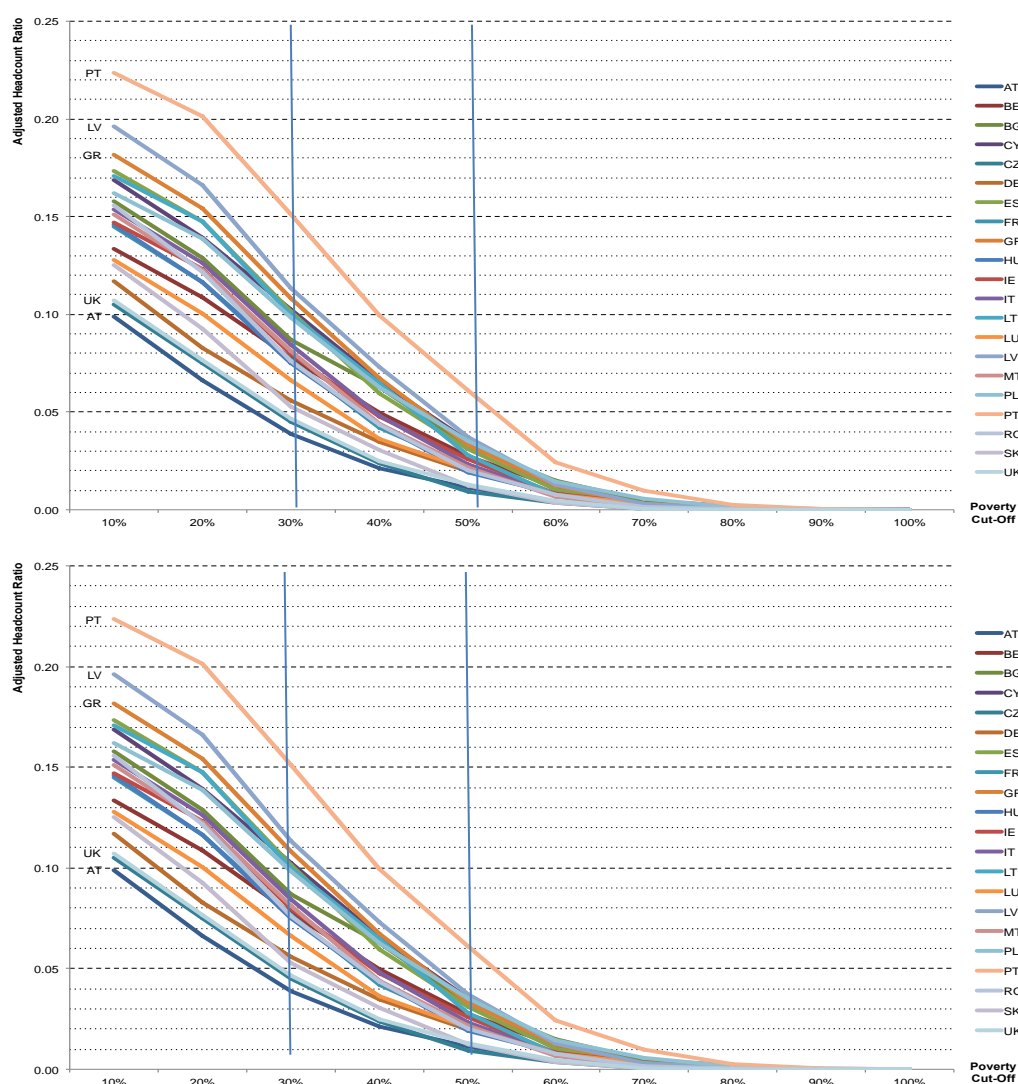
Naturally, some deprivations may not indicate poverty. A person who formally never finished primary schooling and remains uneducated may have won the lottery so not be poor. Also, some deprivations may be due to non-sampling error: a person who has not formally completed primary school may have been home-schooled, so their official level of schooling is a poor proxy for their educational attainment.

In what follows we have selected poverty cut-offs which require a person to be poor in strictly greater than one dimension or the equivalent sum of weighted deprivations drawn from several dimensions. This definition assures that each person identified as poor is indeed deprived in two or more dimensions, which coheres with the idea of 'multidimensional' poverty.[5] We also report findings for all measures when the poverty cut-offs are 50%.

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[5] We are grateful to Tony Atkinson for suggesting that this conceptual issue needs to be addressed and, when the purpose of the measure permits, satisfied.

5.2. *Poverty across countries, 2010 (M_0, H, A, contribution, raw and censored headcounts)*

This section presents and discusses the four measures' results in the year 2010. To make comparisons we select a given poverty cut-off for each measure. For each measure, we present the M_0 poverty value as well as its associated indices: the prevalence or percentage of the population identified as multidimensionally poor for a given cut-off (H), and the intensity, or average percentage of weighted deprivations experienced by poor people (A).

From Table 8 below, we see first of all that each of the four measures, which differ in weights and indicators, generate relatively similar country rankings. Kendal tau b rank correlations across the 18 countries range from 0.67 to 0.87, which suggest that more detailed robustness tests may find the measures to be relatively robust changes in indicators and weights.[6] The levels of poverty provided by measure D tend to be highest, followed by measure B and C; while measure A tends to have the lowest levels, but there are exceptions. In all four measures, Portugal has the highest poverty rates. Austria, the UK, the Czech Republic and Germany have the lowest poverty rates in all four measures.

Table 8: Measures A-D, 2010, k=34%/26%

2010	Measure A, k=34%			Measure B, k=26%			Measure C, k=34%			Measure D, k=34%		
	M0	H	A	M0	H	A	M0	H	A	M0	H	A
AT	0.03	0.07	0.45	0.05	0.13	0.38	0.03	0.05	0.54	0.06	0.11	0.58
BE	0.07	0.14	0.47	0.10	0.22	0.44	0.09	0.15	0.58	0.12	0.19	0.66
CY	0.09	0.18	0.47	0.14	0.30	0.46	0.12	0.21	0.59	0.17	0.25	0.67
CZ	0.04	0.08	0.44	0.05	0.14	0.37	0.03	0.07	0.49	0.07	0.11	0.59
DE	0.05	0.10	0.47	0.06	0.17	0.39	0.04	0.07	0.53	0.07	0.12	0.58
ES	0.08	0.18	0.46	0.12	0.28	0.43	0.12	0.21	0.56	0.16	0.25	0.63
FR	0.06	0.14	0.45	0.11	0.25	0.43	0.10	0.18	0.57	0.14	0.22	0.62
GR	0.09	0.20	0.46	0.14	0.30	0.45	0.13	0.22	0.59	0.16	0.23	0.69
HU	0.06	0.13	0.45	0.09	0.22	0.41	0.07	0.14	0.54	0.13	0.21	0.62
IE	0.07	0.14	0.46	0.09	0.20	0.43	0.09	0.16	0.57	0.14	0.21	0.64
IT	0.07	0.16	0.45	0.11	0.25	0.43	0.10	0.17	0.57	0.13	0.20	0.64
LT	0.09	0.19	0.45	0.10	0.23	0.43	0.09	0.17	0.57	0.15	0.23	0.64
LU	0.06	0.12	0.45	0.10	0.24	0.42	0.09	0.17	0.55	0.12	0.20	0.63
LV	0.09	0.20	0.47	0.12	0.31	0.41	0.08	0.16	0.53	0.15	0.24	0.61
PL	0.08	0.18	0.47	0.12	0.25	0.45	0.12	0.20	0.60	0.17	0.25	0.67
PT	0.13	0.28	0.47	0.21	0.44	0.47	0.21	0.35	0.60	0.26	0.37	0.70
SK	0.04	0.10	0.44	0.06	0.17	0.38	0.04	0.09	0.50	0.09	0.15	0.59
UK	0.04	0.08	0.45	0.05	0.13	0.37	0.02	0.05	0.49	0.07	0.12	0.56

In table 8 we have arbitrarily set the poverty cut-off such that each person is identified as poor if they are deprived in strictly more than one dimension. In Table 9 below we provide the poverty figures for a considerably higher cut-off of 50%. As expected, the levels of poverty are lower in all countries and the average deprivation share or intensity is higher (the higher poverty cut-off entails identifying as non-poor those persons who deprivation scores less than 50%). We see that the Portugal once again remains the poorest, and that Austria, the Czech Republic, the UK are among the least poor. The choice of a poverty cut-off should be normative. But in what follows we use the lower poverty cut-off without normative justification, because

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[6] For measures of robustness to weights and cut-offs see Alkire et al 2010; Ura et al 2012.

it shows greater variation across countries and so is convenient for the illustrative analyses that follow.

Note that the intensity factor varies relatively little across countries – only a four per cent variation in both measures. However notice also that intensity tends to be highest in the countries with highest poverty – a finding that has been noted elsewhere also.

Table 9, below, provides those findings for a higher poverty cut-off in each measures, corresponding therefore to lower incidence, intensity, and poverty measures for each country.

Table 9: Measures A-D, 2010, k=50%

| 2010	Measure A, k=50%			Measure B, k=50%			Measure C, k=50%			Measure D, k=50%		
	M0	*H*	*A*	*M0*	*H*	*A*	*M0*	*H*	*A*	*M0*	*H*	*A*
AT	0.01	0.02	0.58	0.01	0.02	0.59	0.02	0.03	0.01	0.05	0.08	0.63
BE	0.03	0.05	0.60	0.04	0.07	0.59	0.06	0.09	0.00	0.11	0.16	0.70
CY	0.04	0.06	0.57	0.07	0.11	0.60	0.09	0.14	0.00	0.15	0.20	0.74
CZ	0.01	0.02	0.58	0.01	0.01	0.56	0.01	0.02	0.00	0.06	0.09	0.63
DE	0.02	0.03	0.59	0.02	0.03	0.59	0.02	0.03	0.00	0.06	0.09	0.63
ES	0.03	0.05	0.58	0.05	0.08	0.58	0.08	0.13	0.00	0.13	0.19	0.69
FR	0.02	0.04	0.59	0.04	0.07	0.58	0.07	0.11	0.00	0.11	0.16	0.68
GR	0.03	0.06	0.59	0.06	0.11	0.59	0.10	0.15	0.00	0.15	0.20	0.72
HU	0.02	0.03	0.59	0.03	0.05	0.59	0.04	0.06	0.00	0.11	0.17	0.66
IE	0.03	0.04	0.58	0.03	0.06	0.58	0.06	0.10	0.00	0.11	0.17	0.69
IT	0.02	0.04	0.58	0.05	0.08	0.59	0.07	0.11	0.00	0.11	0.15	0.71
LT	0.03	0.05	0.57	0.04	0.07	0.57	0.07	0.10	0.00	0.13	0.18	0.69
LU	0.02	0.04	0.59	0.04	0.06	0.57	0.06	0.09	0.00	0.10	0.14	0.69
LV	0.04	0.06	0.58	0.04	0.06	0.58	0.05	0.08	0.00	0.13	0.20	0.64
PL	0.04	0.06	0.60	0.06	0.10	0.59	0.09	0.13	0.00	0.15	0.21	0.72
PT	0.06	0.10	0.60	0.11	0.19	0.60	0.16	0.24	0.00	0.24	0.32	0.74
SK	0.01	0.02	0.58	0.01	0.02	0.55	0.02	0.03	0.00	0.07	0.12	0.63
UK	0.01	0.02	0.58	0.01	0.01	0.56	0.01	0.02	0.00	0.05	0.09	0.59

After censoring the deprivations of non-poor people, these measures can be broken down by indicator. Figure 2 provides the percentage contribution of each indicator of poverty measure A in the year 2010, using k=34%. The countries are ranked from those having highest rates of poverty to those with lowest rates.

We can notice visually that the material deprivation indicator – here represented by the small stripes on the left hand side(MD1-MD9) – tend to have a variation in the direct contribution of each indicator to poverty, which we anticipated upon seeing the raw headcounts but need to reverify in the censored headcounts reflected here. Note that we can see each of the indicators of material deprivation precisely because they are *not*, in measure A, aggregated using a counting approach into a sub-indicator. When indicators are entered directly, as in measure A, the M_0 poverty measure can be decomposed down to component indicators. When they are aggregated into a sub-index, this is not possible (it can be done, but changes in each indicator may not affect the overall poverty measure). Thus one further point to consider alongside the tests of validity and reliability when assessing whether to aggregate indicators into a sub-index, is whether it is necessary for policy purposes to track changes in each individual indicator over time. If it is, then there may be an argument for entering indicators directly into a higher order multidimensional measure, as it enables a

direct consideration of them in analysing the composition of poverty or, as we shall see, their contribution to changes in poverty over time. On the other hand, clearly it is more challenging to interpret an index with many subcomponents. If each indicator is of less individual importance – as perhaps may be the case in material deprivation, where a 'counting' approach across indicators permits deprivations in some but not all aspects – then there is a strong argument for the development of well-constructed sub-indices.

Note also that in this measure A there are six equally-weighted dimensions. However the percentage contribution of education in particular varies greatly across countries, raising questions again about its accuracy. However note that in general in the least poor countries the relative contribution of educational deprivations is lower and labour deprivations are relatively higher. In contrast, the environmental indicators, which appear on the far right, show relatively less variation across countries as a group.

Figure 2: Dimensional Breakdown Model A with k=34%, 2010
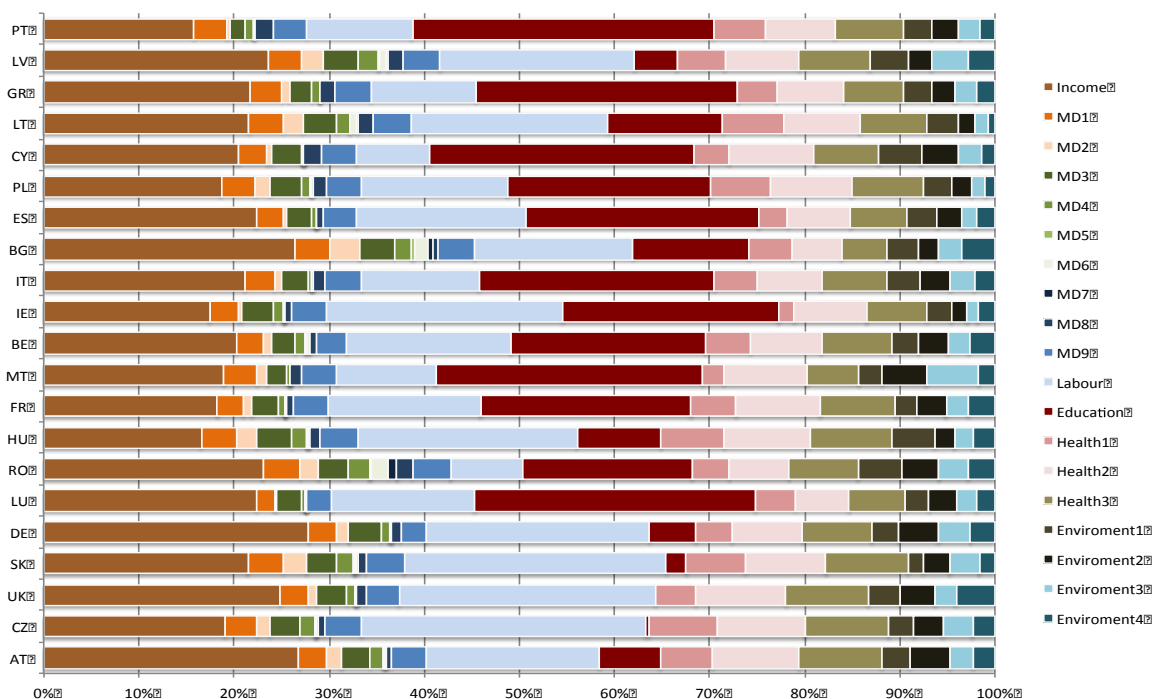
In Figure 3 below, we can compare two similar measures using 2010 data. Measure C and D have the same indicators, cut-offs and weights. However in the case of measure C, the income, material deprivation, and labour deprivations are entered directly; in the case of measure D, in a separate extra counting step, each person is identified as deprived in a multidimensional sub-index if they are deprived in any one of the three indicators.

In both graphics of Figure 3, the countries are ranked from low to high poverty, left to right. As we can see, in measure C the relative contribution of labour, material deprivation decline as overall poverty in a country increases, as do the relative contributions of the health variables. The educational deprivations' contribution to multidimensional poverty increases strikingly in the poorer countries. In measure D,

there is a similar although less marked trend. The aggregated labour-income-material deprivation variable has a higher contribution to overall poverty, because its headcount, being the union of the three indices, is higher than the average deprivation of the three indices which is reflected in measure C. With a sub-index there is also, as was mentioned above in the case of the material deprivation indicators in measure A, an inability to decompose the sub index down directly to the component indicators, so a separate analysis is required.

Figure 3: Per cent Contribution Measures C&D k=34%, 2010
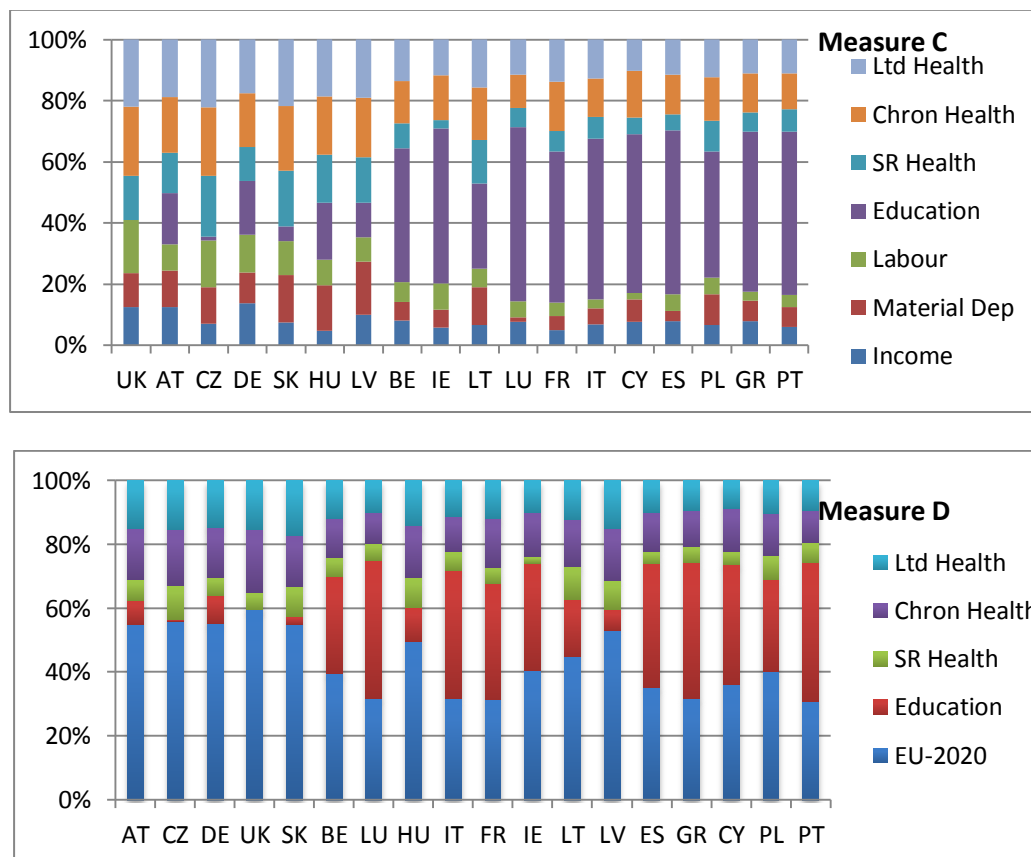
Naturally the composition of poverty is affected both by the rates of deprivations in each indicator and also by the weights applied to it. It can also therefore be useful to view the levels of deprivation in each indicator individually, separately from the weights. To do this we construct censored headcount ratios, which show the percentage of people who are identified as poor and are deprived in each particular indicator. Note that the poverty measure M_0 is merely the simple average of the weighted censored headcounts – that is, the sum of the censored headcounts of each indicator, where censored headcount is multiplied by its respective weight.

Figure 4 below provides the raw and censored headcounts of three countries: Austria, Poland and Portugal, using Measure B (k=26%) in 2010. Necessarily, the censored headcounts are equal to or lower than the raw headcounts. The difference between these shows whether some persons who are deprived in that indicator are not simultaneously deprived in enough other indicators to be identified as multi-dimensionally poor. For example, in all indicators, the difference between raw and censored headcounts is particularly noticeable in relation to chronic health, and

health limitations as well as noise, crime and pollution. In this way the poverty cut-off may be used to 'clean' the observations of deprivations that do not signify poverty – in some cases because they may reflect varying frames of reference (noise), or standards (housing). Note also that the deprivations with the highest weight (Income, labour, education) have relatively less differences between raw and censored headcounts than the others because one requires fewer additional indicators to be identified as poor. Of these three, the differences between raw and censored headcounts in income tend to be larger, but this is not a fixed rule.

This section has illustrated the basic analyses of multidimensional poverty measures and their partial indices; the appended tables provide comprehensive results for all measures across all years, with varying poverty cut-offs. The next section analyses the changes in poverty across time.

Figure 4: Raw & Censored Headcount Ratios, Austria, Poland and Portugal, Measure B, 2010, k=26%
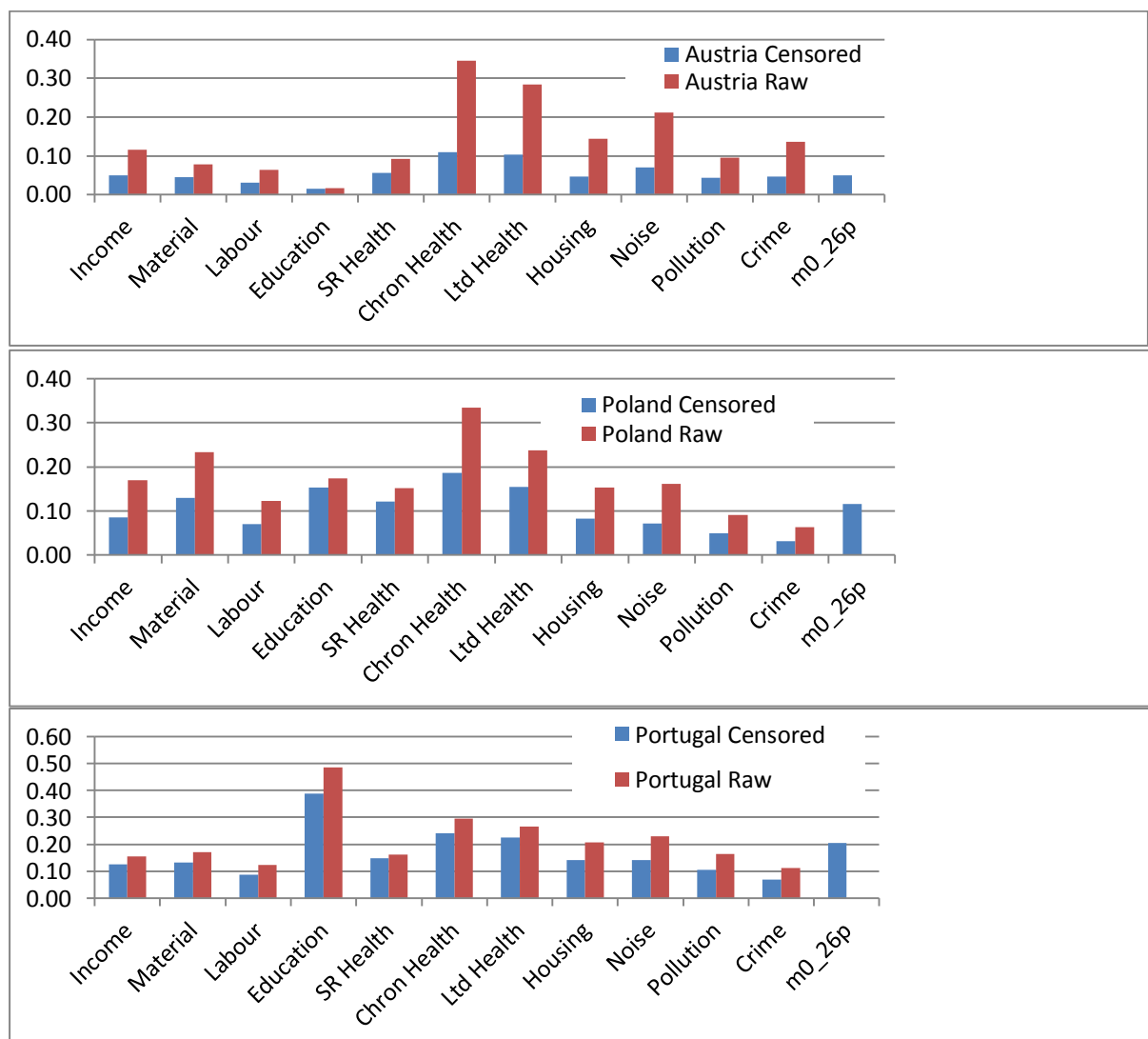
5.3.   Poverty across time: 2006-2010

This section presents the annual time comparisons. Figure 5 below shows the evolution of M_0 across time for all measures across all countries. In this analysis we

have included Romania, Malta, and Bulgaria, which appear at the end because they lack data for the early periods of EU-SILC.

In all graphics, the countries are ranked from low to high poverty using 2006 poverty data for the measure shown. According to all measures, while poverty increased in some intervening periods for some countries, in all countries poverty was lower in 2010 than in 2006. Most countries show low or no decrease from 2009 to 2010. In all measures except B, there is a relatively stronger decrease in poverty from 2008-9. Some of this apparent decrease may be due to drops in the (relative) income poverty rates due to the financial crisis, illustrating the need for care in interpreting mixed relative and absolute indicators. Patterns also vary by country. For example, using Measure C we find that Italy and Greece show the strongest decrease in poverty across the 2006-10 time period, followed by Latvia, Hungary and France.

Figure 5: Poverty across time, Measures A, B, C, and D
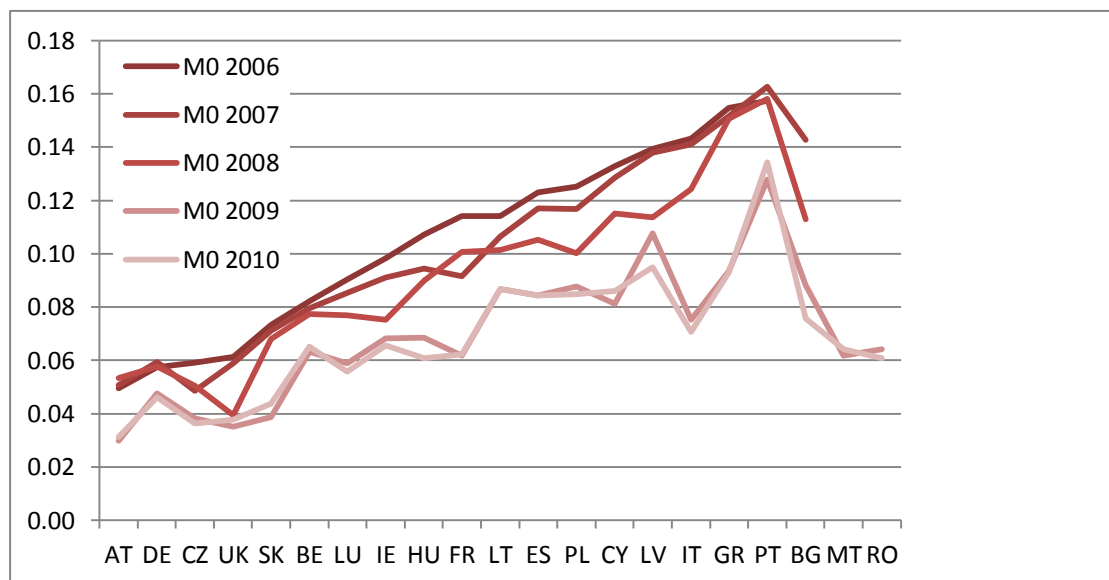
Measure A: changes across time, k=34%
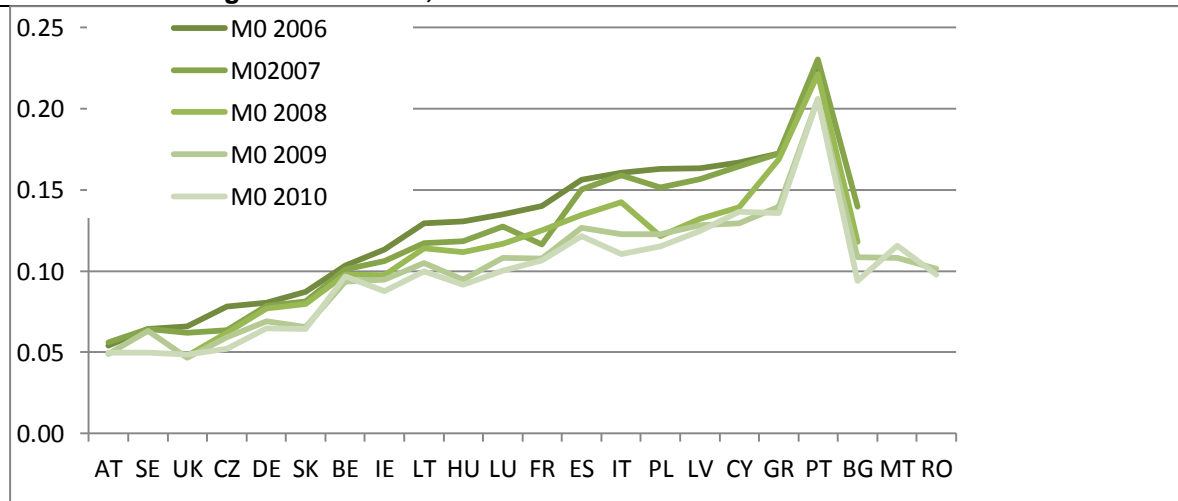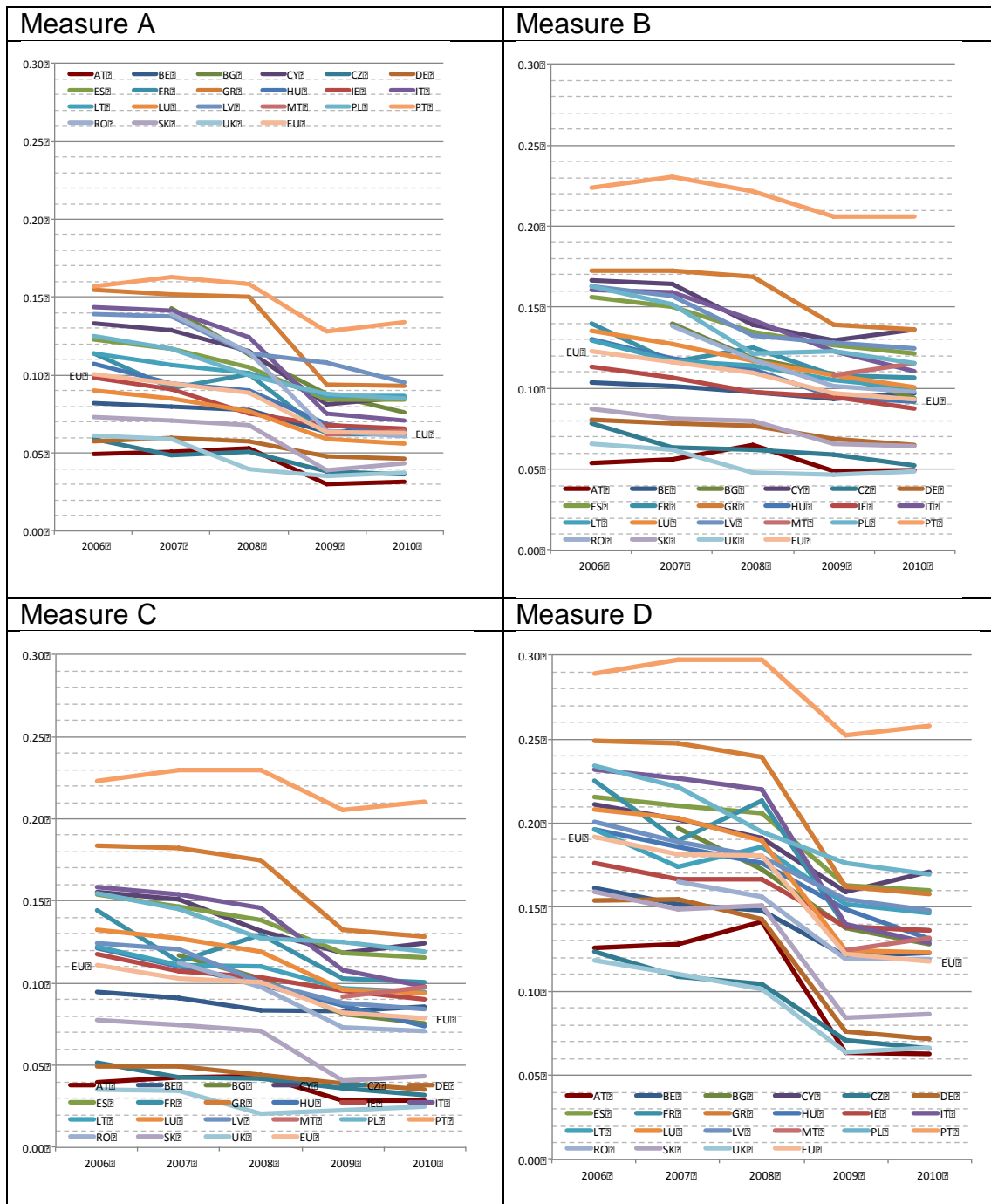
Measure B: Changes across time, k=26%
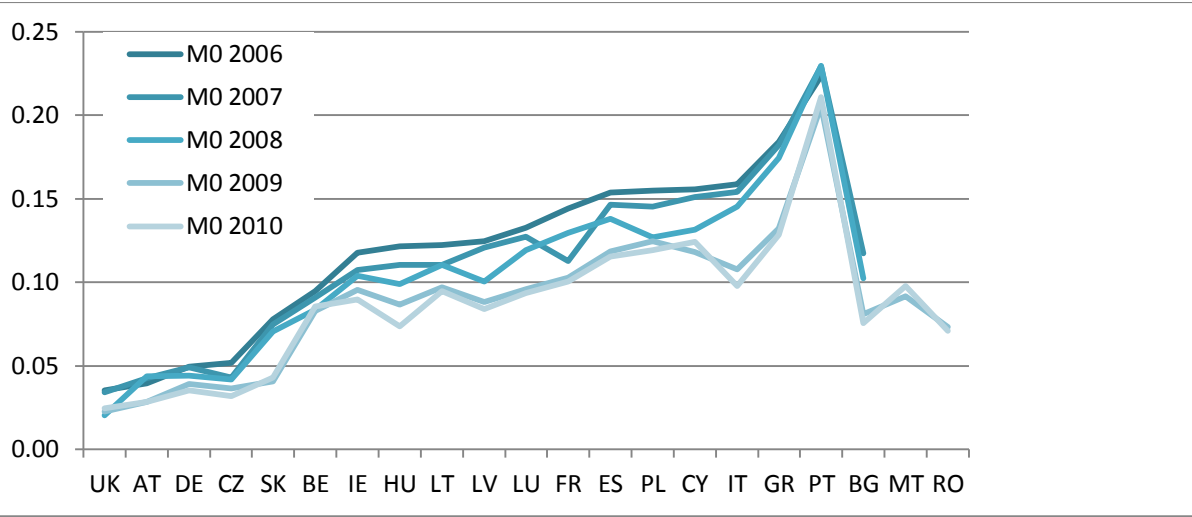
Measure C: Changes across time, k=34%
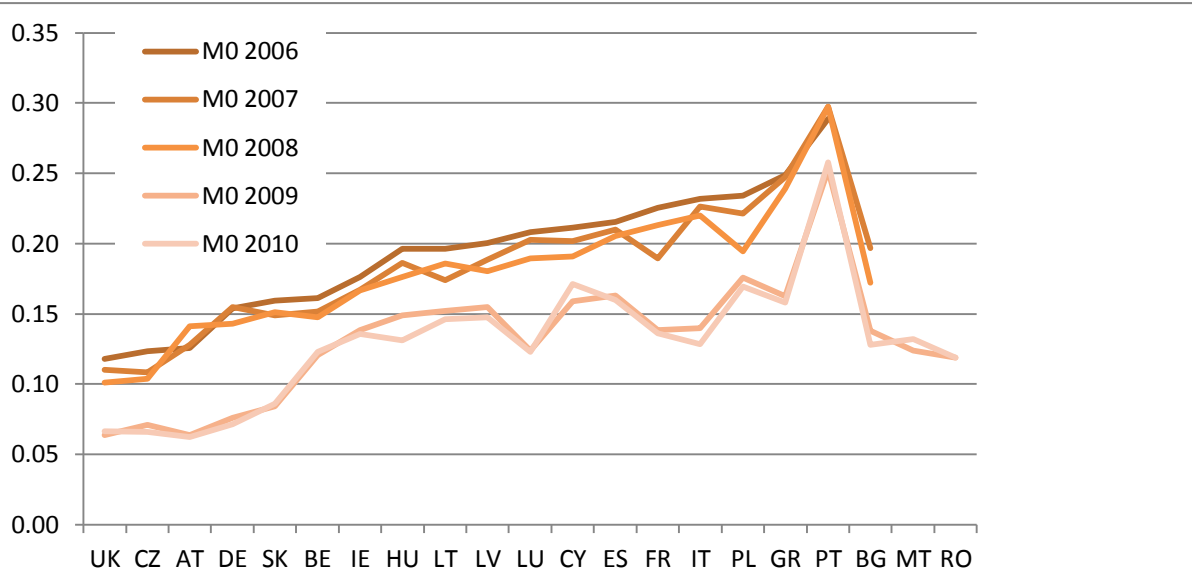
Measure D: Changes across time, k=34%

An alternative method to present the same material is to show changes by each country over time: that is presented in the panel below.

Table 9 Changes by country over time, all measures

It can be useful alongside the overall trends to consider the partial indices of headcount ratio and intensity. Table 9 presents these figures for Measure A across all periods. Interestingly, the top five countries in terms of headcount reduction are the same for Measure A as were listed above for the M_0 of Measure C.

Table 10: Multidimensional Poverty 2006-2010, Measure A, k=34%

	2006			2007			2008			2009			2010		
	H	A	M0	H	A	M0	H	A	M0	H	A	M0	H	A	M0
AT	11%	44%	0.05	12%	44%	0.05	12%	43%	0.05	7%	45%	0.03	7%	45%	0.03
BE	17%	47%	0.08	17%	47%	0.08	17%	46%	0.08	13%	47%	0.06	14%	47%	0.07
BG				29%	49%	0.14	24%	47%	0.11	18%	49%	0.09	16%	48%	0.08
CY	24%	54%	0.13	23%	55%	0.13	23%	49%	0.12	17%	47%	0.08	18%	47%	0.09
CZ	14%	42%	0.06	12%	42%	0.05	12%	42%	0.05	9%	44%	0.04	8%	44%	0.04
DE	13%	44%	0.06	13%	44%	0.06	13%	44%	0.06	10%	48%	0.05	10%	47%	0.05
ES	25%	48%	0.12	24%	48%	0.12	22%	47%	0.11	18%	46%	0.08	18%	46%	0.08
FR	24%	48%	0.11	20%	46%	0.09	22%	47%	0.10	14%	45%	0.06	14%	45%	0.06
GR	32%	49%	0.15	31%	49%	0.15	31%	49%	0.15	21%	45%	0.09	20%	46%	0.09
HU	23%	47%	0.11	21%	46%	0.09	20%	45%	0.09	15%	45%	0.07	13%	45%	0.06
IE	20%	48%	0.10	19%	48%	0.09	17%	45%	0.08	15%	47%	0.07	14%	46%	0.07
IT	29%	49%	0.14	29%	49%	0.14	26%	47%	0.12	17%	45%	0.08	16%	45%	0.07
LT	23%	49%	0.11	21%	50%	0.11	21%	48%	0.10	19%	46%	0.09	19%	45%	0.09
LU	19%	47%	0.09	19%	46%	0.09	17%	46%	0.08	13%	45%	0.06	12%	45%	0.06
LV	28%	49%	0.14	28%	50%	0.14	24%	46%	0.11	23%	46%	0.11	20%	47%	0.09
MT										14%	44%	0.06	14%	45%	0.06
PL	26%	48%	0.13	24%	48%	0.12	21%	48%	0.10	19%	47%	0.09	18%	47%	0.08
PT	32%	49%	0.16	32%	50%	0.16	33%	49%	0.16	28%	46%	0.13	28%	47%	0.13
RO				28%	50%	0.14	24%	47%	0.11	14%	45%	0.06	13%	45%	0.06
SK	17%	44%	0.07	16%	43%	0.07	16%	43%	0.07	9%	44%	0.04	10%	44%	0.04
UK	14%	43%	0.06	14%	43%	0.06	9%	42%	0.04	8%	45%	0.04	8%	45%	0.04

The value of including the intensity in the poverty measure is evident in figure 6 below. The bubble graphic plus the headcount and intensity of every country. The different periods are shown in contrasting colours. The size of the bubble corresponds to the population of the country. We see, first of all, that across all countries and all periods, the intensity of poverty is highest in the countries which simultaneously have high headcount ratios of poverty – located in the upper right hand corner. However we also see that at the same headcount – for example 10%, the headcounts vary, with some countries having 47% and others 42%. We also see that in some countries such as in the circled pair the reduction of poverty does occur by reducing intensity relatively more than headcount. A measure focused solely on the reduction of the prevalence of poverty would overlook these important changes. Further, as was mentioned above, such a measure could not be broken down by indicator into consistent sub-indices (Alkire Foster and Santos 2011).

It would be good to look further into how poverty was reduced, and in particular on the relative contributions of reductions in headcount vs intensity, and in the possibility of showing how the censored headcounts of different indicators changed

across time. There are several methodologies for approaching this analysis. Perhaps the most compact is to use Shapley decomposition.[7]

Figure 6: Bubble graph of changes by H and A 2006-10
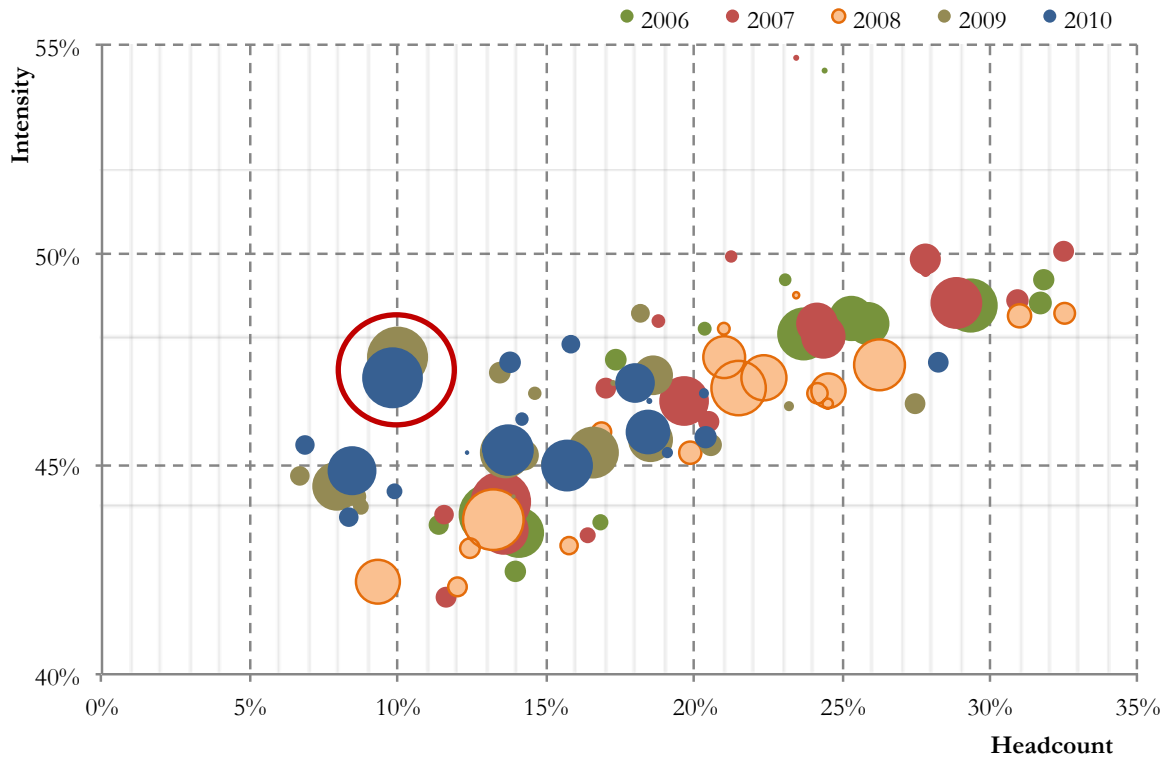
Normally the poverty analyses are undertaken at the country level to facilitate national policy design. However it can be quite interesting from a human-centric perspective to look across countries, and see where the people who are identified as poor by each measure live, and what proportion of poverty each country contributes to the whole. Among the 18 countries used in this analysis, we have aggregated their M_0 measures using annual population figures for each of the years 2006 to 2010. Figure 7, below, provides this information. The height of the stripe associated with each country depicts that countries' relative contribution to the overall M_0 of the 18 countries together. The graphic also depicts what was already seen earlier, namely the sharp drop between 2008-9 and the relative stability of poverty 2009-10. The progress of Italy is visibly prominent due to its large population size, as is the decrease in France, Spain and Poland. Such depictures are useful complements to detailed national analyses. Furthermore, with changes in population share it is possible decompose changes in multidimensional poverty which might eventuate from demographic shifts across countries.

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[7] Shapley decompositions have been tailored to the AF measures by Roche 2012.

Figure 7: Poverty contributions by country, population-weighted

Evolution of M0 (Adjusted Headcount Ratio) with contribution by country
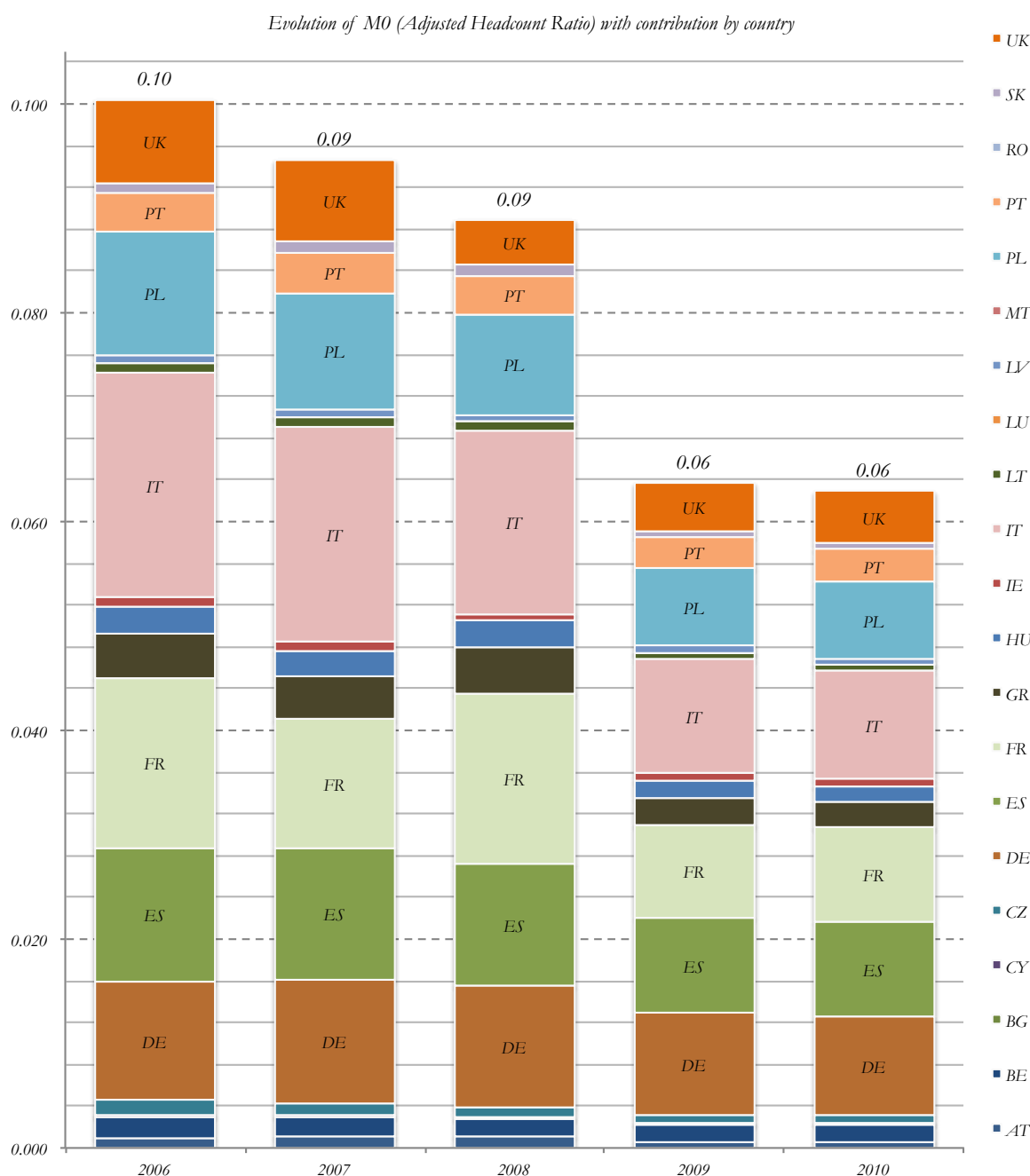
5.3.1. Shapley Value Decomposition and Changes over time

Table 10 below gives a quick overview of the Shapley value decompositions for all measures across the time periods, aggregating each country using population weights. They can be interpreted as conveying the share of the reduction in M_0 which can be attributed to changes in headcount and in intensity. What might be surprising is that intensity reduction does indeed contribute significantly in some periods. Figure 10, below, provides country-specific examples using Measure A. We can see sharply varying patterns of change in intensity and headcount by country and by time period.

Table 11 Shapley Decomposition Overview

		2006-07	2007-08	2008-09	2009-2010
Measure A	Contribution Changes in Headcount	69%	75%	75%	96%
	Contribution Changes in Intensity	31%	25%	25%	4%
Measure B	Contribution Changes in Headcount	69%	71%	72%	88%
	Contribution Changes in Intensity	31%	29%	28%	12%
Measure C	Contribution Changes in Headcount	69%	74%	81%	91%
	Contribution Changes in Intensity	31%	26%	19%	9%
Measure D	Contribution Changes in Headcount	83%	84%	81%	95%
	Contribution Changes in Intensity	17%	16%	19%	5%

Figure 8: Shapley Decomposition using Measure A - all years

Decomposition of Changes in M0 2006-2007

Decomposition of Changes in M0 2007-2008

Decomposition of Changes in M0 2008-2009

Decomposition of Changes in M0 2009-2010
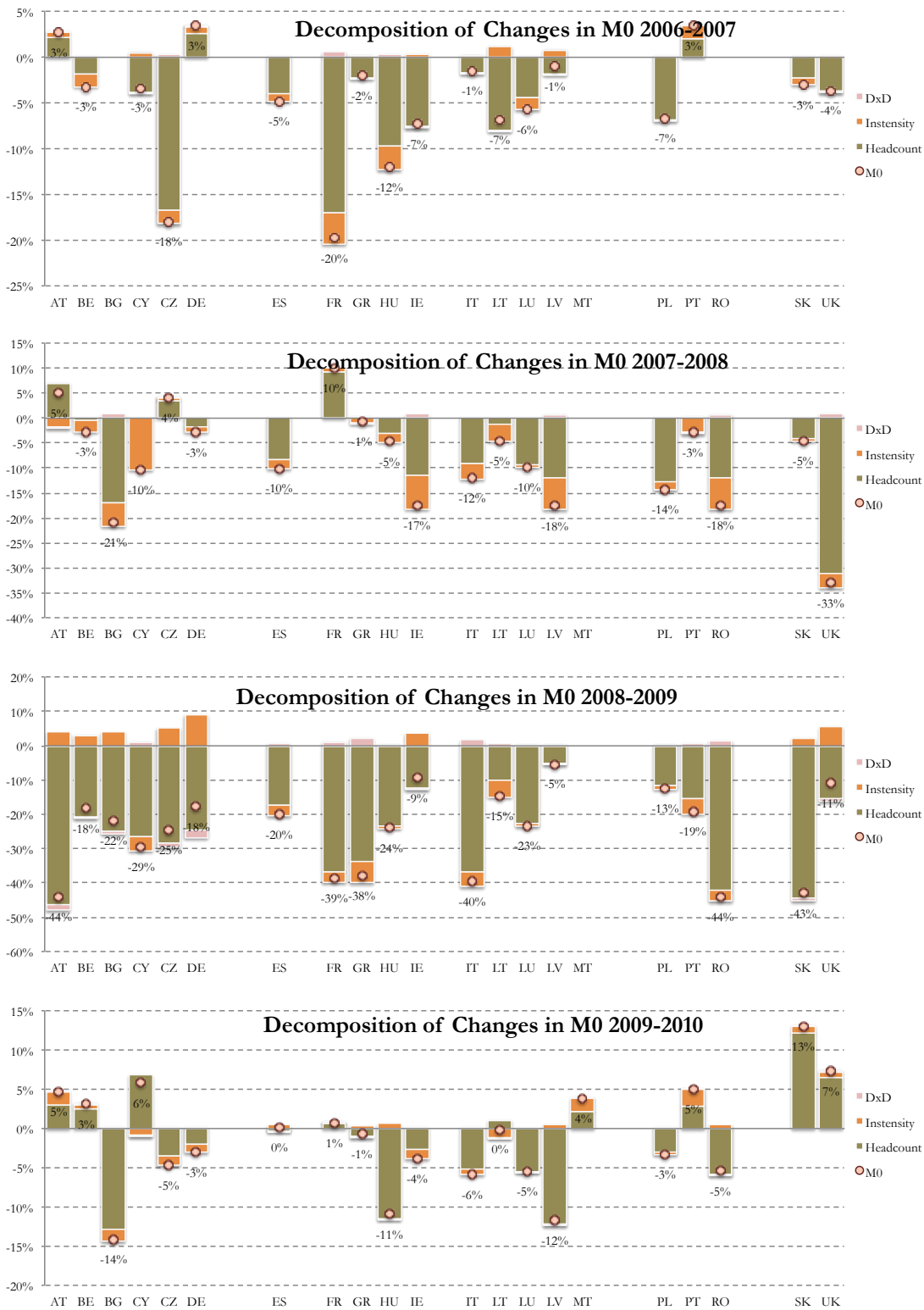
An alternative method to investigate the evolution of headcount and intensity is to break down the change into changes in H, changes in intensity, and changes in an interaction term. This methodology was proposed by Apablaza and Yalonetzky (2011). Table 11 below provides the results by country for this decomposition.

	2006-2007				2007-2008				2008-2009				2009-2010			
	H	A	H*A	M0	H	A	H*A	M0	H	A	H*A	M0	H	A	H*A	M0
AT	2%	1%	0%	3%	7%	-2%	0%	5%	-46%	4%	-2%	-44%	3%	2%	0%	5%
BE	-2%	-1%	0%	-3%	-1%	-2%	0%	-3%	-21%	3%	-1%	-18%	3%	1%	0%	3%
BG					-17%	-5%	1%	-21%	-25%	4%	-1%	-22%	-13%	-1%	0%	-14%
CY	-4%	1%	0%	-3%	0%	-10%	0%	-10%	-26%	-4%	1%	-29%	7%	-1%	0%	6%
CZ	-17%	-1%	0%	-18%	4%	1%	0%	4%	-28%	5%	-1%	-25%	-4%	-1%	0%	-5%
DE	3%	1%	0%	3%	-2%	-1%	0%	-3%	-25%	9%	-2%	-18%	-2%	-1%	0%	-3%
ES	-4%	-1%	0%	-5%	-8%	-2%	0%	-10%	-17%	-3%	1%	-20%	0%	0%	0%	0%
FR	-17%	-3%	1%	-20%	9%	1%	0%	10%	-37%	-3%	1%	-39%	1%	0%	0%	1%
GR	-2%	0%	0%	-2%	0%	-1%	0%	-1%	-34%	-6%	2%	-38%	-1%	0%	0%	-1%
HU	-10%	-3%	0%	-12%	-3%	-2%	0%	-5%	-24%	0%	0%	-24%	-11%	1%	0%	-11%
IE	-8%	0%	0%	-7%	-11%	-7%	1%	-17%	-12%	4%	0%	-9%	-3%	-1%	0%	-4%
IT	-2%	0%	0%	-1%	-9%	-3%	0%	-12%	-37%	-4%	2%	-40%	-5%	-1%	0%	-6%
LT	-8%	1%	0%	-7%	-1%	-4%	0%	-5%	-10%	-5%	1%	-15%	1%	-1%	0%	0%
LU	-4%	-1%	0%	-6%	-9%	0%	0%	-10%	-23%	-1%	0%	-23%	-5%	0%	0%	-5%
LV	-2%	1%	0%	-1%	-12%	-6%	1%	-18%	-5%	0%	0%	-5%	-12%	1%	0%	-12%
MT													2%	2%	0%	4%
PL	-7%	0%	0%	-7%	-13%	-2%	0%	-14%	-12%	-1%	0%	-13%	-3%	0%	0%	-3%
PT	2%	1%	0%	3%	0%	-3%	0%	-3%	-15%	-4%	1%	-19%	3%	2%	0%	5%
RO					-12%	-6%	1%	-18%	-42%	-3%	1%	-44%	-6%	0%	0%	-5%
SK	-2%	-1%	0%	-3%	-4%	0%	0%	-5%	-44%	2%	-1%	-43%	12%	1%	0%	13%
UK	-4%	0%	0%	-4%	-31%	-3%	1%	-33%	-15%	5%	-1%	-11%	6%	1%	0%	7%

We see that the 'interaction' term is vanishingly small, and so an alternative way of proceeding is to allocate this alternatively to H or A.

5.4. Decompositions

Because the AF methodology satisfies the property of subgroup-consistency and subgroup decomposability, it is possible to break down the measure by any sub-groups for which the data are representative and the measure is appropriate. Decompositions are also useful to check the adequacy of indicators for different subgroups. To illustrate this, we decompose all four measures by gender and by age category for all periods.

5.4.1. By gender

We cannot assess the statistical significance of gender inequalities. However across all measures, women are poorer than men in all countries in 2006. Women remain poorer than men in all countries in measures B, C, and D although their relative disparity evolves. In 2010, according to measure A (only) we see a change: in 2010 women's poverty is lower than or roughly equal to men's poverty in the UK, Ireland, Latvia, Lithuania, and Slovakia. The two graphics below show the M_0 levels for

Measure B when $k = 34\%$, for 2006 and 2010. We see that in all countries women are poorer than men in both periods. We also see that in most countries the gender differential appears to have declined, suggesting that this may be a fruitful avenue for further enquiry, particularly with a finalised set of variables.
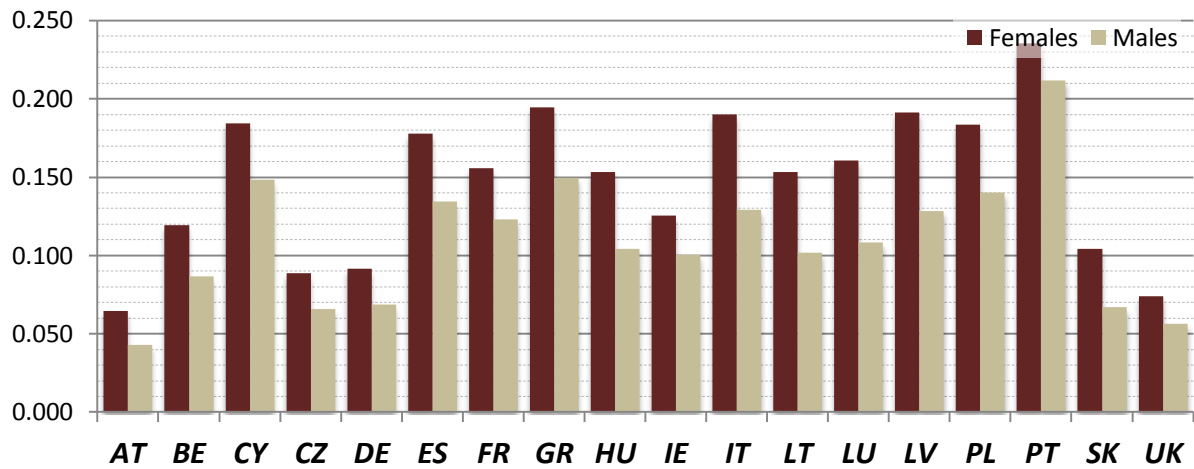

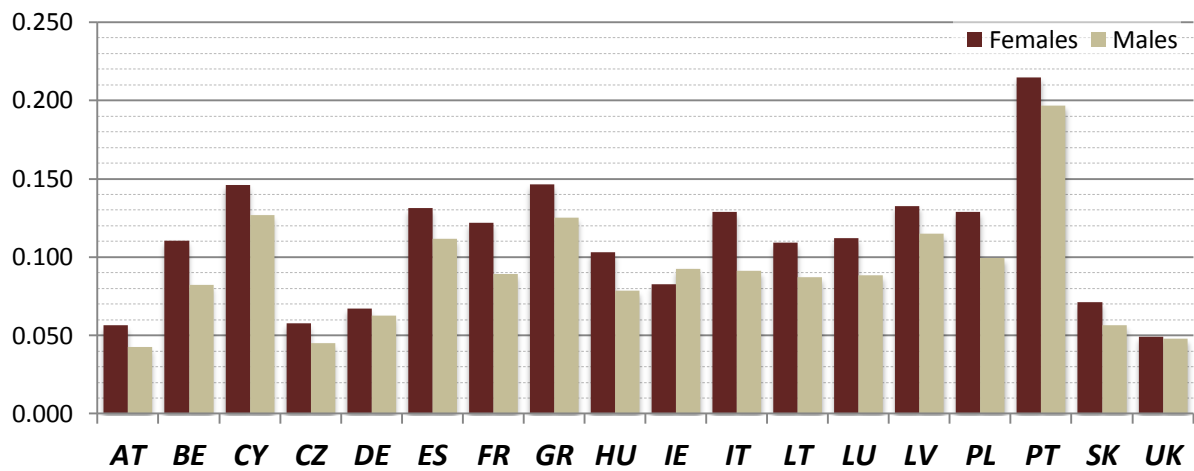**Figure 9 Gender decomposition by country 2006(Measure B)**
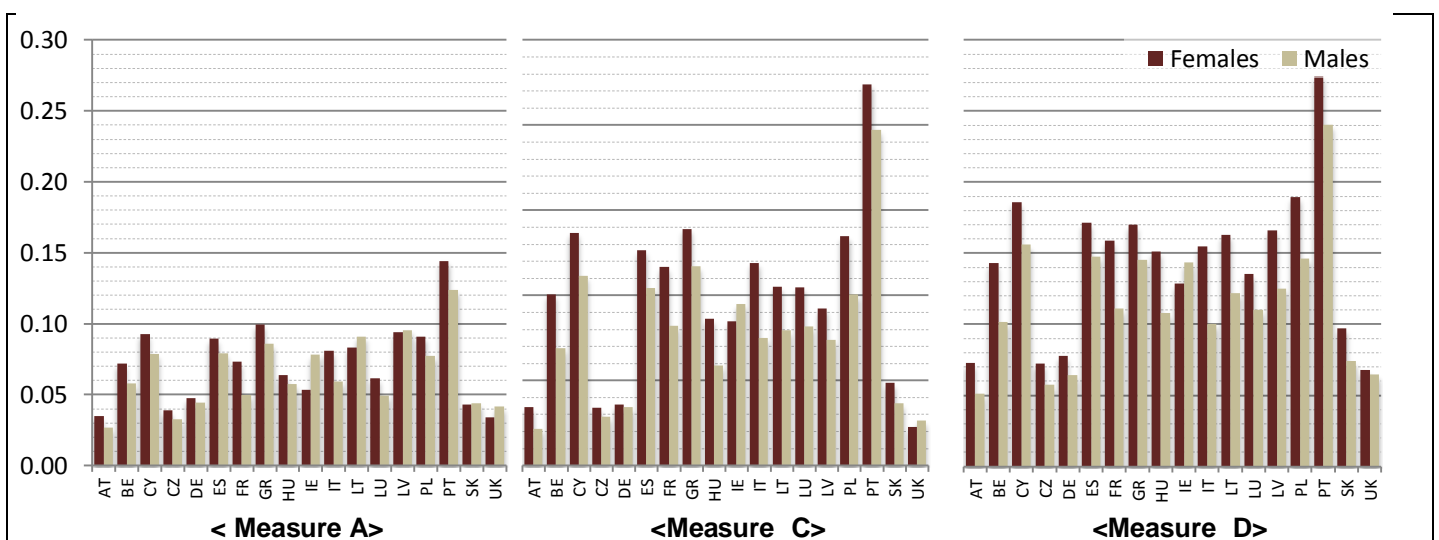

**Figure 10 Gender decomposition by country 2010 (Measure B)**

Figure 11 Gender decomposition by Country 2010 (Measure A, C,D)

Naturally, the question arises how the composition of poverty for women and men varied. Figure 12 below shows that gendered differences in poverty composition are relatively less than inter-country differences – even for education (the orange stripe) which is a wholly individual dimension. Obviously part of the coincidence is due to the shared household level indicators that are used in the measure.

Figure 12: Gendered Composition of Poverty by Gender & Country, Measure B 2006 & 2010
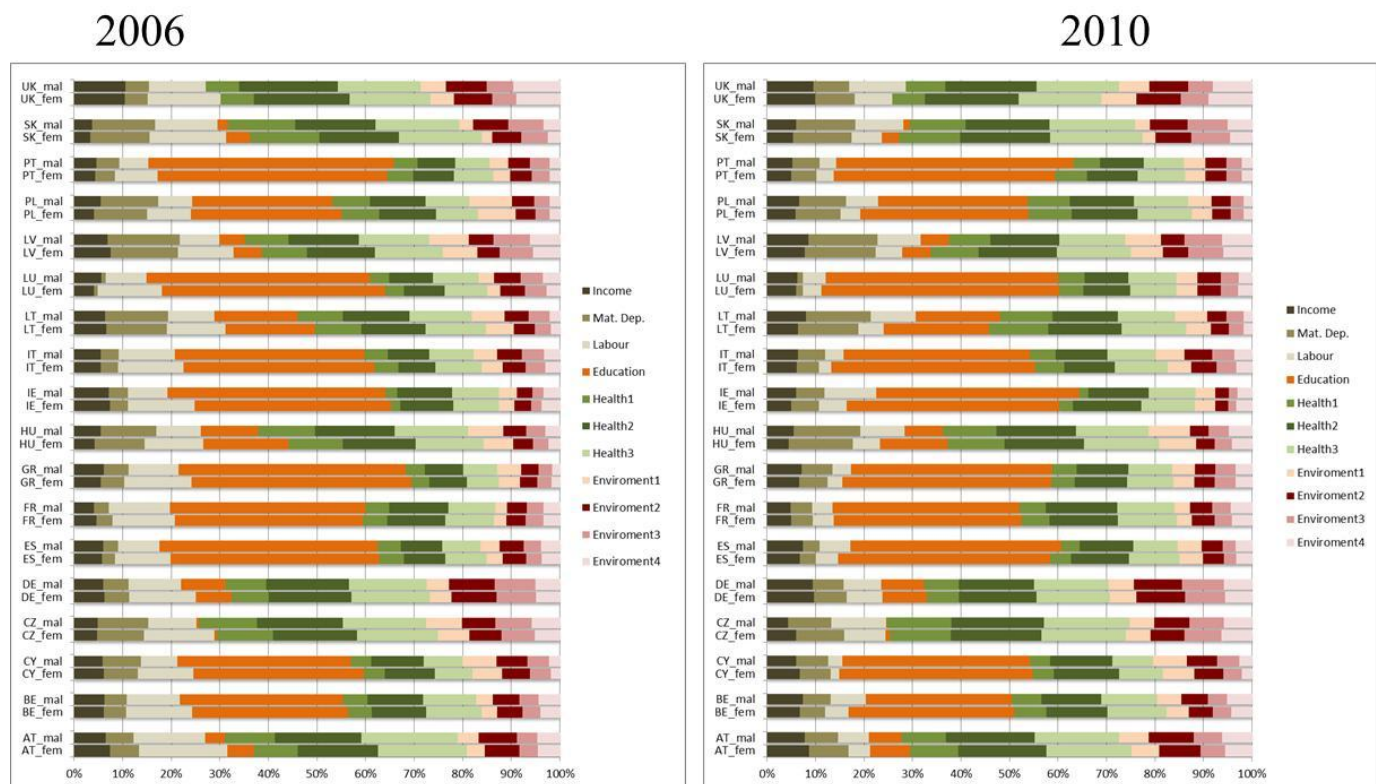
5.4.2. By age

Finally, we also decompose the measures by four age categories: 16-30, 31-45, 46-60 and above 60 years of age. Here we find a clear interaction between variable definition and poverty levels, particularly in the 60+ category. In all countries elder poverty was higher than youth poverty in 2006 for measure B; in 2010 this had changed for a few countries in all measures. The age differential raises further questions as to whether to use the same variables across all age groups – making this an absolute comparison – or whether to use different definitions of some deprivations for older cohorts.
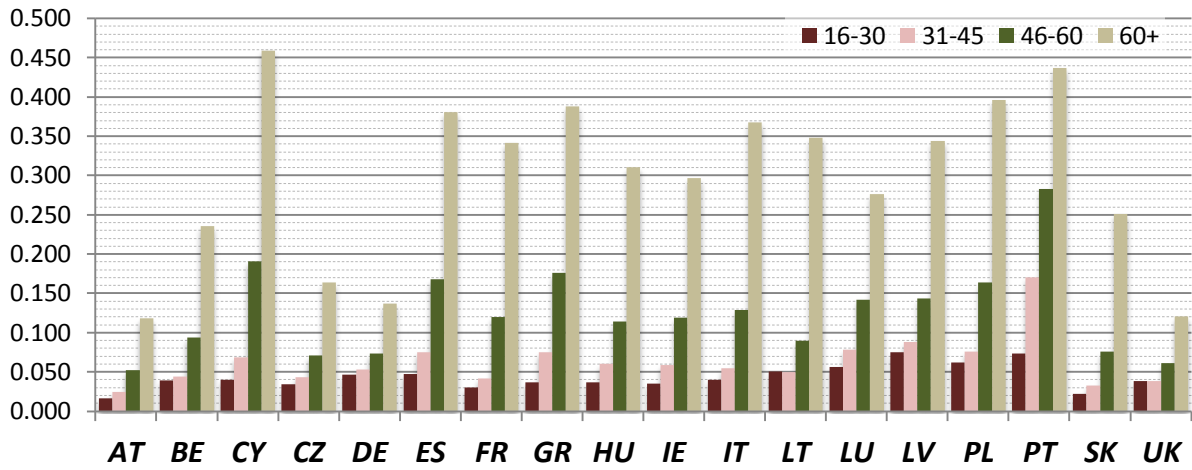
Figure 13 Age group decomposition of M0 by country 2006 (Measure B)
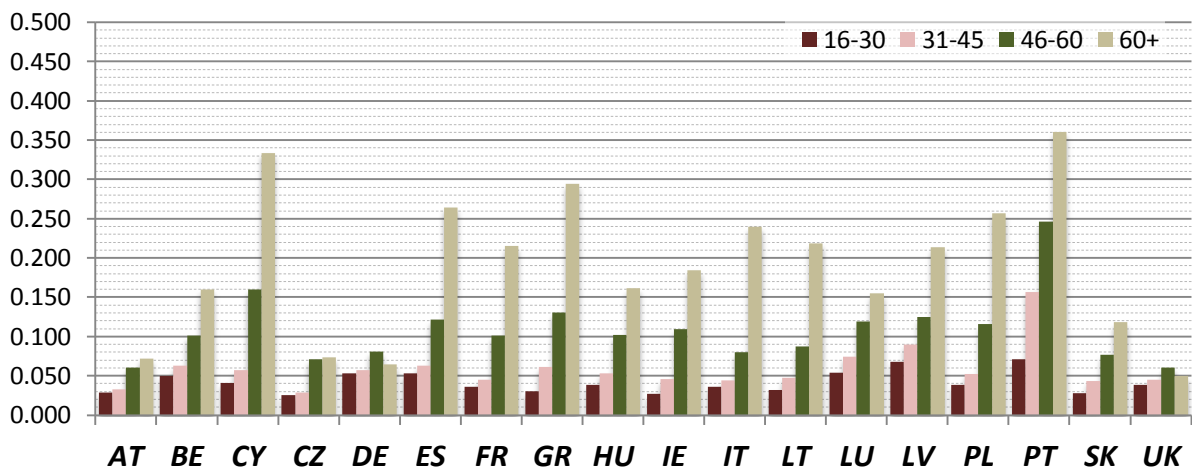
Figure 14 Age group decomposition of M0 by country 2010(Measure B)
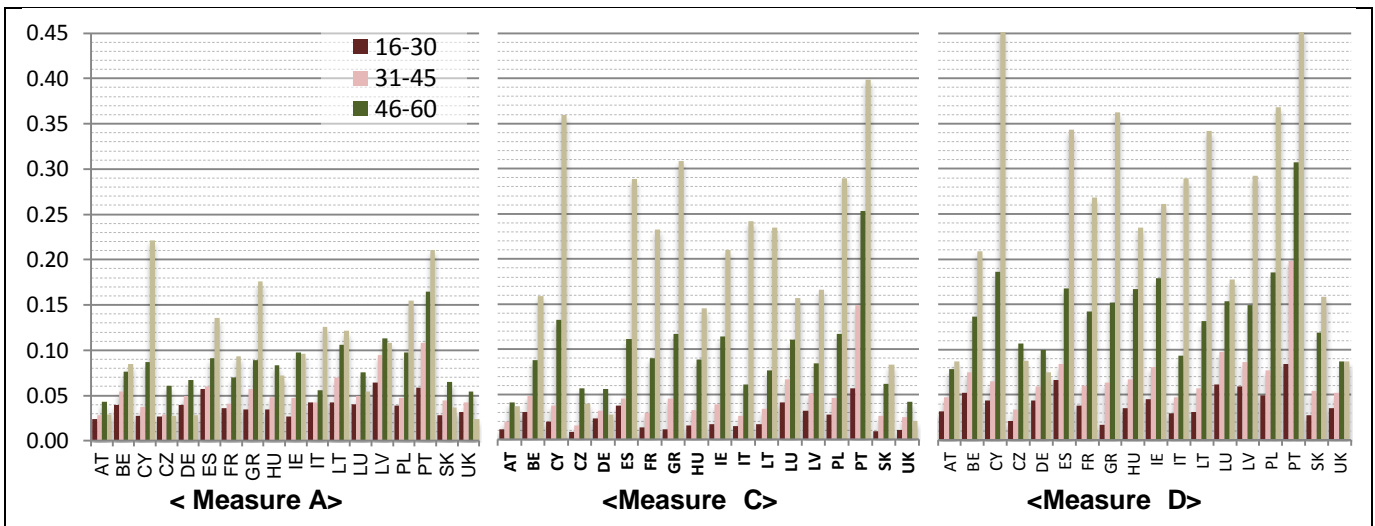
Figure 15 Age group decomposition by country 2010(Measure A,C,D)

6. Concluding Remarks

This paper has presented four experimental multidimensional poverty indices, which have been implementing with the EU-SILC datasets for five waves from 2006-10 using the Alkire Foster Methodology. The paper has not emphasised the choice of indicators but rather the explication of the kinds of analyses that can be completed using this particular class of measures.

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Appendix 1: Dimensions or Indicators of Poverty, Social Exclusion, Quality of Life or Welfare

Allardt (1993) Comparative Scandinavian Welfare Study	Laeken European Council Meeting (2001) Presidency Conclusion	Sten Johansson, Allmanna Forlaget, (1970) Om leviiarlsnivdrinderstikning en, Stockholm: Johansson, Sten
1.*Having:* econ resources, housing, employment, working conditions, health, education 2.*Loving:* attachments/ contacts with local community, family and kin, friends, associations, work-mates *3. Being* self-determination, political activities, leisure-time activities, meaningful work, opportunities to enjoy nature.	1. At-risk-of-poverty rate; 2. At-risk-of-poverty threshold (illustrative values); 3. Income quintile ratio; 4. Persistent at-risk-of-poverty rate; 5. Relative median poverty risk gap; 6. Regional cohesion; 7. Long-term unemployment rate; 8. Population living in jobless households: children; 9. Population living in jobless households: prime-age adults; 10. Early school leavers not in education or training; 11. Low reading literacy performance of pupils; 12. Life expectancy; 13. Self-defined health status by income level; 14. Dispersion around the at-risk-of-poverty threshold; 15. At-risk-of-poverty rate anchored at a moment in time; 16. At-risk-of-poverty rate before social cash transfers; 17. Gini coefficient; 18. Persistent at-risk-of-poverty rate (50% of median income); 19. Working poor (in-work poverty risk); 20. Long-term unemployment share; 21. Very long-term unemployment rate 22. Persons with low educational attainment;	1. health, 2. nutritional habits, 3. residence, 4. living conditions during childhood and family relations, 5. education, 6. degree of employment and work conditions, 7. economic resources, 8. political resources, 9. leisure

Galtung 1994: HR in Another Key (1994)	Whelan, C.T., Nolan, B. and Maitre, B. (2012) Multidimensional Poverty Measurement in Europe: An Application of the Adjusted Headcount Approach	Whelan, C.T. (2007) Understanding the Implications of Choice of Deprivation Index for Measuring Consistent Poverty in Ireland	Whelan, C.T. and Maître, B. (2008) The 'Europeanisation' of Reference Groups: A Reconsideration Using EU-SILC
1. Survival needs: *to avoid violence* individual & collective 2. Well-being needs: *to avoid misery:* nutrition, water, air, movement, excretion, sleep, sex, protection against climate, against diseases, against heavy degrading boring work, self-expression, dialogue, education 3. Identity needs: *to avoid alienation*: creativity, praxis, work, self-actuation, realising potentials, well-being, happiness, joy, being active subject, not passive client/object, challenge and new experiences, affection, love, sex; friends, offspring, spouse, roots, belongingness, networks, support, esteem, understanding social forces, social transparency, partnership with nature, a sense of purpose, of meaning , closeness to the transcendental, transpersonal education 4. Freedom needs: *choice :* in receiving/ expressing information & opinion, of people/places to visit and be visited, in consciousness formation, in mobilization, confrontation, occupation, job, spouse, goods/services, way of life	Basic Deprivation: comprising items relating to enforced absence of a 1. meal, 2. clothes, 3. a leisure activity, 4. a holiday, 5. a meal with meat or a vegetarian alternative, 6. adequate home heating, 7. shoes; Consumption Deprivation: Comprising three items relating a 1. PC, 2. car 3. internet connection; Health: comprising three items relating to 1. The health of the HRP, namely current reported self-assessed health status, 2. Restrictions on current activity 3. The presence of a chronic illness; Neighbourhood Environment: comprising five items comprising 1. reported levels of litter, 2. damaged public amenities, 3. pollution, 4. crime/violence/vandalism 5. noise in the neighbourhood	Basic Deprivation: 1. Two pairs of strong shoes 2. A warm waterproof overcoat 3. Buy new rather than second hand clothes 4. Eat meals with meat, chicken or fish (or vegetarian equivalent) every second day 5. Have a roast joint (or its equivalent) one a week 6. Go without heating during the past twelve months 7. Keeping the home adequately warm 8. Replace any worn out furniture 9. Buy presents for family or friends once a year 10. Have family or friends for a drink or meal once a month 11. Have a morning, afternoon or evening out in the past fortnight for entertainment	Household Income: the total annual disposable household income; Material Deprivation: 1. Cannot afford meal with meat, chicken, fish (or vegetarian) every second day; 2. Inability to keep home adequately warm; 3. Cannot afford to have a car; 4. Cannot afford a telephone; 5. Cannot afford a PC; 6. Cannot afford a colour TV; 7. Cannot afford a washing machine; 8. Cannot afford a week of holiday away from home; 9. Cannot afford to pay unexpected required expenses; 10. Experiencing arrears on rent, mortgage, utility bills or hire purchase payments; Economic stress: Qualitative answers to the question "Thinking now of your household's total income, from all sources and from all household members, would you say that your household is able to make ends meet""

| Bossert, W., Chakravarty, S.R. and D'Ambrosio, C. (2009) Multidimensional Poverty and Material Deprivation, CIREQ (Material deprivation)	Coromaldi, M. and Zoli, M. (2012) Deriving Multidimensional Poverty Indicators: Methodological Issues and an Empirical Analysis for Italy
1. The dwelling has a leaking roof, damp walls/doors/foundations, or rot in doors, window frames or door. 2. The household lacks the ability to keep the home adequately warm 3. The dwelling does not have a proper room with a bath or shower 4. The dwelling does not have an indoor using toilet for the sole use of household 5. The household has been in arrears at any time in the last 12 months on mortgage or rent payments 6. The household has been in arrears at any time in the last 12 months on utility bills 7. The household has been in arrears at any time in the last 12 months on hire purchase instalments or other loan payments 8. The household cannot afford to pay for a one-week annual holiday away from home 9. The household cannot afford a meal with meat, chicken, (or vegetarian equivalent) every second day 10. The household lacks the capacity to face unexpected required expenses 11. The household cannot afford a telephone (including mobile phone) 12. The household cannot afford a colour TV 13. The household cannot afford a computer 14. The household cannot afford a washing machine 15. The household cannot afford to have a car 16. The dwelling has noise from neighbours or noise from the street 17. The household lives in an area with pollution, grime or other environmental problems caused by traffic or industry 　The household lives in an area with crime, violence or vandalism.	Maintenance capacity: 1. Arrears on utility bills 2. Holiday 3. Capacity to afford a meal (with meat…) 4. Capacity to face unexpected expenses 5. Ability to make ends meet 6. Ability to keep home adequately warm 7. Financial burden of the total housing cost 8. Ability to purchase food 9. Ability to purchase clothes 10. Capacity to spend money for health 11. Capacity to spend money for education 12. Capacity to spend money for transport 13. Capacity to spend money for paying taxes 14. Capacity to spend money for medical treatment 15. Capacity to spend money for dental examination; Consumption deprivation: 16. Possession of Mobile 17. Possession of Telephone 18. Possession of Computer 19. Possession of Car 20. Possession of Dishwasher 21. Possession of VHS 22. Possession of Camera 23. Possession of Aerial 24. Access to Internet; Health Status: 1. General health 2. Suffer from chronic illness 3. Limitation in activities because of health problems 4. Incapacity to look for a job because of personal illness; Housing facilities: 1. Possession of TV 2. Possession of washing machine 3. Possession of fridge 4. Problems with dwelling (darkness) 5. Bath or shower in dwelling 6. Indoor toilet 7. Hot water in dwelling; Other housing related problems: 1. Problems of noise 2. Problems of pollution 3. Problems of crime 4. Problems of leaking roof 5. Problems with dwelling (dampness) 6. House density 7. Financial burden of mortgage 8. Arrear on mortgage 　Financial burden of rent

Fusco, A., Guio, A. and Marlier, E. (2011) Income poverty and material deprivation in European countries, CEPS	Guio, A., Fusco, A. and Marlier, E. (2009) A EU Approach to Material Deprivation using EU-SILC and Eurobarometer data, IRISS Working Paper Series	Guio, A. and Maquet, I.S. (2006) "Material deprivation and poor housing" What can be learned from the EU-SILC 2004 data? How can EU-SILC be improved in this matter?	Adamson, Peter, (2012), 'Measuring Child Poverty: New league tables of child poverty in the world's rich countries', UNICEF Innocenti Research Center, Report Card 10
Income poverty: 1. at-risk-of-poverty; 2. the median at-risk-of-poverty gap; Material deprivation: 1. to face unexpected expenses; 2. one week annual holiday away from home; 3. to pay for arrears (mortgage or rent, utility bills or hire purchase instalments); 4. a meal with meat, chicken or fish every second day; 5. to keep home adequately warm; 6. to have a washing machine; 7. to have a colour TV; 8. to have a telephone 9. to have a personal car.	Material deprivation: 1. to face unexpected expenses; 2. one week annual holiday away from home; 3. to pay for arrears (mortgage or rent, utility bills or hire purchase instalments) 4. a meal with meat, chicken or fish every second day; 5. to keep home adequately warm; 6. to have a washing machine; 7. to have a colour TV; 8. to have a telephone; 9. to have a personal car.	Economic strain: Could not afford – 1. One week annual holiday away from home 2. Arrears (mortgage or rent, utility bills or hire purchase instalments) 3. A meal with meat, chicken or fish every second day 4. To keep home adequately warm 5. Capacity to face unexpected expenses; Durables: Enforced lack of 1. Colour TV 2. Telephone 3. Personal car 4. Washing machine; Housing: 1. Leaking roof, damp walls/floors/foundations, or rot in window 2. Frames or floor 3. Accommodation too dark 4. Bath or shower in dwelling 5. Indoor flushing toilet for sole use of the household	1. Three meals a day 2. At least one meal a day with meat, chicken or fish (or a vegie equivalent) 3. Fresh fruit and vegetables every day, 4. Books suitable for the child's age and knowledge level (not including schoolbooks) 5. Outdoor leisure equipment (bicycle, roller-skates, etc.) 6. Regular leisure activities (swimming, playing an instrument, participating in youth organizations etc.) 7. Indoor games (at least one per child, including educational baby toys, building blocks, board games, computer games etc.) 8. Money to participate in school trips and events 9. A quiet place with enough room and light to do homework 10. An Internet connection 11. Some new clothes (i.e. not all second-hand) 12. Two pairs of properly fitting shoes(including at least one pair of all-weather shoes) 13. The opportunity, from time to time, to invite friends home to play and eat 14. The opportunity to celebrate special occasions such as birthdays, name days, religious events, etc.

| Whelan, C.T. and Maître, B. (2008) Measuring Material Deprivation in the Enlarged European Union	Gabos, A., Ozdemir, E., Ward, T. (2011) Material Deprivation among Children	Jana, S., Nad'a, B., Jana, T. (2012) Material Deprivation in Selected EU Countries According to EU-SILC Income Statistics
Consumption deprivation: 1. Afford to pay unexpected required expenses; 2. Weeks holiday away from home; 3. Meals with meat, chicken, fish (or vegetarian); 4. Can afford a PC?; 5. Arrears relating to mortgage payments, rent, utility bills, hire purchase; 6. Inability to keep home adequately warm; 7. Respondent for household can afford to have a car; Household facilities: 8. Bath or shower in dwelling; 9. Indoor toilet; 10. Can afford a telephone?; 11. Can afford a colour TV? 12. Can afford a washing machine?; Neighbourhood environment: 1. Pollution, grime or other environmental problems in the area caused by traffic or industry; 2. Noise from neighbours or noise from the street; 3. Crime, violence or vandalism in the area; Others: 1. Rooms too dark, light problems; 2. Leaking roof, damp walls/ceilings/floors/foundations, rot in doors, window frames	Basic Needs: 1. Some new clothes; 2. Two pairs of shoes; 3. Fresh fruit daily; 4. Three meals a day; 5. One meal with meat; Education and leisure needs: 1. Books; 2. Outdoor leisure equipment 3. Indoor games; 4. Celebration on Special occasions; 5. Invite friends; 6. Participate in school trips; 7. Place to study; 8. Outdoor space to play;	1. Household ability to pay rent, mortgage, loans and utility bills, 2. ability to keep the home adequately warm, 3. the ability to face unexpected expenses, 4. to eat meat or proteins regularly, 5. to go on holiday once a year, 6. whether the household has a TV, a refrigerator, a car and a telephone

Appendix 2: All measures across all periods as k varies by decile.
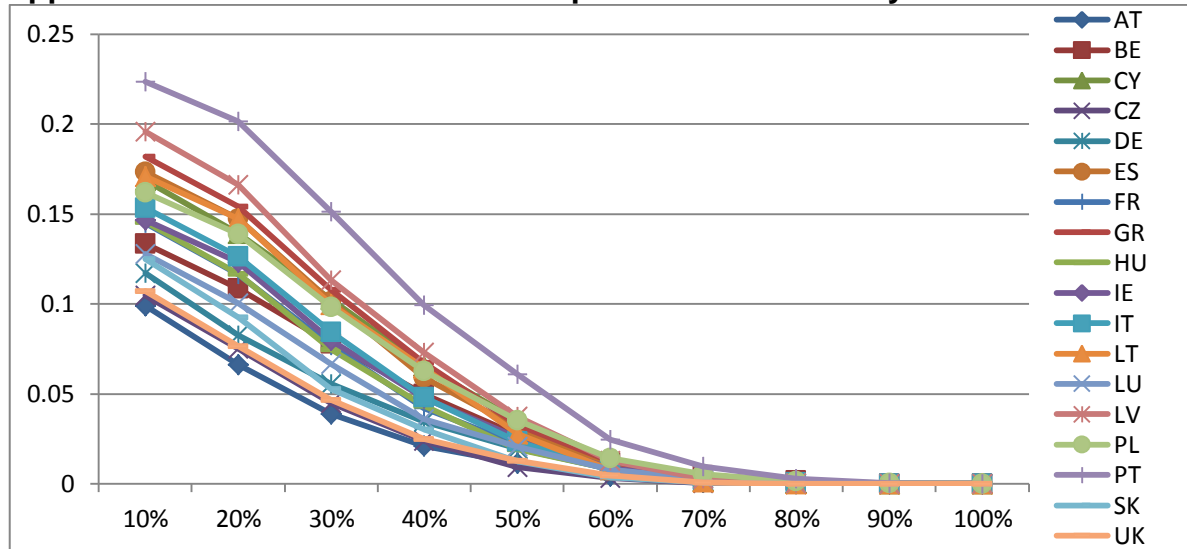
Figure 16 Change of M0 by countries in 2010 (Measure A)
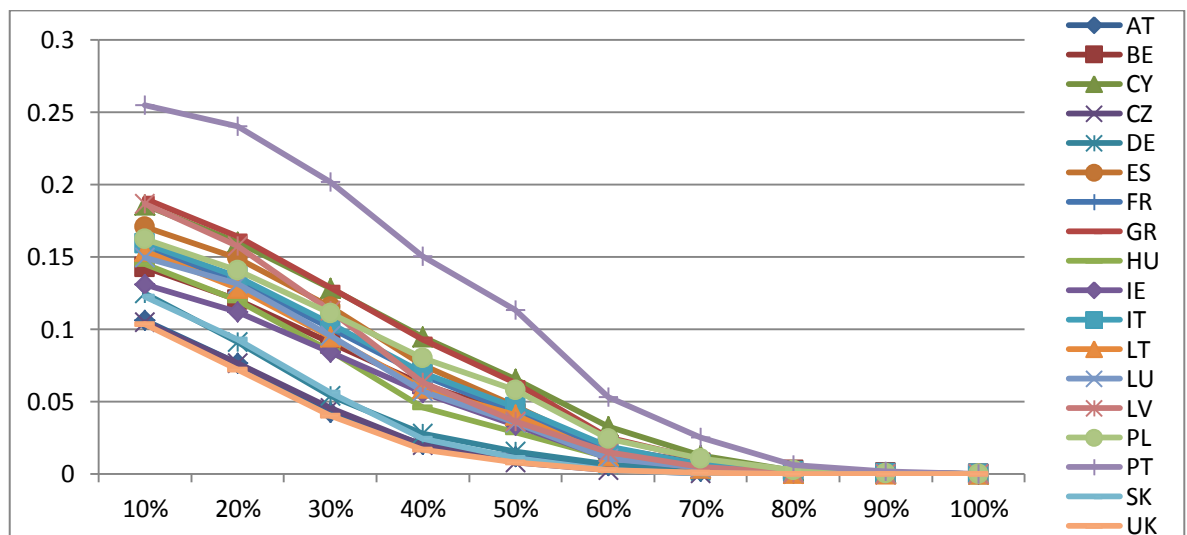
Figure 17 Change of M0 by countries in 2010 (Measure B)
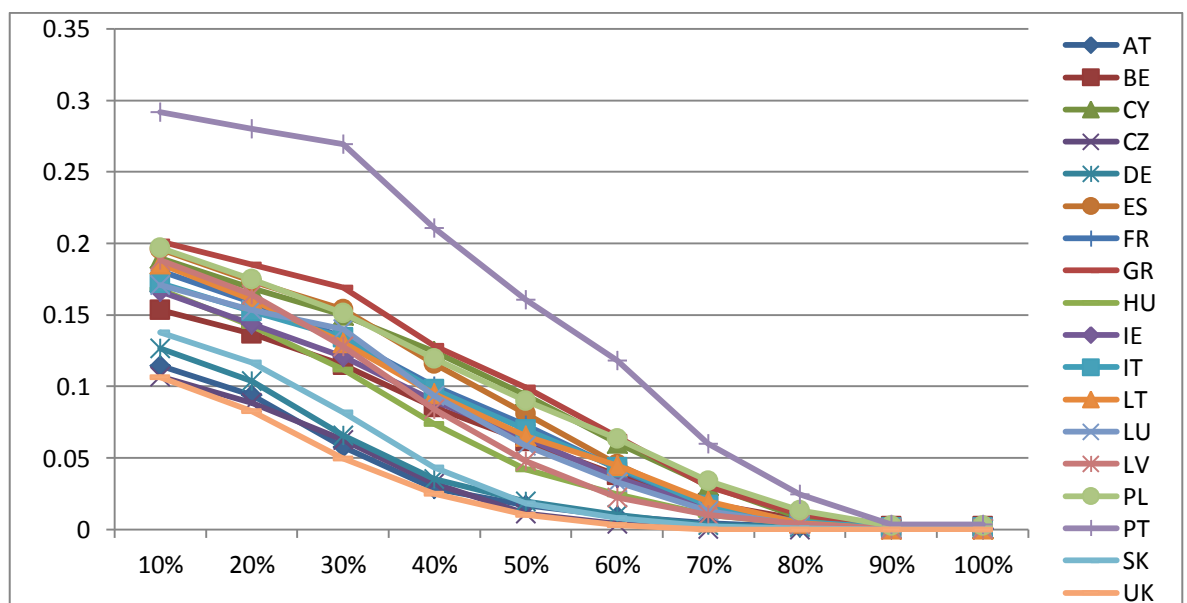
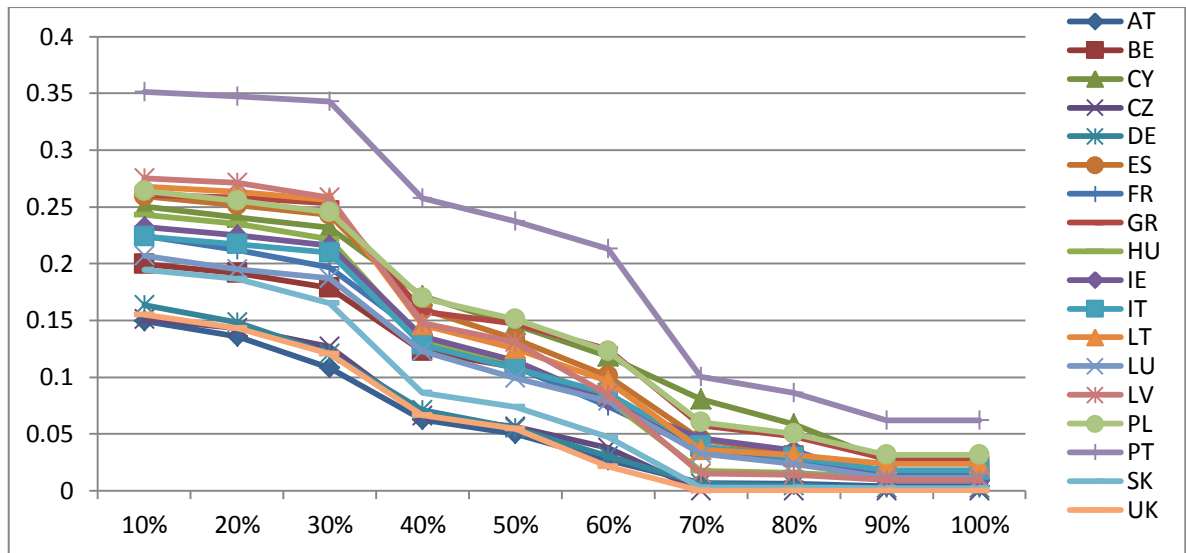**Figure 18 Change of M0 by countries in 2010 (Measure C)**
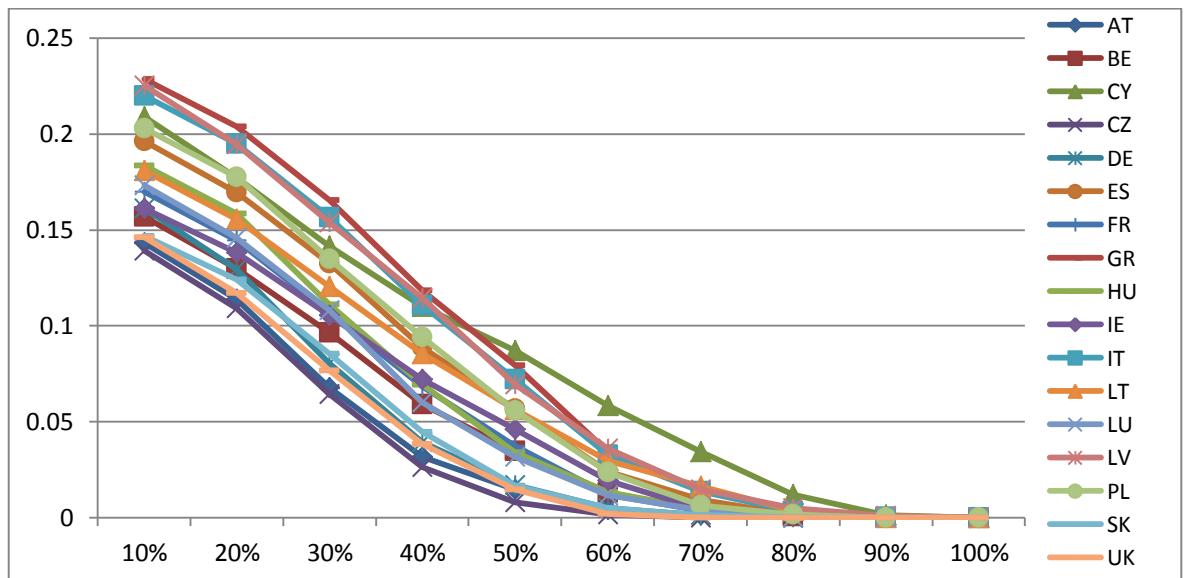
Figure 19 Change of M0 by countries in 2010 (Measure D)
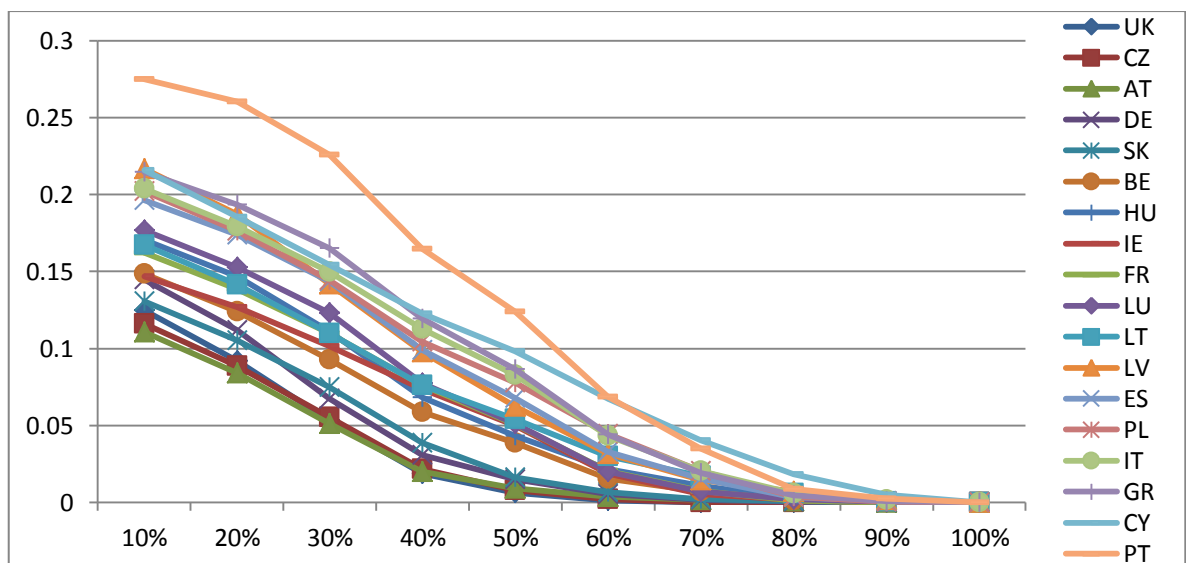

Figure 20 Change of M0 by countries in 2006 (Measure A)

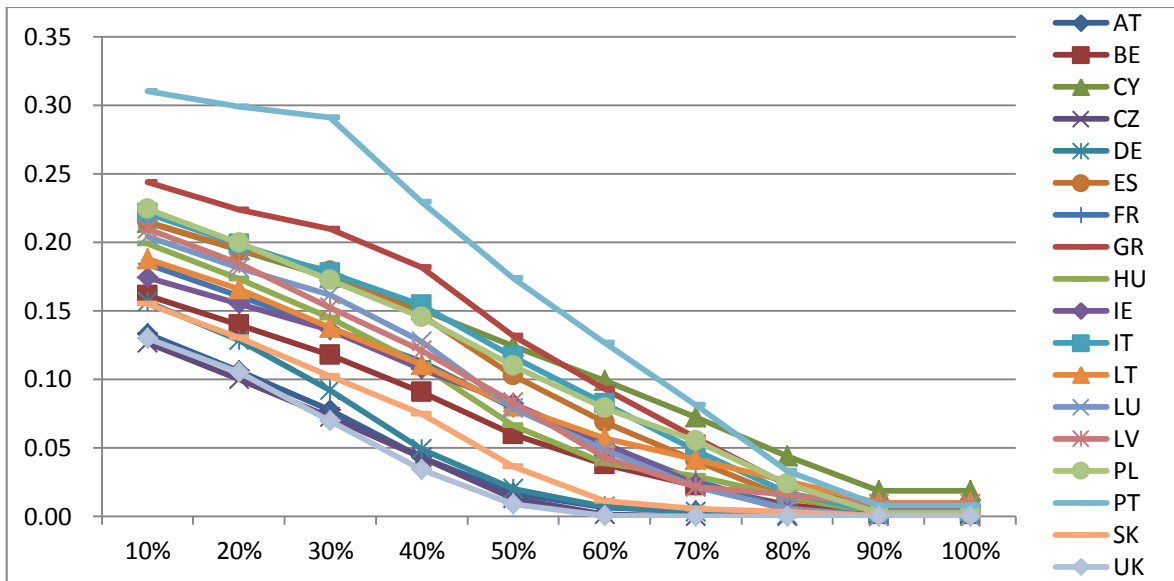**Figure 21 Change of M0 by countries in 2006 (Measure B)**
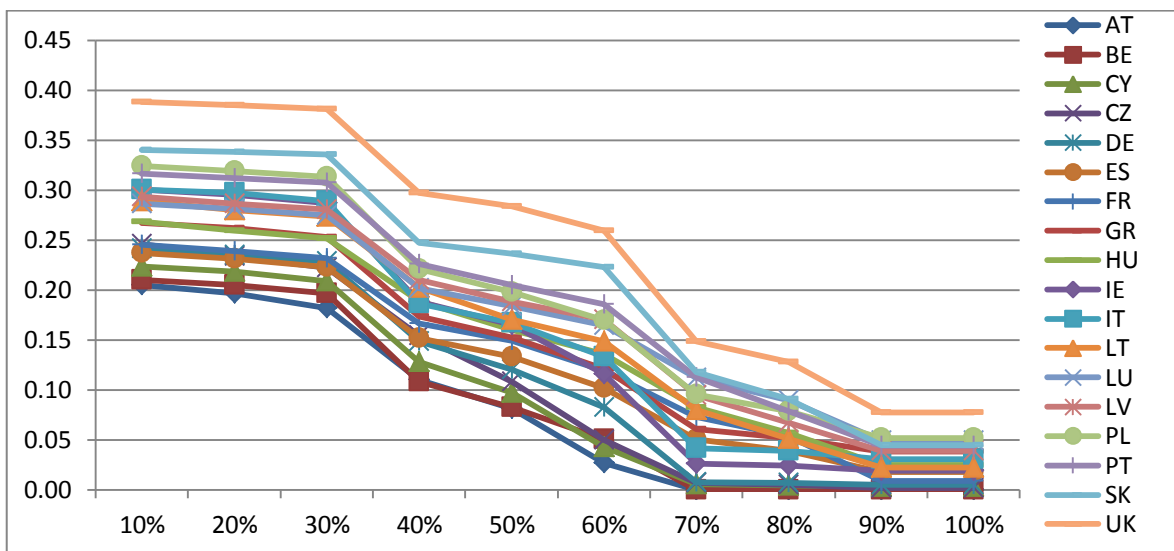
Figure 22 Change of M0 by countries in 2006 (Measure C)

Figure 23 Change of M0 by countries in 2006(Measure D)

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