THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Understanding the Links between Inequalities and Poverty (LIP)

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Multidimensional poverty and income inequality in the EU

CASEpaper 207/ LIPpaper 4

ISSN 1460-5023

CASE
Centre for Analysis of Social Exclusion
Research at LSE

Supported by
JRF JOSEPH ROWNTREE FOUNDATION

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CASE/207
November 2017

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Editorial note

Lin Yang is a Research Officer at CASE. Polly Vizard is an Associate Director and Associate Professorial Research Fellow at CASE.

This paper is part of the *Improving the Evidence Base for Understanding the Links between Inequalities and Poverty programme* funded by the Joseph Rowntree Foundation. The views expressed are those of the authors and not necessarily those of the funder.

Data for the European Quality of Life Survey (EQLS) were made available by the UK Data Service and data for the EU Statistics on Living Conditions (EU-SILC) were made available by Eurostat. The EQLS is copyright European Foundation for the Improvement of Living and Working Conditions and EU-SILC is copyright European Union. Stata code for constructing the MPI was adapted from the Oxford Poverty and Human Development Initiative (OPHI, 2011) and the UNDP Human Development Report Office website: http://hdr.undp.org/en/content/mpi-statistical-programmes. We are grateful to OPHI and the UNDP for making this available.

The authors would like to thank Abigail McKnight, Eleni Karagiannaki, Tania Burchardt, John Hills, Aaron Reeves, Fiona Steele, Kenneth Benoit, Benjamin Lauderdale, and members of the Advisory Group and research team for the Joseph Rowntree Foundation programme for their valuable comments and feedback. All errors and ambiguities remain the authors' responsibility.

Abstract

This paper examines the link between the way a country's most deprived individuals experience disadvantage across multiple dimensions of life and how this may relate to its level of income inequality. By expanding the definition of disadvantage beyond income poverty, we overcome some of the limitations presented by the mechanical link between strictly income-based measures of poverty and inequality. We consider whether – and if so, how – three measures of material deprivation and multidimensional poverty relate

to income inequality, focusing our analysis on European Union countries.

Key words: Multidimensional poverty, material deprivation, inequality, EU

JEL number: D31, I30, I32

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Summary

This paper examines the link between the way a country's most deprived individuals experience disadvantage across multiple dimensions of life and how this may relate to its level of income inequality. By expanding the definition of disadvantage beyond income poverty, we overcome some of the limitations presented by the mechanical link between strictly income-based measures of poverty and inequality. We consider whether – and if so, how – three measures of material deprivation and multidimensional poverty relate to income inequality, focusing our analysis on European Union countries.

Our descriptive analysis finds that *levels* of material deprivation and income inequality, and levels of multidimensional poverty and income inequality are strongly positively related to one another when comparing across countries. However, this does not necessarily mean that the evolution of these follow that of income inequality over time within countries. Our descriptive findings for these relationships over time are that while changes in material deprivation and multidimensional poverty (as captured by the MPI1 measure) do in general appear to be positively related to changes in income inequality, this relationship is not statistically significant.

The cross-sectional relationship remains even when we factor in micro level compositional factors such as citizenship, marital status, and occupational group, as well as macro level covariates using a multivariate multilevel analysis. The micro-level variables paint a generally uniform picture for all outcome variables that multidimensional poverty and material deprivation are experienced to a higher degree by females and single parents, non-EU citizens and people working in unskilled elementary occupations. The relationship also remains when we account for differences in GDP per capita.

Our results also show that policy matters, since including welfare regime categories in the models show that individuals in countries belonging to the social democratic regime category are either as well-off or better-off, on average, than individuals in countries belonging to other welfare categories. This was the case whether we used material deprivation or either of the MPI measures as our dependent variable of broader poverty. It is important to note that the income inequality measures already reflect and capture some effect of welfare policy through taxes and transfers. Using the post-tax and transfer measures of inequality as we did, the most redistributive and generous social democratic welfare regime tended to be

the most deprivation-reducing regime type. This relationship is therefore over and above any redistributive effect captured by our post-tax and transfer inequality measures.

We also present an extension of the cross-sectional multilevel models to allow for an analysis of material deprivation and the MPI1 specification over two waves of the EQLS data (2007 and 2011), while simultaneously distinguishing between cross-sectional and over-time relationships. We find that the over-time relationships are distinct from the cross-sectional ones. While individuals in countries with higher income inequality tend to suffer more severely from material deprivation and multidimensional poverty, the severity of deprivation and poverty does not seem to have tracked changes in income inequality from the 2007 to 2011 wave, accounting for differences in various micro and macro level factors.

While inequality is important in terms of its positive cross-sectional relationship with material deprivation and multidimensional poverty across countries, this relationship significantly weakens when looking at changes within countries over the period we consider.

1 Introduction

This paper is one in a series examining the empirical relationship between poverty and income inequality. While a previous paper (Karagiannaki, 2017) focused on the relationship between income poverty and inequality, here we focus on expanding the definition of poverty beyond income to examine the link between the way a country's most deprived individuals experience poverty across multiple dimensions of life and how this may relate to its level of income inequality. By using a broader definition of poverty, we overcome some of the limitations presented by the mechanical link between strictly income-based measures of poverty and inequality, and therefore provide a stronger test of the relationship. We consider whether – and if so, how – broader measures of poverty relate to income inequality, focusing our analysis on European Union countries. Specifically, the aim is to examine the associations between material deprivation and income inequality, and multidimensional poverty and income inequality, using a combination of descriptive and multivariate methods.

Our analysis involving multidimensional poverty makes use of the Multidimensional Poverty Index or "adjusted headcount measure", proposed by Alkire and Foster (2009, "Counting and multidimensional poverty measurement"). There is currently only a very small body of literature using multivariate analysis to examine the relationship between macro level covariates and multidimensional poverty, and we have identified only two empirical analyses explicitly examining the relationship between income inequality and multidimensional poverty, as measured by the MPI (Whelan et al., 2014; Watson et al., 2016). There is, however, a larger literature on the covariates of material deprivation and the relationship between material deprivation and income inequality, which we briefly review in Section 2.1. Our goal is to add to the literature examining the relationship between income inequality and these wider definitions of poverty, and in doing so, better understand how different aspects of poverty may interact with each other in a way that is systematically related to the unequal distribution of income within the population.

Section 2 introduces the concepts of material deprivation and the MPI, and reviews the literature on existing applications in the context of the OECD and European Union. Section 3 discusses the data used for our analysis, including details of two MPI specifications that we construct from the data. The income inequality measures examined are discussed in Section 4. Section 5 presents our descriptive and multilevel regression analyses of the relationships between material deprivation, MPI poverty and income inequality. Section 6 concludes.

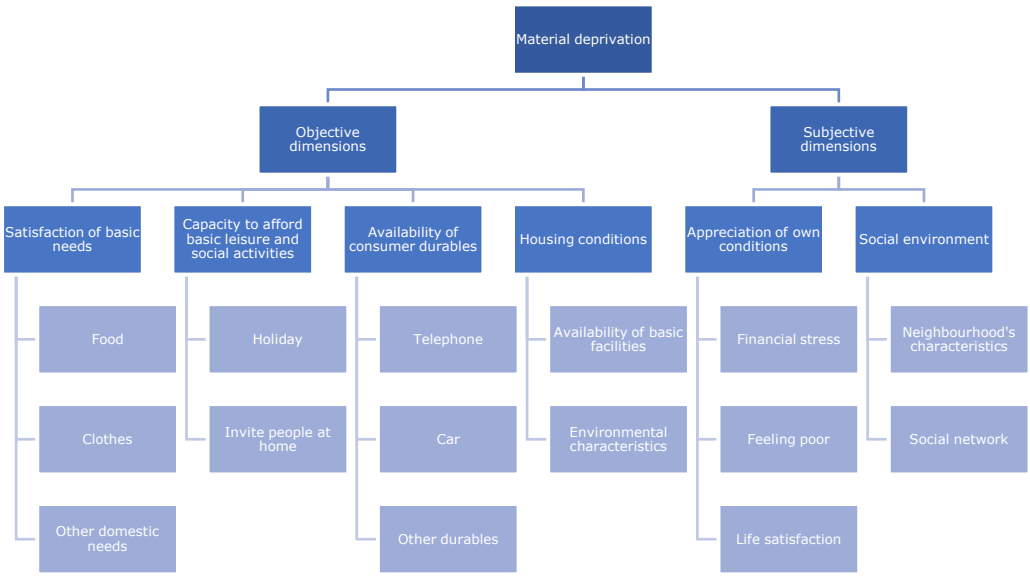
2 Non-income concepts of poverty

2.1 Material deprivation

Measures of material deprivation can be seen as being situated within multidimensional approaches to poverty measurement, which broaden and complement the purely monetary concept of poverty. A more detailed discussion of material deprivation and broader concepts of poverty is provided in an earlier paper in this series (Yang, 2017). The concept of material deprivation has been attributed to Townsend (1987), who referred to it as lack of "the material standards of diet, clothing, housing, household facilities, working, environmental and locational conditions and facilities which are ordinarily available in their society". This definition later evolved from "lack" to "enforced lack", specifying those who would *like to* have these items but are unable to afford them, therefore reflecting genuine deprivation and not preferences or tastes.

Various typologies of material deprivation now exist in the literature, including in the context of cross-country analyses. In some studies, approaches such as factor analysis and reliability tests have been applied. For example Whelan and Maître (2008; 2012) use this type of approach to identify the main components of material deprivation. Whelan and Maître (2008) identify three dimensions of material deprivation (consumption, household facilities, and neighbourhood environment) and Whelan and Maître (2012) identify six (basic, consumption, household facilities, health, neighbourhood environment, and access to public facilities). Boarini and Mira d'Ercole (2006) review statistical measures of material deprivation from national data across OECD countries, and suggest a taxonomy of material deprivation comprised of six components, shown in Figure 1.

Figure 1. The different dimensions and components of material deprivation *(Boarini and Mira d'Ercole, 2006)*



The European Commission definition of material deprivation encompasses a number of the components listed in Figure 1. Specifically, it measures the proportion of the population with an enforced lack of at least three out of the following nine items (basic deprivation is defined as enforced lack of at least two, and severe deprivation enforced lack of at least four):

- Arrears on mortgage or rent payments, utility bills, hire purchase instalments or other loan payments
- Capacity to afford paying for one week's annual holiday away from home
- Capacity to afford a meal with meat, chicken, fish (or vegetarian equivalent) every second day
- Capacity to face unexpected financial expenses (set amount corresponding to the monthly national at-risk-of-poverty threshold of the previous year)
- Household cannot afford a telephone (including mobile phone)
- Household cannot afford a colour TV
- Household cannot afford a washing machine
- Household cannot afford a car
- Ability of the household to pay for keeping its home adequately warm

Our multivariate analysis uses a definition of material deprivation staying as close as possible to the European Commission definition. However, due to the data available in EQLS we are unable to include

information on ability to afford household durables or unexpected financial expenses.

Whelan and Maître (2012) use their basic deprivation component of material deprivation (enforced lack of a meal, clothes, leisure activity, holiday, meal with meat or vegetarian alternative, adequate home heating, and shoes) in a multilevel analysis investigating the relationship between basic deprivation and income inequality at the individual and country level. They use the Gini coefficient, but find it does not have significant power in explaining the variation in basic deprivation once differences in gross national disposable income per capita (GNDH) are taken into account. A similar multilevel study of EU-SILC data by Israel and Spannagel (2013) does find a significant relationship, however, using the European Commission definition of material deprivation and P50/P10 measure of income inequality.

Calvert and Nolan (2012) also explicitly focus on identifying any relationship between material deprivation and income inequality using EU-SILC data, using the European Commission definition of material deprivation and only macro-level variables. The authors emphasise the significance from a policy perspective if such a relationship were to be established, indicating that the distribution of income, as well as its level, should be incorporated in order to account for variation in deprivation. They find that controlling for national income, an increase in the level of Gini income inequality is indeed associated with an increase in country-level material deprivation using repeat cross-sectional data from 2004-2010, but that the impact of inequality on deprivation decreases for higher income countries.

2.2 The Multidimensional Poverty Index

The MPI, also known as the adjusted headcount ratio, is a measure of the extent to which a country's population experiences multidimensional poverty, that is, overlapping deprivations in multiple aspects of life. The most commonly-used measure of disadvantage focuses only on monetary poverty, yet in reality disadvantage is often experienced in a broader sense. If an individual suffers from multiple disadvantages at the same time – for example lack of schooling, chronic bad health and poor living environment – then focusing on income alone does not capture a comprehensive picture of such an individual's circumstances. If we know an individual is multidimensionally poor, then we can break down the MPI to see how they are poor, and whether such deprivations affect the same individuals and households or different ones.

The MPI relies on the Alkire Foster (AF) method of poverty measurement (Alkire and Foster, 2011), which is itself a flexible methodological framework that leaves users to make their own decision about parameters within the general method. These parameters – dimensions, indicators, two sets of weights and cut-off points – will be discussed further below, however it may be useful to first summarise the AF method in intuitive terms.

In brief, the AF method may be understood as:

- First, counting the (weighted) number of indicators in which individuals experience deprivation; this requires the selection of dimensions, indicators for each dimension, as well as binary cut-offs for what constitutes deprivation.
- Second, deciding which of these individuals experience a number of deprivations exceeding a chosen cut-off value "k", and are therefore identified as "multidimensionally poor". This requires the selection of the binary cut-off for number of deprived dimensions; those who don't reach the cut-off are removed from consideration ("censored"), focusing instead on those who are multidimensionally poor.
- Finally, the first two parts of information are used to calculate:
  a) the proportion of all individuals who are multidimensionally poor (known as the "incidence" or censored headcount ratio "H"), and
  b) the average number of deprivations experienced by those who are multidimensionally poor (known as the "intensity" or average number of deprivations "A").

The MPI is calculated by multiplying the incidence of poverty "H" by the average intensity of poverty "A", and is known in the general AF terminology as the "adjusted headcount ratio" or "M_0". That is,

$$MPI = M_0 = H \times A$$

The terms "MPI", "adjusted headcount ratio", and "M_0" will be used interchangeably. The metric of the MPI can range from zero to one. It shows the proportion of deprivations that a country's poor people experience out of the total possible deprivations that would be experienced if every person in the society were poor and deprived in every indicator.

The MPI allows comparisons to be made both across countries and within countries among different subgroups of people. It provides both a headline poverty measure, which captures the incidence and intensity of

multidimensional poverty, and can be broken down by indicator to show the range of different disadvantages experienced. This headline MPI measure can also be seen as a compromise between the union and intersection approaches to multidimensional poverty measurement. The union approach identifies an individual as poor if she is deprived in any dimension, whereas the intersection approach identifies an individual as poor only if she is deprived in all dimensions of poverty that are considered. It can be argued that the union approach does not consider the joint distribution of deprivations at all, while the intersection criteria is too demanding and may fail to identify many significantly deprived individuals. The multidimensional cut-off approach of the MPI therefore offers a less extreme method of identifying who is poor.

2.2.1 Methodological choices in the MPI

As mentioned, the AF method is a general framework for measuring multidimensional poverty, allowing users to set the parameters according to the context and purpose of their measure. The method does not itself specify the dimensions, indicators, weights, or cutoffs to be used. Specifically, decisions by the user are required for:

1) The selection of dimensions, and indicators to represent these dimensions
2) The selection of dimension weights and indicator weights (to indicate the relative importance of the different deprivations)
3) Binary indicator cut-off criteria (to determine when an individual is deprived in that indicator), and
4) A binary poverty cut-off (to determine when individuals experience enough deprivations to be considered to be poor).

The MPI has attracted some critique for the perceived arbitrariness of the method in terms of weights and cut-offs for aggregating into a single index, and for the heavy data requirements of the method (all indicators must be matched at the individual-level and therefore come from the same dataset). Discussion of these critiques and their counterarguments are laid out in more detail in an earlier paper in the series (Yang, 2017). Nevertheless, the MPI has well-understood theoretical properties and provides a structured and transparent way of measuring the experience of poverty in multiple dimensions.

2.2.2 Applications of the MPI

The Global MPI developed for, and used by, the United Nations Development Programme for the annual assessment of 102 developing

countries since 2010 is perhaps the most well-known application of the AF method. Recently the AF methodology has also been applied to EU-SILC data to measure multidimensional poverty in developed countries in Europe. Since these applications are most relevant to our analysis, we briefly review them here.

Alkire and Apablaza (2016) implement the AF method using 2006-2012 EU-SILC data. The authors use dimensions and indicators incorporating the three EU 2020 inclusive growth targets: relative income poverty (household equivalised disposable income after social transfers), employment (household joblessness) and material deprivation, as well as three additional dimensions: education, living environment and health. The study is descriptive, finding that poverty in the countries examined decreased on average between 2006 and 2012, mainly due to reduction in the percentage of multidimensionally poor people (the censored headcount ratio) rather than a reduction in poverty intensity of the poor. The Southern Region of the continent is identified as the most multidimensionally poor, and the Northern area the least poor.

There is a very small body of literature examining the macro-level covariates of multidimensional poverty, and we have identified only one empirical analysis explicitly examining the relationship between income inequality and multidimensional poverty, as measured by the MPI (Whelan et al., 2014). Using 2009 EU-SILC data, Whelan et al. (2014) conduct an OLS multilevel analysis of micro-level covariates of multidimensional poverty, as well as investigating its relationship with some macro-level variables including Gini income inequality. The authors find a positive relationship between income inequality and their MPI specification, which includes dimensions of basic deprivation, consumption deprivation, health and neighbourhood environment. However, they find that the relationship with Gini income inequality is not statistically significant once GDP per capita is controlled for.

Watson et al. (2016) conduct an analysis of multidimensional poverty in Ireland, basing their MPI measure on the Whelan et al. specification. They are unable to investigate variables such as income inequality that vary at the country level, however, and focus on micro-level covariates. There has also been a country-specific study of the MPI for Germany (Suppa, 2015), as well as multiple studies of specific developing countries.

3 Empirical MPI specifications

3.1 Data

We draw data from two sources for our analysis. First, we use Eurostat data on macro-level income indicators. Second, we use data from the European Quality of Life Survey (EQLS) to construct our MPI poverty measures at the micro level. The methodology of the MPI is such that data for all indicators must be matched at the level of the individual, and therefore must come from a single dataset.

The EQLS is a pan-European survey, established in 2003 and carried out every four years. The strength of the EQLS lies in its coverage of subjective topics, which tend not to be covered in as much depth in general economic statistics. Such topics include the perceived quality of society, how satisfied they are with their lives, and their participation in society. This coverage enables us to explore the implications of using a broader concept of multidimensional poverty in this paper. Objective circumstances are also surveyed, including topics covered by the Eurostat data, such as material deprivation, housing and health. The survey is a repeated cross-sectional study of residents aged 18 and over in 27 EU countries (as of the 2011 wave) as well as a number of non-EU countries which vary in coverage by wave. Interviews are carried out face-to-face, with 43,636 respondents in total in the 2011 wave ranging from around 1,000 in the smaller countries to 3,000 in the largest. In all countries, a multi-stage, stratified and clustered random sampling design is used, with weighting coefficients included to reweight the sample by gender, age, urbanisation level, region and household size to be representative of the population.

Income in the EQLS surveys is measured as the respondent's estimated net household income, with a variety of answering options (weekly, monthly, annual) and the option of providing income bands if a precise figure cannot be given. The income question is somewhat rough, since the income of individual household members is not asked about separately, and information is not checked with the main income earner in cases where this is not the respondent. However, because of the requirement that data for all the MPI indicators must come from a single dataset, we use the EQLS data for the income dimension of the MPI. However, for the macro-level variables on income inequality, GDP per capita and relative poverty we use the Eurostat data rate due to its greater accuracy. Despite the differing quality, it has been shown that median country incomes calculated using the EQLS data are sufficiently correlated with the GDP per capita to be used with a degree of accuracy (Fahey et al., 2005).

Note also that we lose observations of individuals with missing data for any of the indicators required for the MPI. This is again due to the MPI's measurement of individual-level deprivation in multiple dimensions, and is why the multilevel models of the different MPI specifications (detailed in Section 3.2) have different numbers of observations N in Table 5 to Table 7. While post-stratification weights are applied to adjust for over and underrepresentation of certain groups in the sample due to differences in availability to participate in a survey, no further corrections are made to adjust for missing indicator data.

3.2 Two MPI specifications

In line with the theoretical framework of the MPI as explained in Section 2, this section describes the two alternative specifications we develop for a multidimensional poverty index (MPI) – MPI1 and MPI2.

3.2.1 MPI1 (replication of Alkire and Apablaza (2016) MPI)

MPI1 is based on Alkire and Apablaza (2016), reviewed in Section 2.2.2, which incorporates six dimensions of deprivation: relative income poverty, employment, material deprivation, education, living environment and health. The Alkire and Apablaza (2016) indicators within each of these dimensions were matched to EQLS variables, and dimensions were weighted equally, in line with Alkire and Apablaza (2016). Details of the corresponding variables are provided in Table 1, along with their deprivation cut-offs and weights.

There are some key differences to note between the Alkire and Apablaza (2016) MPI and our MPI1 specification due to differences in the EU-SILC and EQLS datasets. Alkire and Apablaza use a household level indicator of employment (household work intensity) whereas our specification uses individual-level employment status. They also use the European Commission definition for their material deprivation dimension, whereas information on some of the European Commission deprivation items are unavailable to us in the EQLS data, and likewise within the living environment and health dimensions, the crime and morbidity indicators were not available to us. Despite these differences, the indicator-specific deprivation rates of our specification using the EQLS are very similar to those reported in Alkire and Apablaza (2016).

3.2.2 MPI2 (EMF based MPI)

An alternative specification, MPI2, is based on indicators from the Equality Measurement Framework (EMF) developed by Burchardt & Vizard (2011) which evaluates inequality and disadvantage across 10 critical domains of

life (or capabilities). Suh et al. (2013) used the EQLS to examine outcomes across five different EMF domains across the EU 27 countries. Here, we similarly expand the multidimensional definition of poverty to cover five of the EMF domains: standard of living, productive and valued activities, health, education and individual life.

This approach allows us to incorporate some of the rich information on outcomes available through the EQLS, including information on unpaid productive and valued activities (such as caring activities and volunteering), mental health and aspects of individual life such as freedom, autonomy, dignity and life satisfaction. The productive and valued activities dimension includes homemakers as non-deprived in that dimension (although they form a small portion of the sample) and retirees as non-deprived if engaged in caring or volunteering. In this way, the MPI2 specification recognises the value of unpaid domestic labour by homemakers, and the contribution of caring and volunteering by those who are not in the labour market. Conversely, it also recognises that the absence of productive contributions can have a detrimental effect on well-being for those who are retired but who do not engage in caring or volunteering activities. Ideally, we would have a more flexible definition of productive and valued activities, taking account of any activity that *would* be valued positively in the labour market if someone else were paid to carry it out. With the data at hand, however, this is not possible. A more detailed breakdown of the MPI2 specification, including weights and criteria for deprivation thresholds, is given in Table 1.

Table 1. List of MPI parameters for MPI specifications 1 and 2

Dimension	EQLS variable		Weight	Binary deprivation cut-off	Waves used
MPI1					
Income (1/6)	Equivalised net household income per month (PPS)		1/6	Below 60% of median	2011, 2007
Employment (1/6)	Employment status		1/6	Unemployed	2011, 2007
Material Deprivation (1/6)	Has rent or utilities arrears		1/6	Deprived in >2 indicators	2011, 2007
	Cannot afford a week's annual holiday				2011, 2007
	Cannot afford meat/equivalent meal every 2nd day				2011, 2007
	Cannot afford to keep house adequately warm				2011, 2007
Education (1/6)	Level of education (ISCED level)	Education	1/6	No secondary education	2011, 2007
Environment (1/6)	Noise from street		1/18	Many/some reasons to complain	2011,
	Air pollution	Air pollution	1/18	Many/some reasons to complain	2007
	Air quality			Many/some reasons to complain	2011
	Rot	Housing problems	1/18	Many/some reasons to complain	2011, 2007

	Damp/leaks			Many/some reasons to complain	2011, 2007
Health (1/6)	Self-rated general health		1/18	Bad/very bad	2011, 2007
	Chronic/long-standing illness	Chronic illness	1/18	Yes	2011, 2007
	Unmet medical needs		1/18	A little/very difficult seeing doctor due to either distance/ appointment delay/waiting time/cost	2011, 2007
MPI2					
Standard of living (1/5)	Equivalised net household income per month (PPS)		1/15	Below 60% of national median	2011, 2007
	Material deprivation		1/15	Deprived in ≥3 indicators (as above)	2011, 2007
	Noise from street	Environment	1/45	Many/some reasons to complain	2011, 2007
	Air quality		1/45	Many/some reasons to complain	2011, 2007
	Housing problems		1/45	Many/some reasons to complain	2011, 2007
Productive and valued activities (1/5)	Not working (either paid or unpaid, excluding full-time students)		1/5	Not working and no caring or volunteering	2011, 2007
	Caring activities				2011, 2007
	Volunteering				2011, 2007

Health (1/5)	Self-rated general health		1/20	Bad/very bad	2011, 2007
	WHO index (cheerful/calm/active/fresh/ interesting daily life)	Mental health	1/40	Combined score <13 out of 25[1]	2011, 2007
	Negative mental health (tense/lonely/downhearted)		1/40	All the time/more than half the time	2011, 2007
	Chronic/long-standing illness		1/20	Yes	2011, 2007
	Unmet medical needs		1/20	A little/very difficult seeing doctor due to either distance/ appointment delay/waiting time/cost	2011, 2007
Education (1/5)	Secondary education		1/5	No secondary education	2011, 2007
Individual life (1/5)	Autonomy (perceptions of being free to decide how to live life)		1/20	Disagree or strongly disagree	2011, 2007
	Self-rated social exclusion (perceptions of being left out of society)		1/20	Agree/strongly agree	2011, 2007
	Dignity (perceptions of being looked down on)		1/20	Agree/strongly agree	2011, 2007
	Perceptions of life satisfaction		1/20	≤ 5 out of 10	2011, 2007

[1] A score below 13 indicates poor well-being and is an indication for testing for depression (World Health Organization, 1998).

4 Measures of income inequality

Since we are interested in the relationship between income inequality and our multidimensional measures of poverty, we first discuss the income inequality indicators to be used in the analysis. For these aggregate-level inequality measures, income data is taken from Eurostat rather than calculating the measures over the EQLS micro-level data. This is for the reasons of income data quality given in Section 3.1. Income is defined as household disposable income from employed and self-employed earnings, capital income and public cash transfers in a given year, net of income taxes and social security contributions. This disposable household income is equivalised, allocating among household members and adjusting for economies of scale within the household to reflect different needs for households of different sizes. Inequality is then calculated over the resulting equivalised disposable incomes. It is important to note, therefore, that the income inequality measures already reflect and capture some effect of government policy through taxes and transfers.

Four measures of income inequality among individuals are investigated: the Gini coefficient, P90/P10 ratio, P90/P50 ratio, and P50/P10 ratio. The widely-used Gini coefficient is based on comparing cumulative proportions of the population against cumulative proportions of income they receive, and it ranges between 0 in the case of perfect equality and 1 in the case of perfect inequality. P90/P10 is the ratio of the upper bound value of the ninth decile (i.e. the level of income at which there are 10% of people in the distribution with a higher income) to that of the first decile; P90/P50 of the upper bound value of the ninth decile to the median income; and P50/P10 of median income to the upper bound value of the first decile.

Each of these inequality measures varies in its sensitivity to changes in different parts of the distribution. The Gini coefficient is most sensitive to changes near the mode and less sensitive to changes at the two tails. The percentile ratio measures are sensitive only to the disparities between the specified pair of deciles: the P90/P10 is sensitive to disparities between the top and bottom 10% of the distribution, the P90/P50 is sensitive to disparities in the top half of the distribution, and the P50/P10 to disparities in the bottom half. These percentile ratio measures are readily available in macro level datasets and comparable across countries. While other measures, such as the Atkinson or Generalised Entropy families of inequality measures, have the advantage of some theoretically attractive properties, in practice they are less frequently published in macro level data series.

5 Empirical analysis

5.1 Relationship between dimensions of poverty

We first highlight the importance of focusing on the multidimensionally poor by constructing "censored" deprivation rates. These are the percentage of MPI-poor people who are deprived in each indicator, as opposed to the raw deprivation rates for the population as a whole, including those who are not MPI-poor. Table 2 shows the correlations between our MPI1 dimensions of poverty, with the raw (uncensored) deprivation rates above the diagonal and censored deprivation rates below the diagonal.

From Table 2 we see that the correlations between the censored deprivation rates below the diagonal are much higher than those of the raw deprivation rates. The average correlation between raw deprivation rates is 0.108, whereas average correlation between censored deprivation rates, observing only those who are MPI poor, is over three times as high: 0.393. Using the censored approach of the MPI therefore highlights the much more difficult experience of the multidimensionally poor, who clearly have much more closely associated dimensions of deprivation in comparison to the population as a whole.

Table 2. Correlation matrices of MPI1 indicators, with raw deprivation rates above the diagonal and deprivation rates for the MPI1-poor below the diagonal

	Income	Unempl	Material	Educ	Noisy	Air poll	Housing	Health	Chronic	Medical
Income	1	0.194	0.198	0.134	0.023	0.011	0.131	0.097	0.069	0.072
Unempl	0.502	1	0.148	0.135	0.041	0.038	0.103	-0.016	-0.035	0.058
Material	0.488	0.398	1	0.179	0.075	0.085	0.250	0.171	0.093	0.181
Educ	0.481	0.457	0.477	1	0.028	0.024	0.120	0.137	0.109	0.113
Noisy	0.303	0.303	0.315	0.322	1	0.507	0.100	0.032	0.019	0.070
Air poll	0.292	0.304	0.323	0.325	0.629	1	0.096	0.028	0.007	0.080
Housing	0.522	0.469	0.582	0.506	0.349	0.348	1	0.113	0.085	0.098
Health	0.367	0.193	0.418	0.414	0.250	0.246	0.383	1	0.450	0.138
Chronic	0.514	0.353	0.472	0.554	0.323	0.314	0.448	0.648	1	0.055
Medical	0.345	0.309	0.430	0.401	0.259	0.275	0.385	0.352	0.349	1

5.2 Descriptive relationships of income inequality, material deprivation and MPI poverty

Here we investigate whether, and how, the relationship between our broader definitions of poverty and income inequality differ from the relationship between income poverty and inequality. This descriptive analysis builds on an earlier paper within this series (Karagiannaki, 2017), which finds a strong correlation between levels of income poverty and income inequality when looking at cross-sectional differences across a number of European countries. The strongest correlation was found for inequality measures capturing income dispersion at the bottom of the distribution and measures of income poverty rates rather than income poverty depth. Karagiannaki finds that the link between poverty and inequality remains when one considers changes in inequality and poverty across countries over time, but that this is much weaker than the cross-sectional relationship across countries, especially when considering top income shares as the measure of income inequality.

Table 3 presents cross-sectional correlations for 2011 between the different measures of poverty and income inequality. The four measures of income inequality are those detailed in Section 4: the Gini coefficient, and the P90/P10, P90/P50 and P50/P10 income percentile ratios. The measures of poverty are income poverty (<60% of median equivalised income), material deprivation as measured by the material deprivation dimension of the MPIs using EQLS data (see Table 1), and our two MPI specifications.

Table 3. Correlations of broader poverty and income inequality measures 2011. Source: EU-SILC for income and material deprivation measures[2], based on own calculations from EQLS for MPI measures

2011

	Income poverty	Material dep	MPI1	MPI2
Gini	0.87***	0.58***	0.61***	0.62***
P90/P10	0.94***	0.73***	0.61***	0.63***
P90/P50	0.77***	0.58***	0.60***	0.61***
P50/P10	0.97***	0.74***	0.57**	0.58**

*** p≤0.001 ** p≤0.01 *p≤0.05

[2] Here and in Table 4 we use income and material deprivation measures from EU-SILC to maintain a degree of comparability with Karagiannaki (2017). Sensitivity analysis shows that using EQLS data does not substantively affect these descriptive findings.

Across all four inequality measures, the strongest positive correlations with income inequality are observed with the income poverty measure. Given that both these poverty and inequality measures are summary measures of the same distribution – income – this result should not be surprising. Although the correlations between income inequality and the broader poverty measures are slightly weaker, all are consistently significant and positive. For the income poverty measure, the correlation with P90/P50 inequality is the weakest among the inequality measures. Intuitively, since the <60% median poverty measure and P90/P50 inequality measures each focus on mutually exclusive portions of the income distribution, this correlation coefficient does not capture any mechanical correlation from measuring overlapping portions of the distribution. That these non-overlapping measures are still strongly significantly and positively correlated indicates there are other substantive mechanisms generating this link between income poverty and inequality.

For the two MPI measures, the weakest correlation with an income inequality measure is in fact not with the P90/P50 measure, but with the P50/P10 inequality measure. However, the differences between the weakest and strongest correlations between the MPI and inequality measures are less pronounced than the differences between the income poverty and inequality measures.

The material deprivation measure shows the weakest correlations with the Gini and P90/P50 income inequality measures, which may reflect that it does not directly include income poverty unlike the MPI1 and MPI2 measures, which include an income poverty dimension. The correlation of the MPI measures are not purely driven by the income dimension, however. If the income dimension is removed from the MPI measures altogether, the significant positive relationship with income inequality remains.

Table 4 considers correlations between changes in income inequality and our broader definitions of poverty across countries over time from 2007 to 2011. While the link between income poverty and inequality remains when we consider changes in poverty and inequality over time rather than a cross-sectional correlation, the relationship is weaker. Weakest is the relationship between income poverty changes and changes in inequality captured by the top part of the income distribution, for which the correlation is statistically insignificant. This is in keeping with Karagiannaki (2017). For changes in material deprivation and the MPI1 measure, while the relationship with changes in income inequality measures appear to be positive in general, statistical insignificance testing shows that this relationship is not significant. (We are unable to calculate changes in MPI2

because a number of variables necessary to construct the MPI2 measure are only available in 2011.)

The indication of this is that while *levels* of material deprivation and income inequality, and levels of multidimensional poverty and income inequality are strongly positively related to one another, this does not necessarily mean that the evolution of material deprivation and multidimensional poverty will follow that of income. This was also found to be the case when considering correlations between income inequality changes in an earlier period (2003-2007) and lagged changes in measures of material deprivation and multidimensional poverty (2007-2011). The observed lack of relationship over time does not therefore appear to be down to lags between these changes, at least in the short run.

Table 4. Correlations of change in broader poverty and income inequality measures between 2007 and 2011. Source: EU-SILC for income and material deprivation measures, based on own calculations from EQLS for MPI measures

Change from 2007-2011

	Income poverty	Material dep	MPI1	MPI2
Gini	0.55**	-0.01	0.11	-
P90/P10	0.64***	0.15	0.21	-
P90/P50	0.30	0.10	0.13	-
P50/P10	0.73***	0.15	0.20	-

*** p≤0.001 ** p≤0.01 *p≤0.05

5.3 Parametric model specification

The following section details the model specifications for further cross-sectional analysis of the relationship between income inequality and our implementations of the MPI using EQLS data. The rationale for these model specifications is in line with the recommendations of Alkire et al. (2015, pp. 308-309), and we turn to a discussion of these first.

For regressions using the MPI or components of the MPI, two types of dependent variable are possible. The first type is a binary indicator, such as identifying whether an individual or household is multidimensionally poor, or deprived in a dimension of MPI poverty. These variables take a value of one if the household is identified as multidimensionally poor (or deprived in the dimension) and zero otherwise. A probit or logit model would be suitable for these binary indicators, and in our analysis of the material deprivation dimension of MPI poverty a logit model is used.

The second possible type of dependent variable is a proportion, such as the adjusted headcount ratio M_0 (the MPI) or the incidence H, which can take values in the unit interval bounded by zero and one. Alkire et al. suggest a fractional regression model for this type of dependent variable (Ramalho et al., 2011) using a generalised linear model (GLM). In our models of the MPI as dependent variable, we therefore use the 'fractional logit model' suggested by Papke and Wooldridge (1996), which is a GLM with a binomial distribution and logit link function.

In addition, we use a multilevel modelling approach for all our models, also known as a random effects model. Our data are characterized by a hierarchical structure where individual observations are nested within countries, and observations within country clusters may be correlated, for

example due to domestic policy or cultural norms. Using multilevel modelling recognises this hierarchical structure and a) ensures that standard errors of regression coefficients are not underestimated, b) enables us to analyse country effects, and c) allows us to estimate country effects simultaneously with the effects of country-level regressors, of which country-level income inequality is our key regressor of interest.

The analyses presented in Section 5.4 are cross-sectional models using the 2011 wave, although the main results can also be replicated using the previous 2007 wave (large quantities of missing macro data from Eurostat for 2003 meant we were unable to satisfactorily analyse the 2003 wave). Section 5.5 develops the cross-sectional analysis into an over-time multilevel model, incorporating both cross-sectional variation across countries and within-country variation over the two waves.

5.4 Multilevel analysis of relationships

5.4.1 Material deprivation and income inequality

According to the specification described in the section above, Table 5 presents a set of multilevel regressions investigating cross-country variation in the relationship between material deprivation and Gini income inequality. The dependent variable is the binary status of whether an individual is deprived in the material deprivation dimension, with the random intercept multilevel structure taking account of clustering within countries and allowing us to capture the degree of between-country variation (the data contain only one respondent per household so there is no clustering within households). Details of the independent regressors can be found in the appendix.

Coefficients are displayed as odds ratios, so that a value of 1 indicates no directional relationship; a value of less than 1 indicates a negative relationship; and a value of greater than 1 indicates a positive relationship. P-values are displayed in square brackets. The regressions consider the influence of several micro and macro level factors on the focal MPI-inequality relationship, and whether these factors can partly explain the structure of the observed variation.

5.4.1.1 Null and basic models

Column (1) of Table 5 shows the null model with no regressors. The intra-class correlation coefficient (ICC) of 0.310 indicates that between-country variance (or equivalently within-country correlation) accounts for over 30 percent of the total variance in MPI1 scores. Column (2) adds to the null model the Gini variable without other independent regressors, giving us a

basic model for the relationship of interest between multidimensional poverty and income inequality. Consistent with the correlations in Table 3, a positive and significant relationship between material deprivation and Gini income inequality is evident, reducing the ICC to 0.218.

5.4.1.2 Micro level regressors

Column (3) adds a set of individual and household-level regressors, comprising EU citizenship, marital status, sex, number of children in the household, and age group. The set of coefficients follow a systematic pattern of material deprivation tending to be higher for females, single parents, and non-EU citizens. These relationships are all highly statistically significant, and significantly reduce the log likelihood of the model. Their addition does not, however, reduce the ICC, indicating that an important component of the compositional differences in multidimensional poverty between countries may not yet have been factored in.

Occupational group is added as a regressor in column (4), and the reduction in ICC to 0.209 indicates that cross-country compositional differences in relation to occupational group do contribute to explaining the cross-country variance in material deprivation. As expected, the higher skilled managerial and professional groups are associated with lowest material deprivation. The unskilled elementary occupation group tends to suffer from the highest material deprivation, with skilled agricultural forestry and fishery workers doing slightly better, followed by plant and machine operators or assemblers. Our finding aligns with that of Whelan and Maître (2010) that, unlike unidimensional income poverty, which identifies the farming class as having the highest odds of being in poverty, using a broader definition of vulnerability incorporating material deprivation identifies the manual class as the most disadvantaged class.

The coefficient for the Gini variable remains highly significant throughout, with more income-unequal countries tending to have higher odds of material deprivation on average. Micro-level compositional factors are not, therefore, sufficient to account for the cross-country relationship between Gini income inequality and material deprivation.

5.4.1.3 Macro level regressors

In columns (5) to (7), GDP per capita, welfare regime and relative income poverty rate are added as macroeconomic factors that could influence the relationship between multidimensional poverty and Gini inequality. Countries with higher GDP are associated with slightly lower material deprivation on average, and the statistical significance of the coefficient on Gini inequality is not affected by controlling for GDP per capita.

The social democratic welfare regime is associated with lower material deprivation in comparison to the other regime types, including the UK and Ireland (liberal regime), after controlling for differences in GDP per capita and relative income poverty rate. The inclusion of welfare regime in the model does, however, appear to account for the relationship between material deprivation and Gini income inequality. Differences in income inequality therefore cannot contribute additional explanatory power to the variation in material deprivation over and above that explained by welfare regime. Note that the correlation between welfare regime (ordered by mean within-regime GDP per capita) and Gini inequality is -0.7634. Moving to the multilevel models with multidimensional poverty as our dependent variable in Section 5.4.2, we will see that this interpretation is sensitive to using a broader definition of poverty.

Table 5. Set of multilevel random intercept models for material deprivation with micro and macro regressors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	Gini only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Material deprivation							
Gini		1.212***	1.214***	1.202***	1.103**	1.056	1.089
		[0.000]	[0.000]	[0.000]	[0.003]	[0.194]	[0.101]
EU citizen			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Non-EU citizen			2.462***	2.044***	2.052***	2.051***	2.051***
			[0.000]	[0.001]	[0.001]	[0.001]	[0.001]
Married or living with partner			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			2.219***	2.153***	2.150***	2.154***	2.154***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			1.850***	1.685***	1.683***	1.682***	1.682***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Never married and not living with partner			1.658***	1.551***	1.552***	1.554***	1.555***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.159***	1.109**	1.109**	1.110**	1.110**
			[0.000]	[0.001]	[0.001]	[0.001]	[0.001]

Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			1.095*	1.138**	1.137**	1.137**	1.137**
			[0.030]	[0.007]	[0.007]	[0.007]	[0.007]
18-			0.756*	0.600***	0.600***	0.602***	0.601***
			[0.049]	[0.001]	[0.000]	[0.001]	[0.001]
25-			0.899	0.863	0.863	0.864	0.864
			[0.244]	[0.081]	[0.082]	[0.084]	[0.083]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.029	1.006	1.006	1.007	1.007
			[0.700]	[0.930]	[0.928]	[0.922]	[0.923]
55-			1.032	0.974	0.972	0.973	0.973
			[0.708]	[0.753]	[0.743]	[0.748]	[0.748]
65-			0.836	0.751*	0.751*	0.752*	0.752*
			[0.134]	[0.015]	[0.015]	[0.016]	[0.016]
80-			0.665*	0.604**	0.603**	0.604**	0.604**
			[0.013]	[0.002]	[0.002]	[0.002]	[0.002]
Other/unknown occupation				0.682**	0.683**	0.681***	0.681***
				[0.001]	[0.001]	[0.001]	[0.001]
Manager				0.255***	0.255***	0.256***	0.256***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.236***	0.236***	0.236***	0.236***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.265***	0.265***	0.265***	0.265***
				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.312***	0.313***	0.313***	0.313***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.525***	0.525***	0.526***	0.526***
				[0.000]	[0.000]	[0.000]	[0.000]
Skilled agricultural forestry and fishery worker				0.634***	0.633***	0.632***	0.633***
				[0.000]	[0.000]	[0.000]	[0.000]
Craft and related trades worker				0.640***	0.639***	0.639***	0.639***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.657***	0.656***	0.655***	0.656***
				[0.000]	[0.000]	[0.000]	[0.000]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]
GDP per capita					0.993***	0.995***	0.995***
					[0.000]	[0.000]	[0.000]

social democratic regime						1	1
						[.]	[.]
corporatist regime						2.180	2.293*
						[0.055]	[0.045]
liberal regime						4.126***	4.201***
						[0.000]	[0.000]
southern European regime						5.000**	5.512**
						[0.003]	[0.003]
post-socialist corporatist regime						4.960***	5.140***
						[0.000]	[0.000]
post-socialist liberal regime						3.985**	4.225**
						[0.006]	[0.007]
residual regime						4.366**	5.477*
						[0.006]	[0.019]
Relative poverty rate							0.953
							[0.545]
Constant	0.0757***	0.000240***	0.000133***	0.000413***	0.0328**	0.0195***	0.0162***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.008]	[0.001]	[0.000]
Variance of country-level constants	4.378***	2.497***	2.624***	2.382***	1.457**	1.226**	1.218***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.010]	[0.003]	[0.001]
Model (1) ICC	0.310						
Model (2) ICC		0.218					
Model (3) ICC			0.227				
Model (4) ICC				0.209			
Model (5) ICC					0.103		
Model (6) ICC						0.0583	
Model (7) ICC							0.0567
Log likelihood	-10664.2	-9457.7	-9118.3	-8874.7	-8864.7	-8856.4	-8856.1
Degrees of freedom	0	1	13	22	23	26	26
N	35515	33680	33358	33358	33358	33358	33358

Exponentiated coefficients; *p*-values in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.4.2 MPI1 and income inequality

We now investigate cross-country variation in the relationship between MPI1 poverty and income inequality, presented in Table 6. The dependent variable is the individual-level MPI1 score. Coefficients are displayed as relative proportion ratios, to be interpreted in the same way as odd ratios for binary dependent variables.

5.4.2.1 Null and basic models

The ICC for the null model in Column (1) of Table 6 indicates that cross-country variance accounts for over 16 percent of the total variance in MPI1 scores – around half the variance observed for material deprivation. The basic model adding the Gini variable in Column (2) shows a positive and significant relationship between MPI1 poverty and Gini income inequality, consistent with the correlations in Table 3. This model more than halves the ICC compared to the null model to 0.0788.

5.4.2.2 Micro level regressors

Adding the micro-level regressors in Columns (3) and (4) we see a statistically significant pattern consistent with the material deprivation results, of MPI1 poverty tending to be higher for female and single parents, non-EU citizens and people working in unskilled elementary occupations. The significance of the coefficient for the Gini variable shows that even if we expand our definition of deprivation beyond consumption-based material deprivation and incorporate other dimensions of deprivation and poverty, the positive relationship observed between higher deprivation and higher Gini income inequality persists. Repeating the models using the P90/P50 and P50/P10 ratios in place of the Gini variable produces similar substantive relationships with MPI poverty.

5.4.2.3 Macro level regressors

The addition of the macro-level regressors in columns (5) to (7) indicates that countries with higher GDP are associated with slightly but statistically significantly lower MPI1 poverty scores on average. With the social democratic welfare regime as the benchmark, the liberal (UK and Ireland) and Southern European regimes (Cyprus, Greece, Italy, Malta, Portugal, Spain) are associated with relatively higher MPI1 poverty scores, controlling for differences in GDP per capita. As with the material deprivation models, the introduction of relative income poverty rate to the regressors produces almost no reduction in log likelihood, and therefore does not contribute additional explanatory power to variation in MPI1 scores.

Statistical significance of the coefficient on Gini is not affected by adding the macro-level variables. The relationship of multidimensional poverty with income inequality therefore appears to be distinct from any relationship with GDP per capita, welfare regime or relative income poverty in a country. This is a stronger statement than for the material deprivation model, in which the inclusion of welfare regime accounted for the relationship between Gini inequality and material deprivation.

Table 6. Set of multilevel random intercept models for MPI1 with micro and macro regressors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	Gini only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Individual Average deprivation k=34							
Gini		1.151***	1.152***	1.131***	1.098***	1.069*	1.067*
		[0.000]	[0.000]	[0.000]	[0.000]	[0.025]	[0.041]
EU citizen			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Non-EU citizen			2.234***	1.614***	1.623***	1.627***	1.627***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Married or living with partner			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			1.794***	1.783***	1.778***	1.787***	1.787***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			1.576***	1.338*	1.334*	1.339*	1.339*
			[0.000]	[0.016]	[0.017]	[0.014]	[0.014]
Never married and not living with partner			2.029***	1.845***	1.847***	1.851***	1.851***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.357***	1.262***	1.263***	1.264***	1.264***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			1.327***	1.345***	1.343***	1.344***	1.344***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
18-			0.894	0.525***	0.523***	0.527***	0.527***
			[0.494]	[0.000]	[0.000]	[0.000]	[0.000]
25-			1.030	0.969	0.969	0.970	0.970
			[0.846]	[0.818]	[0.814]	[0.821]	[0.822]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.112	1.082	1.083	1.083	1.083
			[0.209]	[0.331]	[0.329]	[0.330]	[0.330]
55-			1.292**	1.202*	1.200*	1.200*	1.200*
			[0.002]	[0.017]	[0.018]	[0.018]	[0.018]
65-			1.091	0.897	0.897	0.895	0.895
			[0.602]	[0.477]	[0.475]	[0.465]	[0.465]

80-			1.288	1.035	1.036	1.032	1.032
			[0.180]	[0.848]	[0.846]	[0.862]	[0.862]
Other/unknown occupation				1.077	1.082	1.071	1.071
				[0.528]	[0.503]	[0.557]	[0.558]
Manager				0.144***	0.144***	0.145***	0.145***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.0918***	0.0921***	0.0925***	0.0925***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.175***	0.176***	0.177***	0.177***
				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.148***	0.149***	0.148***	0.148***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.365***	0.366***	0.366***	0.366***
				[0.000]	[0.000]	[0.000]	[0.000]
Skilled agricultural forestry and fishery worker				0.724**	0.723**	0.720***	0.720***
				[0.001]	[0.001]	[0.001]	[0.001]
Craft and related trades worker				0.530***	0.529***	0.530***	0.530***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.553***	0.552***	0.549***	0.549***
				[0.000]	[0.000]	[0.000]	[0.000]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]
GDP per capita					0.998***	0.998*	0.998*
					[0.000]	[0.020]	[0.020]
social democratic regime						1	1
						[.]	[.]
corporatist regime						1.128	1.125
						[0.666]	[0.677]
liberal regime						1.744*	1.742*
						[0.020]	[0.020]
southern European regime						2.159*	2.146*
						[0.012]	[0.015]
post-socialist corporatist regime						1.437	1.434
						[0.153]	[0.159]

post-socialist liberal regime						0.948	0.945
						[0.863]	[0.857]
residual regime						1.553	1.532
						[0.169]	[0.260]
Relative poverty rate							1.003
							[0.945]
Constant	0.100***	0.00147***	0.000488***	0.00263***	0.0117***	0.0178***	0.0180***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Variance of country-level constants	1.913***	1.325***	1.356***	1.225**	1.160**	1.062*	1.062*
	[0.000]	[0.001]	[0.000]	[0.002]	[0.002]	[0.026]	[0.027]
Model (1) ICC	0.165						
Model (2) ICC		0.0788					
Model (3) ICC			0.0847				
Model (4) ICC				0.0581			
Model (5) ICC					0.0431		
Model (6) ICC						0.0180	
Model (7) ICC							0.0180
Log likelihood	-8338.5	-7354.5	-7017.3	-6533.2	-6529.4	-6520.4	-6520.4
Degrees of freedom	0	1	13	22	23	26	26
N	25795	24346	24162	24162	24162	24162	24162

Exponentiated coefficients; *p*-values in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.4.3 MPI2 and income inequality

5.4.3.1 Null and basic models

The same set of models for the MPI2 model is presented in Table 7. The null model with no regressors in Column (1) of Table 7 has an intra-class correlation coefficient (ICC) of 0.0986. The proportion of between-country variance in the MPI2 scores is therefore lower than that of the MPI1 scores, accounting for just under 10 percent of the total variance in MPI2 scores. The basic model with the Gini variable in Column (2) shows, as with MPI1, a positive and statistically significant relationship between MPI2 and Gini income inequality. This model almost halves the ICC compared to the null model to 0.0502.

5.4.3.2 Micro level regressors

The interpretation of the micro regressors for the MPI2 model is mostly in line with the corresponding models for MPI1 in Table 6. From Column (3) we again see the pattern of MPI2 poverty tending to be higher for females, single parents, and non-EU citizens. However, a key difference is that age group now takes on a strong directional relationship with MPI2 poverty, with the MPI2 scores of older age groups tending to be significantly higher.

This is in contrast to the relationship with MPI1, and may be due to the MPI2 classification of retirees in the productive and valued activities dimension as "unproductive" unless engaged in caring or volunteering. The MPI2 scores of retirees are therefore partly driven by lack of caring and volunteering activities, whereas this was not the case with MPI1 scores.

The addition of occupational group in column (4) shows the same relationship as before, with managerial and professional groups associated with lowest MPI2 poverty and the elementary occupation group associated with the highest MPI2 poverty scores. Controlling for occupational group also accounts for the variation previously attributed to sex, number of children and non-EU citizenship. The other micro-level regressors remain highly statistically significant, and significantly reduce the log likelihood of the model.

Again, the coefficient for the Gini variable remains highly significant throughout. It appears that moving towards a broader concept of deprivation, from a narrow definition of material deprivation in Table 5 to incorporating wider ranges of dimensions from Figure 1, does not diminish the observed relationship of countries with higher Gini income inequality having higher multidimensional deprivation. This was true in moving to the MPI1 specification and again to the MPI2 specification. Again, compositional factors are not enough to account for the cross-country relationship between Gini income inequality and MPI2 poverty.

5.4.3.3 Macro level regressors

GDP per capita, welfare regime and relative income poverty rate are again introduced in columns (5) to (7). Interestingly, the coefficients on neither GDP per capita nor relative income poverty rate are significant. Differences in welfare regime also seem to have little bearing on cross-country variation in MPI2 poverty, although the post-socialist corporatist regime (Czech Republic, Hungary, Poland, Slovakia, Slovenia) does seem to relate to higher MPI2 scores compared with the social democratic base category (Denmark, Finland, Netherlands, Sweden).

Statistical significance of the coefficient on Gini is not affected by adding the macro-level variables. The relationship of multidimensional poverty with income inequality therefore appears to be distinct from any relationship with general income level and relative income poverty in a country. All three macro level regressors produce only marginal or no reduction in log likelihood, and therefore the introduction of these variables does not seem to contribute much additional explanatory power to the micro variables.

Repeating the models using the P90/50 ratio in place of the Gini coefficient produces similar substantive relationships with MPI poverty, and using the P90/10 and P50/P10 ratios produces similar substantive relationships up to model (6), before welfare regime is added to the model. Regression tables using these inequality measures can be found in the Appendix.

Table 7. Set of multilevel random intercept models for MPI2 with Gini as measure of income inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	Gini only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Individual Average deprivation k=34							
Gini		1.116***	1.135***	1.118***	1.095***	1.125***	1.122**
		[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.009]
EU citizen			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Non-EU citizen			1.597***	1.209	1.212	1.216	1.216
			[0.000]	[0.121]	[0.115]	[0.110]	[0.110]
Married or living with partner			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			2.078***	2.121***	2.119***	2.128***	2.128***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			2.313***	2.063***	2.061***	2.062***	2.062***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Never married and not living with partner			2.893***	2.720***	2.720***	2.732***	2.732***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.105***	1.040	1.041	1.042	1.042
			[0.001]	[0.165]	[0.158]	[0.147]	[0.147]
Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			0.890*	0.913	0.912	0.912	0.912
			[0.048]	[0.124]	[0.119]	[0.119]	[0.119]
18-			0.411***	0.293***	0.293***	0.293***	0.293***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

25-			0.672**	0.656**	0.656**	0.655**	0.655**
			[0.009]	[0.003]	[0.003]	[0.003]	[0.003]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.746***	1.722***	1.722***	1.721***	1.721***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
55-			3.233***	3.169***	3.166***	3.165***	3.165***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
65-			6.659***	6.488***	6.482***	6.484***	6.484***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
80-			11.65***	11.63***	11.62***	11.62***	11.62***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Other/unknown occupation				0.702*	0.704*	0.701*	0.701*
				[0.016]	[0.016]	[0.015]	[0.015]
Manager				0.130***	0.131***	0.132***	0.132***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.0907***	0.0908***	0.0913***	0.0913***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.177***	0.177***	0.178***	0.178***
				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.195***	0.196***	0.197***	0.197***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.422***	0.423***	0.424***	0.424***
				[0.000]	[0.000]	[0.000]	[0.000]
Skilled agricultural forestry and fishery worker				0.803	0.803	0.803	0.803
				[0.105]	[0.104]	[0.103]	[0.101]
Craft and related trades worker				0.554***	0.553***	0.554***	0.554***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.737**	0.736**	0.737**	0.737**
				[0.002]	[0.002]	[0.002]	[0.002]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]
GDP per capita					0.998	0.999	0.999
					[0.073]	[0.536]	[0.535]
social democratic regime						1	1
						[.]	[.]
corporatist regime						0.970	0.966

						[0.923]	[0.914]
liberal regime						0.889	0.888
						[0.670]	[0.665]
southern European regime						1.223	1.212
						[0.553]	[0.582]
post-socialist corporatist regime						1.654*	1.649*
						[0.040]	[0.041]
post-socialist liberal regime						0.922	0.917
						[0.829]	[0.820]
residual regime						1.187	1.163
						[0.648]	[0.733]
Relative poverty rate							1.004
							[0.930]
Constant	0.141***	0.00529***	0.000735***	0.00315***	0.00897***	0.00265***	0.00269***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Variance of country-level constants	1.433***	1.190***	1.265***	1.186***	1.151***	1.119***	1.119***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]
Model (1) ICC	0.0986						
Model (2) ICC		0.0502					
Model (3) ICC			0.0666				
Model (4) ICC				0.0492			
Model (5) ICC					0.0411		
Model (6) ICC						0.0331	
Model (7) ICC							0.0331
Log likelihood	-9315.2	-8454.5	-7093.2	-6614.0	-6611.8	-6609.1	-6609.1
Degrees of freedom	0	1	13	22	23	26	26
N	24702	23323	23152	23152	23152	23152	23152

Exponentiated coefficients; *p*-values in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.5 Over-time multilevel analyses

This section presents an extension of the cross-sectional multilevel models to allow for an analysis of material deprivation and the MPI1 specification over two waves of the EQLS data (2007 and 2011), while simultaneously distinguishing between cross-sectional and over-time relationships. That is, the models are able to separate how the relationship between material deprivation and inequality, and the relationship between MPI1 poverty and inequality differ both *between* countries and *within* countries from one wave to the next. We are unable to carry out this analysis for the MPI2

specification since the complete set of variables necessary to construct the MPI2 measure are only available for 2011.

To do this analysis, we first calculate the mean of inequality across waves for each country. The coefficient on this country-mean variable captures the variation in multidimensional poverty explained by country differences in income inequality. To capture the variation in multidimensional poverty explained by variation over time within each country, inequality in each wave is then subtracted from mean inequality. The coefficient on the resulting country-year level variable can be estimated separately from the country-mean variable. This extension allows us to examine the over-time aspect of the relationship between material deprivation and inequality and between MPI poverty and inequality in a multilevel multivariate setting, without assuming the over-time relationship is the same as the cross-sectional one.

In Table 8 and Table 9, mean Gini and deltaGini indicate the country-mean and country-year level variables, capturing the between-country and within-country relationships respectively. The inclusion of the deltaGini variable, made possible by the additional wave of data, investigates the possible covariation between a shift in inequality and shift in material deprivation over time for Table 8, and a shift in inequality and shift in MPI1 poverty over time for Table 9. This relationship is estimated simultaneously alongside the cross-sectional associations between material deprivation and inequality, and MPI1 poverty and inequality respectively.

It can be seen that the over-time relationships are distinct from the cross-sectional ones. In Table 8 the positive and significant meanGini coefficients for models (1) to (5) reinforce the cross-sectional results for the material deprivation models from Table 5 –individuals in countries with higher Gini inequality tend to also have higher average levels of material deprivation, taking into account micro-level compositional factors. Looking at the deltaGini coefficients, the value of less than 1 for deltaGini in model (2) indicates a negative relationship between changes in material deprivation and changes in Gini inequality. However, this relationship becomes insignificant when micro-level compositional factors are accounted for.

In Table 9 the positive and significant meanGini coefficients for all models from (1) to (7) are again consistent with the cross-sectional results from the previous MPI1 models from Table 6. However, the deltaGini coefficients are statistically insignificant. It therefore appears that while individuals in countries with higher income inequality tend to suffer more

severely from material deprivation and multidimensional poverty, the severity of deprivation and poverty does not seem to have tracked changes in income inequality from the 2007 to 2011 wave, accounting for differences in various micro and macro level factors.

These over-time results may be due to the reductions in income inequality and rises in poverty that hit some European countries across the period of the Great Recession. The results may therefore be somewhat anomalous, and it is possible that analysing this over-time relationship for earlier and more extended periods may have resulted in a different finding for these over-time relationships. The earlier paper in this series by Karagiannaki (2017) did, however, identify a positive and statistically significant relationship between changes in income poverty and income inequality over a different time period. Time period may therefore be important in thinking about the relationship between poverty and income inequality. If EQLS and Eurostat data were jointly available for a much longer time series than a single four-year period, this may have captured greater variation giving us a better chance of identifying any longitudinal relationship. Our current model reinforces the descriptive evidence provided in Table 4. We find that a significant relationship between changes in material deprivation and Gini income inequality, and between changes in MPI1 poverty and Gini income inequality is *not* observed when we account for multivariate differences across countries over the time periods for which we have data.

Table 8. Multilevel model of micro level material deprivation with changes over time

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	Gini only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Material deprivation							
2nd EQLS (2007)	1	1	1	1	1	1	1
	[.]	[.]	[.]	[.]	[.]	[.]	[.]
3rd EQLS (2011)	1.269	1.482***	1.435***	1.535***	1.547***	1.546***	1.563***
	[0.068]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
meanGini		1.195***	1.200***	1.185***	1.097**	1.053	1.092
		[0.000]	[0.000]	[0.000]	[0.005]	[0.160]	[0.052]
deltaGini		0.908*	0.903	0.915	0.965	0.965	0.939
		[0.038]	[0.054]	[0.103]	[0.398]	[0.397]	[0.173]
Married or living with partner			1	1	1	1	1

			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			2.193***	2.145***	2.167***	2.170***	2.173***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			1.836***	1.667***	1.686***	1.684***	1.686***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Never married and not living with partner			1.585***	1.480***	1.471***	1.472***	1.468***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.186***	1.131***	1.130***	1.131***	1.130***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			1.106**	1.114**	1.115**	1.115**	1.114**
			[0.001]	[0.002]	[0.002]	[0.002]	[0.002]
18-			0.759*	0.593***	0.595***	0.596***	0.595***
			[0.025]	[0.000]	[0.000]	[0.000]	[0.000]
25-			0.957	0.928	0.929	0.929	0.928
			[0.480]	[0.190]	[0.190]	[0.192]	[0.190]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.001	0.979	0.972	0.972	0.972
			[0.984]	[0.700]	[0.615]	[0.617]	[0.605]
55-			1.015	0.964	0.964	0.965	0.964
			[0.865]	[0.677]	[0.681]	[0.682]	[0.678]
65-			0.916	0.832	0.827	0.827	0.827
			[0.468]	[0.139]	[0.129]	[0.130]	[0.129]
80-			0.702*	0.641**	0.628**	0.629**	0.629**
			[0.022]	[0.005]	[0.004]	[0.004]	[0.004]
Other/unknown occupation				0.721***	0.717***	0.715***	0.715***
				[0.001]	[0.001]	[0.001]	[0.001]
Manager				0.262***	0.258***	0.259***	0.258***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.224***	0.223***	0.223***	0.222***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.258***	0.255***	0.255***	0.256***
				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.306***	0.304***	0.304***	0.305***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.496***	0.493***	0.493***	0.493***
				[0.000]	[0.000]	[0.000]	[0.000]

Skilled agricultural forestry and fishery worker				0.612***	0.614***	0.614***	0.612***
				[0.000]	[0.000]	[0.000]	[0.000]
Craft and related trades worker				0.551***	0.565***	0.565***	0.564***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.723***	0.709***	0.709***	0.708***
				[0.000]	[0.000]	[0.000]	[0.000]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]
GDP per capita					0.991***	0.992**	0.992*
					[0.000]	[0.006]	[0.011]
social democratic regime						1	1
						[.]	[.]
corporatist regime						2.554***	2.713***
						[0.000]	[0.000]
liberal regime						2.984***	3.170***
						[0.000]	[0.000]
southern European regime						4.309***	4.906***
						[0.001]	[0.000]
post-socialist corporatist regime						5.250***	5.434***
						[0.000]	[0.000]
post-socialist liberal regime						4.401***	4.915***
						[0.000]	[0.000]
residual regime						6.266***	8.222***
						[0.000]	[0.000]
Relative poverty rate							0.945
							[0.149]
Constant	0.0592***	0.000251***	0.000133***	0.000426***	0.0246**	0.0129***	0.0101***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.003]	[0.000]	[0.000]
Variance of country-level constants	3.959***	2.215***	2.269***	2.111***	1.371**	1.170**	1.159**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]	[0.006]	[0.002]
Model (1) ICC	0.295						
Model (2) ICC		0.195					

Model (3) ICC			0.199				
Model (4) ICC				0.185			
Model (5) ICC					0.0876		
Model (6) ICC						0.0457	
Model (7) ICC							0.0429
Log likelihood	-18677.5	-16117.3	-15592.0	-15174.8	-15127.8	-15118.1	-15114.9
Degrees of freedom	1	3	14	23	25	26	26
N	66687	62940	62226	62226	62226	62226	62226

Exponentiated coefficients; *p*-values in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9. Multilevel model of micro level MPI1 with changes over time

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	Gini only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Individual Average deprivation k=34							
2nd EQLS (2007)	1	1	1	1	1	1	1
	[.]	[.]	[.]	[.]	[.]	[.]	[.]
3rd EQLS (2011)	0.938	0.990	0.973	0.993	0.991	0.990	0.993
	[0.332]	[0.864]	[0.629]	[0.917]	[0.890]	[0.879]	[0.907]
meanGini		1.153***	1.158***	1.133***	1.120***	1.093***	1.101**
		[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.003]
deltaGini		0.987	0.986	1.007	1.013	1.012	1.008
		[0.447]	[0.429]	[0.715]	[0.514]	[0.535]	[0.736]
Married or living with partner			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			1.913***	1.950***	1.952***	1.959***	1.960***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			1.567***	1.350**	1.351**	1.351**	1.351**
			[0.000]	[0.004]	[0.004]	[0.004]	[0.004]
Never married and not living with partner			1.894***	1.709***	1.710***	1.712***	1.711***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.338***	1.241***	1.241***	1.242***	1.241***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			1.543***	1.452***	1.452***	1.452***	1.452***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
18-			1.000	0.565***	0.564***	0.566***	0.566***
			[0.997]	[0.000]	[0.000]	[0.000]	[0.000]
25-			1.078	1.023	1.023	1.024	1.024
			[0.540]	[0.838]	[0.836]	[0.832]	[0.833]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.134	1.113	1.113	1.113	1.113
			[0.088]	[0.130]	[0.132]	[0.132]	[0.132]
55-			1.310**	1.225*	1.225*	1.225*	1.224*
			[0.009]	[0.025]	[0.025]	[0.026]	[0.026]
65-			1.307	1.083	1.083	1.082	1.082
			[0.101]	[0.593]	[0.598]	[0.600]	[0.601]
80-			1.468*	1.165	1.163	1.165	1.165
			[0.029]	[0.355]	[0.360]	[0.355]	[0.354]
Other/unknown occupation				1.238*	1.239*	1.230*	1.230*
				[0.012]	[0.012]	[0.014]	[0.014]
Manager				0.120***	0.119***	0.120***	0.120***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.0923***	0.0923***	0.0926***	0.0925***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.166***	0.166***	0.167***	0.167***
				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.146***	0.146***	0.146***	0.146***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.350***	0.350***	0.351***	0.350***
				[0.000]	[0.000]	[0.000]	[0.000]
Skilled agricultural forestry and fishery worker				0.695**	0.696**	0.693**	0.692**
				[0.004]	[0.004]	[0.003]	[0.003]
Craft and related trades worker				0.499***	0.501***	0.500***	0.500***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.570***	0.568***	0.568***	0.567***
				[0.000]	[0.000]	[0.000]	[0.000]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]
GDP per capita					0.999	1.000	1.000

					[0.121]	[0.468]	[0.466]
social democratic regime						1	1
						[.]	[.]
corporatist regime						1.276	1.294
						[0.401]	[0.370]
liberal regime						1.533	1.555
						[0.104]	[0.093]
southern European regime						2.544**	2.615**
						[0.003]	[0.002]
post-socialist corporatist regime						1.825*	1.840*
						[0.024]	[0.025]
post-socialist liberal regime						1.176	1.206
						[0.595]	[0.547]
residual regime						1.850	1.960
						[0.057]	[0.069]
Relative poverty rate							0.989
							[0.742]
Constant	0.105***	0.00140***	0.000387***	0.00232***	0.00426***	0.00465***	0.00443***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Variance of country-level constants	1.999***	1.303***	1.325***	1.202***	1.184***	1.080**	1.079**
	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]	[0.004]	[0.006]
Model (1) ICC	0.174						
Model (2) ICC		0.0745					
Model (3) ICC			0.0788				
Model (4) ICC				0.0530			
Model (5) ICC					0.0489		
Model (6) ICC						0.0227	
Model (7) ICC							0.0225
Log likelihood	-14708.4	-12705.4	-12050.2	-11181.2	-11179.9	-11170.7	-11170.6
Degrees of freedom	1	3	14	23	25	26	26
N	45756	42842	42490	42490	42490	42490	42490

Exponentiated coefficients; *p*-values in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6 Conclusion

Our descriptive analysis concludes that *levels* of material deprivation and income inequality, and levels of multidimensional poverty and income inequality are strongly positively related to one another when comparing across countries. However, this does not necessarily mean that the evolution of these follow that of income inequality over time within countries. Our descriptive findings for these relationships over time are that while changes in material deprivation and multidimensional poverty (as captured by the MPI1 measure) do in general appear to be positively related to changes in income inequality, this relationship is not statistically significant.

The presence of a strong cross-sectional relationship echoes the findings of an earlier paper in this series (Karagiannaki, 2017), which focused exclusively on the relationship between income poverty and income inequality. We build on this earlier analysis by investigating whether these relationships remain consistent when the definition of poverty is broadened beyond income to include wider aspects of poverty and material deprivation. While Karagiannaki (2017) identifies a statistically significant positive relationship between income inequality and income poverty over time, however, we do not find that this relationship holds over a different time period using our broader measures of poverty.

Further developing this descriptive result using multivariate analysis, our multilevel model finds that this significant cross-sectional relationship is not accounted for by compositional differences in population across countries, or other macro level covariates. We continue to observe a significant positive relationship among EU countries between levels of income inequality (as measured by Gini and by income percentile ratios), and levels of multidimensional deprivation (as measured by material deprivation and our two MPI measures).

We find that this positive relationship persists even after accounting for differences in micro-level variables, including occupational group, and that this is the case for all outcome variables examined (material deprivation, MPI1 and MPI2). The micro-level variables paint a generally uniform picture for all outcome variables that multidimensional poverty and material deprivation are experienced to a higher degree by females and single parents, non-EU citizens and people working in unskilled elementary occupations. These compositional features of populations are not enough, however, to explain the remaining significant relationship between either

material deprivation and income inequality, or multidimensional poverty and income inequality.

Including country-level macro variables in the models, we find the positive and significant relationships between material deprivation and income inequality, and between multidimensional poverty and income inequality persists once we account for differences in GDP per capita. This is in contrast to Whelan and Maître (2012) and Whelan et al. (2014), who find that the relationships between material deprivation and Gini inequality, and MPI poverty and Gini inequality, respectively, are not statistically significant once differences in gross disposable income per capita (GNDH) are accounted for. The relationships therefore appear to be sensitive to a combination of differences in the model specifications used (these authors use OLS while our paper uses fractional logit models), indicators included in the definitions of material deprivation and multidimensional poverty, and years of data.

Our results also show that policy matters, since including welfare regime categories in the models show that individuals in countries belonging to the social democratic regime category are either as well-off or better-off, on average, than individuals in countries belonging to other welfare categories. This was the case whether we used material deprivation or either of the MPI measures as our dependent variable of broader poverty. Welfare regime does completely account for the relationship between material deprivation and income inequality in our models. However, the relationship between the two MPI measures and income inequality remain significant even once we include welfare regime.

As mentioned, it is important to note that the income inequality measures already reflect and capture some effect of welfare policy through taxes and transfers, and therefore it may be that welfare regime would play a greater role in mediating the relationship if it had been between market income inequality (pre-taxes and transfer) and our outcome material deprivation and poverty variables. Using the post-tax and transfer measures of inequality as we did, the most redistributive and generous social democratic welfare regime tended to be the most deprivation-reducing regime type. This relationship is therefore over and above any redistributive effect captured by our post-tax and transfer inequality measures.

We also present an extension of the cross-sectional multilevel models to allow for an analysis of material deprivation and the MPI1 specification over two waves of the EQLS data (2007 and 2011), while simultaneously

distinguishing between cross-sectional and over-time relationships. We find that the over-time relationships are distinct from the cross-sectional ones. While individuals in countries with higher income inequality tend to suffer more severely from material deprivation and multidimensional poverty, the severity of deprivation and poverty does not seem to have tracked changes in income inequality from the 2007 to 2011 wave, accounting for differences in various micro and macro level factors. We note, however, that it is possible that analysing this over-time relationship for earlier and more extended periods may have resulted in a different finding for these over-time relationships, and in particular the effects of the Great Recession may mean that the relationships we find during this time period are not generalisable.

These findings build on the previous analysis of Karagiannaki (2017), which focused on the relationship between income poverty and inequality. We have expanded the definition of poverty beyond income to examine the link between a country's level of income inequality and how this may relate to the way its most deprived individuals experience poverty across multiple dimensions of life. In doing so, we have also added to the only previous analysis looking at macro-level covariates of multidimensional poverty across Europe using the MPI (Whelan et al., 2014), and in particular we have focused on its relationship with income inequality. The over-time multilevel analysis in Section 5.5 presented a further important extension, allowing for the contributions of both cross-country and within-country variation in inequality to variation in material deprivation and multidimensional poverty to be analysed in a multivariate setting. While Gini inequality is important in terms of its positive cross-sectional relationship with material deprivation and multidimensional poverty across countries, this relationship significantly weakens when looking at changes within countries over time.

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Appendix

Details of independent regressors

Household income

The income question in the EQLS is split in two parts: an unprompted question asking respondents for their net household monthly income and, in case of refusal or 'Don't know' answers, a prompted question. This prompted question includes a table presenting income ranges in weekly, monthly and yearly terms, in the local currency.

The master version, in euros, is converted from local currencies using the current exchange rate at the time of the questionnaire design and rounded to the nearest unit, while making sure that the figures are

consistent both in terms of the differences between each category and between the daily, monthly and annual figures.

Mental health

The WHO Well-Being Index (WHO-5) measures current mental well-being based on five items. Respondents are asked to indicate to what extent, over the last two weeks, they have felt:

1. Cheerful and in good sprits
2. Calm and relaxed
3. Active and vigorous
4. Fresh and rested on waking up
5. Interested in things in daily life

Items are rated on a 6-point Likert scale from 0 to 5, with higher scores indicating better well-being. The total score is out of 25, with a score below 13 indicating poor mental well-being and possible further testing for depression (World Health Organization, 1998).

Since the WHO-5 measure uses only positive mental health items, we have also included a second mental health measure of negative mental health items. Respondents are asked to indicate to what extent, over the last two weeks, they have felt:

1. Particularly tense
2. Lonely
3. Downhearted and depressed

Employment

Respondents are asked which of the following best describes their individual employment situation:

1. At work as an employee or employer/self-employed
2. Employed, on child-care leave or other leave
3. At work as a relative assisting on a family farm of business
4. Unemployed less than 12 months
5. Unemployed 12 months or more
6. Unable to work due to long-term illness or disability
7. Retired
8. Full time homemaker/responsible for ordinary shopping and looking after the home
9. In education (at school, university, etc.)/student
10. Other

For the MPI1 specification, we stay as close as possible to the employment indicator used in Alkire and Apablaza (2016), on which the MPI1 is based. This is the "low work intensity" indicator used by EU-SILC, which is defined as a household where the total number of months that all working-age household members have worked in the previous 12 months is less than 20 percent of the total number of months those household members theoretically could have worked. This excludes children, people aged 60 and over and students aged between 18 and 24.

Using the EQLS data we mirror the EU-SILC indicator as closely as possible, with the limitation that the EQLS data is at the individual respondent level whist the EU-SILC indicator is at the household level. We define the MPI1 employment deprivation indicator as working age individuals who are not in employment but who are able to work. This excludes children, those who are unable to work due to long-term illness or disability, those who are retired, and those in education.

The MPI2 employment deprivation indicator is defined as those who are not engaged in productive and valued activities. Unlike the MPI1 indicator, the MPI2 indicator includes those who are retired and those unable to work due to long-term illness or disability as deprived in this indicator, unless these individuals are engaged in caring or volunteering activities. Homemakers, on the other hand, are non-deprived in this indicator since homemakers are engaged in productive activities that would be positively valued if supplied in the labour market. In this way, the MPI2 specification recognises the value of unpaid domestic labour by homemakers, and the contribution of caring and volunteering by those who are not in the labour market.

Additional regression tables

Table 10. Set of multilevel random intercept models for MPI1 with P90/P10 ratio as measure of income inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	P90/P10 only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Individual Average deprivation k=3 4							
P90/P10 ratio		1.930***	1.968***	1.761***	1.515***	1.274	1.217
		[0.000]	[0.000]	[0.000]	[0.000]	[0.179]	[0.502]
EU citizen			1	1	1	1	1

			[.]	[.]	[.]	[.]	[.]
Non-EU citizen			2.237***	1.618***	1.626***	1.628***	1.628***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Married or living with partner			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			1.793***	1.784***	1.780***	1.788***	1.788***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			1.575***	1.337*	1.334*	1.340*	1.340*
			[0.000]	[0.016]	[0.016]	[0.014]	[0.014]
Never married and not living with partner			2.032***	1.849***	1.850***	1.851***	1.850***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.358***	1.263***	1.264***	1.264***	1.264***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			1.327***	1.344***	1.343***	1.344***	1.344***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
18-			0.894	0.525***	0.524***	0.528***	0.529***
			[0.493]	[0.000]	[0.000]	[0.000]	[0.000]
25-			1.030	0.970	0.969	0.971	0.971
			[0.845]	[0.820]	[0.817]	[0.826]	[0.827]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.113	1.083	1.083	1.083	1.083
			[0.207]	[0.327]	[0.326]	[0.329]	[0.329]
55-			1.292**	1.201*	1.200*	1.200*	1.200*
			[0.002]	[0.017]	[0.018]	[0.018]	[0.018]
65-			1.091	0.897	0.897	0.894	0.894
			[0.602]	[0.476]	[0.474]	[0.462]	[0.462]
80-			1.289	1.036	1.036	1.032	1.032
			[0.180]	[0.845]	[0.843]	[0.863]	[0.863]
Other/unknown occupation				1.075	1.079	1.068	1.068
				[0.533]	[0.513]	[0.572]	[0.573]
Manager				0.144***	0.145***	0.145***	0.145***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.0920***	0.0921***	0.0924***	0.0924***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.176***	0.176***	0.176***	0.176***

				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.148***	0.148***	0.148***	0.148***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.365***	0.366***	0.365***	0.365***
				[0.000]	[0.000]	[0.000]	[0.000]
Skilled agricultural forestry and fishery worker				0.723**	0.723**	0.720***	0.720***
				[0.001]	[0.001]	[0.001]	[0.001]
Craft and related trades worker				0.530***	0.528***	0.530***	0.530***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.552***	0.551***	0.549***	0.549***
				[0.000]	[0.000]	[0.000]	[0.000]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]
GDP per capita					1.000***	1.000*	1.000*
					[0.000]	[0.025]	[0.025]
social democratic regime						1	1
						[.]	[.]
corporatist regime						1.188	1.180
						[0.523]	[0.554]
liberal regime						1.960**	1.959**
						[0.001]	[0.001]
southern European regime						2.330**	2.323**
						[0.004]	[0.005]
post-socialist corporatist regime						1.349	1.352
						[0.247]	[0.244]
post-socialist liberal regime						1.012	1.025
						[0.972]	[0.946]
residual regime						1.481	1.473
						[0.354]	[0.358]
Relative poverty rate							1.011
							[0.864]
Constant	0.100***	0.00763***	0.00245***	0.0115***	0.0363***	0.0512***	0.0513***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Variance of country-							

level constants	1.913***	1.318***	1.335***	1.229***	1.181***	1.073*	1.073*
	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]	[0.016]	[0.016]
Model (1) ICC	0.165						
Model (2) ICC		0.0775					
Model (3) ICC			0.0808				
Model (4) ICC				0.0591			
Model (5) ICC					0.0481		
Model (6) ICC						0.0209	
Model (7) ICC							0.0210
Log likelihood	-8338.5	-7354.2	-7016.6	-6533.2	-6530.6	-6521.6	-6521.5
Degrees of freedom	0	1	13	22	23	26	26
N	25795	24346	24162	24162	24162	24162	24162

Exponentiated coefficients; *p*-values in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11. Set of multilevel random intercept models for MPI1 with P90/P50 ratio as measure of income inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	P90/P50 only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Individual Average deprivation k=3 4							
P90/P50 ratio		13.84***	13.68***	9.621***	5.043**	3.502*	2.999*
		[0.000]	[0.000]	[0.000]	[0.001]	[0.015]	[0.032]
EU citizen			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Non-EU citizen			2.239***	1.618***	1.627***	1.628***	1.626***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Married or living with partner			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			1.793***	1.783***	1.779***	1.787***	1.787***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			1.576***	1.338*	1.334*	1.341*	1.340*
			[0.000]	[0.016]	[0.016]	[0.014]	[0.014]
Never married and not living with partner			2.029***	1.845***	1.847***	1.851***	1.851***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.357***	1.262***	1.263***	1.263***	1.264***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]

Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			1.327***	1.344***	1.343***	1.343***	1.344***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
18-			0.893	0.525***	0.523***	0.527***	0.527***
			[0.492]	[0.000]	[0.000]	[0.000]	[0.000]
25-			1.029	0.969	0.969	0.970	0.970
			[0.848]	[0.817]	[0.813]	[0.821]	[0.822]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.113	1.083	1.083	1.083	1.083
			[0.208]	[0.331]	[0.329]	[0.330]	[0.329]
55-			1.292**	1.201*	1.200*	1.200*	1.200*
			[0.002]	[0.018]	[0.018]	[0.019]	[0.018]
65-			1.091	0.897	0.897	0.894	0.895
			[0.601]	[0.476]	[0.474]	[0.461]	[0.464]
80-			1.290	1.037	1.038	1.033	1.033
			[0.178]	[0.840]	[0.839]	[0.858]	[0.859]
Other/unknown occupation				1.076	1.081	1.069	1.069
				[0.532]	[0.509]	[0.567]	[0.566]
Manager				0.144***	0.144***	0.145***	0.145***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.0918***	0.0921***	0.0924***	0.0924***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.175***	0.176***	0.176***	0.176***
				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.148***	0.148***	0.148***	0.148***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.365***	0.366***	0.365***	0.365***
				[0.000]	[0.000]	[0.000]	[0.000]
Skilled agricultural forestry and fishery worker				0.725**	0.725**	0.722***	0.720***
				[0.001]	[0.001]	[0.001]	[0.001]
Craft and related trades worker				0.529***	0.528***	0.528***	0.529***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.553***	0.551***	0.548***	0.549***
				[0.000]	[0.000]	[0.000]	[0.000]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]

GDP per capita					1.000***	1.000*	1.000*
					[0.000]	[0.014]	[0.014]
social democratic regime						1	1
						[.]	[.]
corporatist regime						1.121	1.064
						[0.645]	[0.818]
liberal regime						1.682**	1.596*
						[0.010]	[0.035]
southern European regime						2.204**	1.949*
						[0.004]	[0.022]
post-socialist corporatist regime						1.276	1.263
						[0.332]	[0.341]
post-socialist liberal regime						0.828	0.759
						[0.545]	[0.414]
residual regime						1.593	1.295
						[0.106]	[0.502]
Relative poverty rate							1.029
							[0.439]
Constant	0.100***	0.000669***	0.000237***	0.00142***	0.00951***	0.0134***	0.0118***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Variance of country-level constants	1.913***	1.389***	1.431***	1.278**	1.196**	1.066*	1.063*
	[0.000]	[0.000]	[0.000]	[0.001]	[0.002]	[0.033]	[0.025]
Model (1) ICC	0.165						
Model (2) ICC		0.0909					
Model (3) ICC			0.0983				
Model (4) ICC				0.0695			
Model (5) ICC					0.0516		
Model (6) ICC						0.0191	
Model (7) ICC							0.0183
Log likelihood	-8338.5	-7356.4	-7019.3	-6535.3	-6531.5	-6520.8	-6520.3
Degrees of freedom	0	1	13	22	23	26	26
N	25795	24346	24162	24162	24162	24162	24162

Exponentiated coefficients; *p*-values in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12. Set of multilevel random intercept models for MPI1 with P50/P10 ratio as measure of income inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Null	P50/P10 only	Plus micro variables, no occup.	Plus occupation group	Plus GDP per capita	Plus welfare regime	Plus relative poverty
Individual Average deprivation k=3 4							
P50/P10 ratio		6.072***	6.629***	4.731***	2.977***	1.446	0.173
		[0.000]	[0.000]	[0.000]	[0.000]	[0.404]	[0.208]
EU citizen			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Non-EU citizen			2.243***	1.623***	1.631***	1.632***	1.642***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Married or living with partner			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Separated or divorced and not living with partner			1.795***	1.786***	1.781***	1.788***	1.787***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Widowed and not living with partner			1.576***	1.338*	1.335*	1.340*	1.339*
			[0.000]	[0.016]	[0.016]	[0.014]	[0.015]
Never married and not living with partner			2.032***	1.849***	1.850***	1.850***	1.846***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Number of children			1.359***	1.264***	1.264***	1.264***	1.264***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Male			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
Female			1.327***	1.345***	1.343***	1.344***	1.344***
			[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
18-			0.895	0.526***	0.525***	0.529***	0.529***
			[0.497]	[0.000]	[0.000]	[0.000]	[0.000]
25-			1.030	0.970	0.970	0.972	0.972
			[0.842]	[0.823]	[0.820]	[0.830]	[0.832]
35-			1	1	1	1	1
			[.]	[.]	[.]	[.]	[.]
45-			1.113	1.083	1.083	1.083	1.083
			[0.207]	[0.328]	[0.327]	[0.330]	[0.329]
55-			1.291**	1.201*	1.199*	1.199*	1.199*
			[0.002]	[0.018]	[0.018]	[0.018]	[0.018]
65-			1.090	0.897	0.896	0.894	0.895
			[0.604]	[0.473]	[0.471]	[0.459]	[0.462]

80-			1.288	1.035	1.036	1.032	1.033
			[0.181]	[0.849]	[0.847]	[0.864]	[0.857]
Other/unknown occupation				1.073	1.077	1.067	1.066
				[0.543]	[0.522]	[0.577]	[0.586]
Manager				0.144***	0.145***	0.145***	0.145***
				[0.000]	[0.000]	[0.000]	[0.000]
Professional				0.0920***	0.0922***	0.0924***	0.0923***
				[0.000]	[0.000]	[0.000]	[0.000]
Technician or junior professional				0.175***	0.176***	0.176***	0.176***
				[0.000]	[0.000]	[0.000]	[0.000]
Clerical support worker				0.148***	0.148***	0.148***	0.148***
				[0.000]	[0.000]	[0.000]	[0.000]
Service worker				0.365***	0.366***	0.365***	0.365***
				[0.000]	[0.000]	[0.000]	[0.000]
Skilled agricultural forestry and fishery worker				0.723**	0.723**	0.721**	0.720***
				[0.001]	[0.001]	[0.001]	[0.001]
Craft and related trades worker				0.530***	0.529***	0.530***	0.529***
				[0.000]	[0.000]	[0.000]	[0.000]
Plant and machine operator or assembler				0.552***	0.551***	0.549***	0.548***
				[0.000]	[0.000]	[0.000]	[0.000]
Elementary occupations				1	1	1	1
				[.]	[.]	[.]	[.]
GDP per capita					1.000***	1.000*	1.000*
					[0.000]	[0.033]	[0.015]
social democratic regime						1	1
						[.]	[.]
corporatist regime						1.267	1.051
						[0.381]	[0.867]
liberal regime						2.234***	1.739**
						[0.000]	[0.007]
southern European regime						2.766***	2.324***
						[0.000]	[0.001]
post-socialist corporatist regime						1.407	1.324
						[0.212]	[0.255]

post-socialist liberal regime						1.302	1.035
						[0.326]	[0.902]
residual regime						1.844	1.745
						[0.109]	[0.106]
Relative poverty rate							1.186
							[0.135]
Constant	0.100***	0.00248***	0.000719***	0.00437***	0.0207***	0.0554**	0.302
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.003]	[0.317]
Variance of country-level constants	1.913***	1.360***	1.367***	1.258**	1.196**	1.079*	1.068**
	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]	[0.011]	[0.009]
Model (1) ICC	0.165						
Model (2) ICC		0.0854					
Model (3) ICC			0.0868				
Model (4) ICC				0.0651			
Model (5) ICC					0.0517		
Model (6) ICC						0.0227	
Model (7) ICC							0.0196
Log likelihood	-8338.5	-7355.5	-7017.6	-6534.5	-6531.5	-6522.3	-6520.9
Degrees of freedom	0	1	13	22	23	26	26
N	25795	24346	24162	24162	24162	24162	24162

Exponentiated coefficients; *p*-values in brackets
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$