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THE CHANGING EDUCATION DISTRIBUTION AND INCOME INEQUALITY IN GREAT BRITAIN

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Over the past years, education attainment has increased at an unprecedented rate in Great Britain. We analyze how the education expansion affected inequality in household net incomes since the early 2000s. We show that, all else being equal, education composition changes led to higher living standards mostly through higher wages. As education expansion led to larger income gains in the middle and top than at the bottom of the distribution, income inequality increased. Despite the increasing share of high-educated workers, we find limited evidence of a "compression" effect on inequality, as the higher education wage premium remained broadly unchanged.

JEL Codes: D31, I24, I26

Keywords: education expansion, income distribution, decomposition

1. INTRODUCTION

Over the past years, there has been an unprecedented increase in education attainment in Great Britain. The share of individuals completing full-time education aged 16 fell by 37 percent between 2001 and 2017; whilst the share of individuals completing education aged 17–19 (beyond compulsory education) increased by 47 percent and the share of those completing education aged 20+ (in Higher Education) increased for women by 66 percent and for men by 49 percent (Table 1).

These large structural changes in education have important consequences for income inequality. For developing countries in particular, it has been noted that the returns to education are convex and hence, an equally distributed expansion of education among low- and high-skilled can lead to a rise in inequality (Battistón *et al.*, 2014). Bourguignon *et al.* (2004) refer to this link between education and

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TABLE 1
Education Shares by Age at Which Completed Full-Time Education (in %)

	2001	2007	2011	2017
Men				
Aged 16 or less	60.1	53.3	45.7	39.5
Aged 17–19	19.1	21.7	26.9	29.3
Aged 20+	20.9	25.0	27.4	31.2
Women				
Aged 16 or less	57.1	50.1	42.5	34.7
Aged 17–19	23.4	25.8	31.3	33.0
Aged 20+	19.5	24.1	26.1	32.3
All				
Aged 16 or less	58.6	51.7	44.1	37.1
Aged 17–19	21.3	23.8	29.1	31.2
Aged 20+	20.2	24.5	26.8	31.8

Notes: Sample includes individuals aged 15 to 64. Individuals are classified into the three categories using information on age completed full-time education (Family Resources Survey variable "tea") or, if missing, using information on their age and whether presently in full-time education (variable "fted").

Source: Author's calculations using the Family Resources Survey for 2001/02 (2001), 2007/08 (2007), 2011/12 (2011) and 2017/18 (2017).

inequality as the "paradox of progress." The literature on the effect of education on income inequality emphasizes the "composition" and "compression" effects of education expansion (Knight and Sabot, 1983; Gregorio and Lee, 2002, Rehme, 2007, Teulings and van Rens, 2008). As the relative size of the high-education group increases—i.e. the "composition" effect—inequality goes up initially; eventually inequality goes down as fewer low-educated people remain. As the share of educated workers increases, the higher education (HE) wage premium goes down which in turn lowers inequality—i.e. the "compression" effect.

The link between the recent education trends and household net income inequality in Great Britain is not well understood and the aim of this paper is to provide an in-depth account of this relationship for the period 2001–17. Our paper contributes to the literature by studying changes along the distribution of income and covering the recent period of education expansion.

We contribute directly to the literature on education and income inequality. Coady and Dizioli (2018) study the relationship between inequality of disposable income and education in many different countries between 1980 and 2010. They find that income inequality increases with inequality in education and average years of schooling. Eika *et al*. (2019) study the impact of education changes on inequality of earnings among couples in the US, UK, Denmark, Germany and Norway. Focusing on changes to educational assortative mating, they find that these matter little for explaining trends in inequality. Brewer and Wren-Lewis (2015) decompose changes to income inequality in Great Britain, by income source and household characteristics. For education, they find that between 1991 and 2008–09 education quantity effects (changes to the distribution of education) raised inequality, while price effects (changes to the returns to education) mitigated this increase. Overall, the relationship between the recent education changes and inequality of household net income in Great Britain remains relatively understudied.

Blundell *et al*. (2018) and Brewer *et al*. (2009) study inequality changes in Great Britain but they do not look at the compression and composition effects of education expansion. Blundell *et al*. (2018) focus in particular on how changes in the labor market have contributed to inequality. Brewer *et al*. (2009) look at inequality changes between and within education groups. They find that earnings inequality fell within education groups and the gap in incomes by education groups narrowed in the 1990s and early 2000s.[1]

Our paper also relates to a large body of income decomposition literature studying how tax-benefit policy changes alone or policy changes versus *other* factors have contributed to inequality changes (e.g. Sefton et al., 2009; Bargain and Callan, 2010; De Agostini *et al*., 2018; Paulus *et al*., 2020; Paulus and Tasseva, 2020).

In more detail, we estimate the separate effects on the income distribution of changes to the HE wage premia, other changes to wages, and changes to the composition of education. We also estimate the effect of changes to tax-benefit policies on incomes. By creating counterfactual distributions of income, the contribution of each of the factors is estimated in isolation from other changes, e.g. we isolate the contribution of the increased amount of education to changes in the income distribution, holding constant the graduate pay premium and income tax rule. We are also able to examine all these effects across the whole income distribution.

Our approach is to combine the methods of Bargain and Callan (2010) and Bourguignon *et al*. (2008). Using a tax-benefit microsimulation model, we separate out the changes to tax-benefit policies from the changes to the distribution of gross market incomes and the composition of the population. Using a regression-based approach and re-weighting, we then decompose the latter two to identify the impact on the income distribution of changes in the HE pay premia, education composition and other population changes. The data used come from the Family Resources Survey for Great Britain for 2001/02, 2007/08, 2011/12 and 2017/18. We analyze separately the periods 2001–07 (boom/pre-crisis), 2007–11 (crisis) and 2011–17 (post-crisis), which broadly capture diverging trends in the economy and the income distribution.[2]

First, we estimate the distributional impact from changes to the HE wage premium. We find that the education earnings differentials have remained broadly unchanged (consistent with Walker and Zhu, 2008; Machin, 2011; Blundell *et al*., 2016) and so there is little impact on the distribution of household net incomes: we estimate a small reduction in inequality due to a fall in the HE wage premia among white British women only, in 2001–07 and 2011–17; but no change to the HE returns among other types of worker. Hence, overall we find limited evidence for an education "compression" effect on inequality in the full period 2001–17.

[1]For the 1970s and 1980s, Brewer *et al*. (2009) find the reverse: an increased gap in earnings and household net incomes within and between education groups.

[2]For example, unemployment was falling between 2001 and 2006, then gradually rose until 2011 and has been going down since then (Office for National Statistics, series MGSX). Similar trend can be seen for other aggregate economic measures such as government net borrowing (deficit) (Eurostat, indicator gov_10dd_edpt1). Looking at household living standards, median net income was going up in the 2000s; then as the crisis hit, net income went down in 2009–11; and has been going up again since then (Department for Work and Pensions, 2019a).

Second, we find evidence for an education "composition" effect. Our results show that, fixing the HE wage premium, education expansion raised living standards through higher earnings and other market incomes. As a result of the education expansion, real mean household income grew by 3.6 percent in the pre-crisis period (2001–07), by 3 percent during the crisis (2007–11) and by further 3.8 percent in the post-crisis years (2011–17). However, the income gains due to education made net incomes more unequal as the gains were larger in the middle and top, than at the bottom of the distribution. This is consistent with the evidence for different countries by Coady and Dizioli (2018) and for Great Britain between 1991 and 2008–09 by Brewer and Wren-Lewis (2015).

Overall, we find that income inequality for the middle 95 percent of the income distribution slightly fell since the 2000s. This was despite the upward pressure due to education. Between 2001 and 2011, it was due to changes in the tax-benefit system, which were equalizing by benefiting mostly the bottom of the income distribution (consistent with e.g. Sefton et al., 2009; De Agostini *et al*., 2018; Paulus *et al*., 2020). Between 2011 and 2017, depending on the inequality indicator, policy changes either reinforced or offset the inequality-increasing impact of education expansion. Although not statistically significant, changes to wages (other than to the HE returns) pushed down inequality in the post-crisis period.

The rest of the paper is structured as follows: Section 2 and Section 3 describe the methodology, data and the tax-benefit model EUROMOD, Section 4 discusses the results and Section 5 concludes.

2. Methodology

The central question addressed in this paper is, other things being equal, what was the contribution of education composition and education premium changes to changes in the distribution of household net incomes in Great Britain since the early 2000s. To answer this, we need to separate the effect of education trends from everything else that could have affected household incomes, such as changes to benefit entitlements and tax liabilities, other compositional changes in the society, or other changes to market incomes. To identify the contribution to total income changes of these different factors, we employ decomposition techniques. The basic idea is that starting from the observed *end-period* income distribution, we can work our way backwards to the observed *start-period* distribution by constructing intermediate counterfactual distributions. By changing different factors one step at a time, the counterfactuals gradually become less like the end-period and more similar and eventually identical to the start-period distribution. A comparison between the different distributions unveils the contribution of each factor to the total change.

First, we decompose the total change in household net incomes into the impact due to changes in population characteristics and market incomes (PCMI) and to changes to tax and benefit policies (TBP). The method follows on the work by Bargain and Callan (2010) who propose a formal framework based on Shorrocks-Shapley decomposition and using a tax-benefit calculator.

Second, we decompose the PCMI effect into the part due to changes in the amount of education; the part due to changes to the pay premium by education; and a residual. The method is based on Bourguignon *et al*. (2008) who build on the work by Juhn *et al*. (1993) and DiNardo *et al*. (1996) and propose a regression-based approach and/or re-weighting suitable for decomposing changes in the income distribution. The method builds on the literature generalizing the Oaxaca-Blinder decomposition of changes in the mean to changes along the distribution of wages.[3]

Although not central to the analysis, a limitation of the approaches adopted in this paper is that we do not estimate separately behavioral responses to tax-benefit changes. These are part of the PCMI effect. Furthermore, the decomposition of the PCMI effect due to changes in education is of a descriptive nature as changes to the education composition and the returns to education do not occur exogenously.

In the rest of the section, we first present formally how we decompose the total change in the income distribution into PCMI and TBP effects. Second, we explain how the PCMI effect can be further decomposed to identify the impact of education changes on the income distribution.

2.1. *Decomposing the Total Change*

Formally, let I be a distribution of household net income (or a functional such as Gini or mean income) and expressed as a function $f(d, e, x, y, o)$ where d denotes the design and parameters of tax-benefit policies (e.g. progressive vs flat tax, 20 percent tax rate, a child benefit of £15 per week), e education level (completed education aged 16 or less, aged 17–19, aged 20+), x a vector of other individual/household characteristics, y gross earnings and o other individual/household gross market incomes (e.g. self-employment income). The change in the distribution I between two periods (0 and 1) is

$$\Delta I = f(d_1, e_1, x_1, y_1, o_1) - f(d_0, e_0, x_0, y_0, o_0). \tag{1}$$

An intermediate, counterfactual distribution is next added (and subtracted) as a function of d from the end-period but e, x, y and o from the start-period. It yields the identity:

$$\begin{aligned} \Delta I = & \underbrace{f(d_1, e_1, x_1, y_1, o_1) - f(d_1, e_0, x_0, y_0, o_0)}_{\text{population characteristics and market income effect (nominal)}} \\ & + \underbrace{f(d_1, e_0, x_0, y_0, o_0) - f(d_0, e_0, x_0, y_0, o_0)}_{\text{tax-benefit policy effect (nominal)}}. \end{aligned} \tag{2}$$

The purpose of adding the counterfactual is to answer two questions: i) given the tax-benefit regime in the end-period, what would have been the impact on I if we would go back to the population and distribution of market incomes from

[3]See Fortin *et al*. (2011) for an overview of the literature that decomposes changes in the earnings distribution.

the start-period; and ii) given the population and distribution of market incomes from the start-period, what would have been the impact on I if tax-benefit policies from the end-period were in place? The first term answers i) which identifies the contribution of changes to population characteristics and market incomes (PCMI) (conditional on d from the end-period) on the total change in I. The second term answers ii) which identifies the contribution of changes to tax-benefit policies (TBP) (conditional on e, x, y and o from the start-period) on the total change in I.

In the counterfactual, tax-benefit amounts from the end-period d_1 are applied on gross market incomes from the start-period y_0 and o_0. To make these comparable (as £1 in period 1 is worth less than £1 in period 0), equation 2 is extended to include two counterfactuals in which y_0, o_0 and d_0 are adjusted for inflation by a factor α = Consumer Price Index:

$$\begin{aligned}\Delta I = & \underbrace{f(d_1, e_1, x_1, y_1, o_1) - f(d_1, e_0, x_0, \alpha y_0, \alpha o_0)}_{\text{i) population characteristics and market income effect (real)}} \\ & + \underbrace{f(d_1, e_0, x_0, \alpha y_0, \alpha o_0) - f(\alpha d_0, e_0, x_0, \alpha y_0, \alpha o_0)}_{\text{ii) tax-benefit policy effect (real)}} \\ & + \underbrace{f(\alpha d_0, e_0, x_0, \alpha y_0, \alpha o_0) - f(d_0, e_0, x_0, y_0, o_0)}_{\text{iii) nominal effect}}.\end{aligned} \tag{3}$$

For a scale-dependent measure (e.g. mean income), the sum of the first two terms in equation 3 gives the *real* change in I and the third term captures the effect of price changes on (start-period) incomes. For a scale-independent measure (e.g. the Gini coefficient) the nominal effect equals 0 as a change in the nominal levels of both tax-benefit policy amounts and market incomes should not affect the relative position of households in the income distribution (Bargain and Callan, 2010). In the results section, we provide estimates of the first two terms only.

The decomposition is path-dependent, i.e. the order in which the different effects are estimated can differ. For example, the change in I can be decomposed by conditioning the PCMI effect either on end- or start-period policies. No one combination is preferable over the other. Thus, we follow here the approach by Paulus and Tasseva (2020, p. 8) to derive all possible combinations and to calculate the PCMI and TBP effect as the average effect across all combinations.

2.2. *Decomposing the changes in PCMI*

We decompose the PCMI effect on I to the HE wage premia and separately to other changes to wages (hereafter changes to wages), using a regression-based approach. We then separately identify the contribution of changes to the education composition, using re-weighting. Further details are given below.

By constructing new counterfactuals, the first term in equation (3) is decomposed as:

$$\Delta I^{i)} = \underbrace{f(d_1, e_1, x_1, y_1, o_1) - f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_1, \hat{\delta}_1, \hat{\nu}_1, \hat{\theta}_{1,e_1}}, o_1)}_{\text{iv) changes to wages}}$$
$$+\underbrace{f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_1, \hat{\delta}_1, \hat{\nu}_1, \hat{\theta}_{1,e_1}}, o_1) - f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_1, \hat{\nu}_1, \hat{\theta}_{1,e_1}}, o_1)}_{\text{v) changes to returns to HE for white British men}}$$
$$+\underbrace{f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_1, \hat{\nu}_1, \hat{\theta}_{1,e_1}}, o_1) - f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_0, \hat{\nu}_1, \hat{\theta}_{1,e_1}}, o_1)}_{\text{vi) changes to returns to HE for non-white-British men}}$$
$$+\underbrace{f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_0, \hat{\nu}_0, \hat{\theta}_{1,e_1}}, o_1) - f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_0, \hat{\nu}_0, \hat{\theta}_{0,e_1}}, o_1)}_{\text{vii) changes to returns to HE for white British women}}$$
$$+\underbrace{f(d_1, e_1, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_0, \hat{\nu}_0, \hat{\theta}_{0,e_1}}, o_1) - f(d_1, \hat{e}_0, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_0, \hat{\nu}_0, \hat{\theta}_0, \hat{e}_0}, o_1)}_{\text{viii) changes to returns to HE for non-white-British women}}$$
$$+\underbrace{f(d_1, \hat{e}_0, x_1, \hat{y}^{\hat{\beta}_0, \hat{\gamma}_0, \hat{\pi}_0, \hat{\rho}_0, \hat{\lambda}_0, \hat{\delta}_0, \hat{\nu}_0, \hat{\theta}_0, \hat{e}_0}, o_1) - f(d_1, e_0, x_0, \alpha y_0, \alpha o_0)}_{\text{ix) changes to education composition}}.$$
$$\underbrace{\qquad\qquad}_{\text{x) residual}}$$

(4)

In term iv) in equation (4), we estimate the impact on the income distribution of changes to wages, but fixing the HE wage premia and amount of education at their $t = 1$ levels. We construct the counterfactual in iv) as follows: first, the following four models of wages are estimated:

$$\begin{aligned}
\ln y^{wBm}_{i(ht)} &= x^{wBm}_{i(ht)}\beta_t + e^{wBm}_{i(ht)}\lambda_t + \epsilon_{i(ht)} \\
\ln y^{nwBm}_{i(ht)} &= x^{nwBm}_{i(ht)}\gamma_t + e^{nwBm}_{i(ht)}\delta_t + \eta_{i(ht)} \\
\ln y^{wBw}_{i(ht)} &= x^{wBw}_{i(ht)}\pi_t + e^{wBw}_{i(ht)}\nu_t + \mu_{i(ht)} \\
\ln y^{nwBw}_{i(ht)} &= x^{nwBw}_{i(ht)}\rho_t + e^{nwBw}_{i(ht)}\theta_t + \upsilon_{i(ht)},
\end{aligned} \tag{5}$$

where $\ln y^{wBm}_{i(ht)}$, $\ln y^{nwBm}_{i(ht)}$, $\ln y^{wBw}_{i(ht)}$ and $\ln y^{nwBw}_{i(ht)}$ are the log of monthly earnings of individual i in household h in period t for the sample of white British men (wBm), non-white-British men (nwBm), white British women (wBw) and non-white-British women (nwBw), respectively. The e's denote the individual level of education while the x's are a set of other observable individual/household characteristics. The residual terms are denoted by $\epsilon_{i(ht)}$, $\eta_{i(ht)}$, $\mu_{i(ht)}$ and $\upsilon_{i(ht)}$.[4] The returns to individual/household characteristics are denoted with β_t, γ_t, π_t, ρ_t and those to education with λ_t, δ_t, ν_t, θ_t.

[4]Since the data used in the paper are cross-sectional, we do not have repeated observations for individuals and households which we note with parenthesis $i(ht)$ in equation (5).

Wages are then predicted for the $t = 1$ sample of workers by: (1) applying the coefficients $\hat{\beta}_0$, $\hat{\gamma}_0$, $\hat{\pi}_0$ and $\hat{\rho}_0$ from the models estimated on $t = 0$ data, (2) applying the returns to higher education (HE) from the models estimated on $t = 1$ data, and (3) adjusting the predicted residuals by the ratio of the estimated standard deviation of the residuals in $t = 0$ and $t = 1$. The counterfactual distribution of wages ($\hat{y}^{\hat{\beta}_0,\hat{\gamma}_0,\hat{\pi}_0,\hat{\rho}_0,\hat{\lambda}_1,\hat{\delta}_1,\hat{v}_1,\hat{\theta}_1,e_1}$) represents workers wages in $t = 1$ if they were renumerated according to the returns prevailing in $t = 0$. By adjusting the predicted residuals, changes in the variation of the unobservables are also captured in the counterfactual.

In terms v) to viii) in equation (4), we use the same procedure as above but apply the returns to HE from the models estimated on $t = 0$ data. In this way, we assess the impact of changes to the returns to HE, i.e. the *education compression effect*, for: v) *white British men* ($\hat{y}^{\hat{\beta}_0,\hat{\gamma}_0,\hat{\pi}_0,\hat{\rho}_0,\hat{\lambda}_0,\hat{\delta}_1,\hat{v}_1,\hat{\theta}_1,e_1}$); *vi) non-white-British men* ($\hat{y}^{\hat{\beta}_0,\hat{\gamma}_0,\hat{\pi}_0,\hat{\rho}_0,\hat{\lambda}_0,\hat{\delta}_0,\hat{v}_1,\hat{\theta}_1,e_1}$); vii) *white British women* ($\hat{y}^{\hat{\beta}_0,\hat{\gamma}_0,\hat{\pi}_0,\hat{\rho}_0,\hat{\lambda}_0,\hat{\delta}_0,\hat{v}_0,\hat{\theta}_1,e_1}$); and viii) *non-white-British women* ($\hat{y}^{\hat{\beta}_0,\hat{\gamma}_0,\hat{\pi}_0,\hat{\rho}_0,\hat{\lambda}_0,\hat{\delta}_0,\hat{v}_0,\hat{\theta}_0,e_1}$). For more details on how we construct the wage counterfactuals, see Appendix A.

The term ix) in equation (4) captures the contribution of changes in the amount of education, i.e. the *education composition effect*. To construct the counterfactual, we use re-weighting to identify the impact of increased education attainment on *I*. The re-weighting approach follows on the algorithm by Gomulka (1992), which minimizes a function of the differences between the base and target weights. In more detail, the household survey data weights in $t = 1$ (*base weights*) are adjusted, so that the education shares (completed education aged 16 or less, aged 17–19, aged 20+) in $t = 1$ correspond to the education shares in $t = 0$ (*target weights*). Furthermore, we account for the relative change in education shares along the following dimensions: age (5-year bands), sex (male/female) and household type (with/without children and with 1/2+ adults in the household).[5] By re-weighting and building on the counterfactual from term viii), another wage counterfactual distribution ($\hat{y}^{\hat{\beta}_0,\hat{\gamma}_0,\hat{\pi}_0,\hat{\rho}_0,\hat{\lambda}_0,\hat{\delta}_0,\hat{v}_0,\hat{\theta}_0,\hat{e}_0}$) is constructed in which the education level of the population in $t = 1$ is like of the population in $t = 0$ ($\hat{e}_0$). The counterfactual distribution of education affects not only wages but also other forms of market incomes, as after the re-weighting more/less weight is given to certain household types (classified by education level, age and sex) who may also be more or less likely to receive certain market incomes (e.g. from private pensions and investment income).

The term x) in equation (4) captures the residual, i.e. the impact on the income distribution of all other changes to market incomes and population characteristics not accounted for by the decomposition, e.g. changes in the distribution of self-employment income, migration etc.

[5]We make use of the Stata command reweight2 by Browne (2012).

In all counterfactuals in terms iv) to x) we apply tax-benefit policies from $t = 1$ using a tax-benefit model. In each scenario the model calculates the counterfactual benefit entitlements and tax liabilities of each individual/household in the end-period, on the basis of their counterfactual wages/education level and end-period other market incomes and characteristics. Thus, although tax-benefit policies are the same across the counterfactuals, the level of benefits and taxes differ across scenarios in response to the wage/education changes. Household gross incomes minus personal taxes and minus national insurance contributions (NI) gives the distribution of household net incomes in each counterfactual.

Finally, we provide bootstrapped standard errors for the change in mean income and income inequality. We construct a bootstrap sample for each data year by sampling households with replacement and drawing the same number of households as the unweighted sample. We draw 400 bootstrap samples and carry out the decomposition analysis for each one of them. Our estimates account for sample variation but not measurement error.

3. Data and the Tax-Benefit Model EUROMOD

We use data from the Family Resources Survey (FRS), which is a purpose built income survey, for 2001/02, 2007/08, 2011/12 and 2017/18 (Department for Work and Pensions, 2005, 2014a, 2014b, 2019b). The data are cross-sectional, nationally representative and contain rich information on individual and households characteristics and circumstances. The FRS serves as the main source for official statistics on incomes, poverty and inequality in the UK: see e.g. the latest report on "Households Below Average Incomes" produced by the Department for Work and Pensions (2019a) or the annual reports on income trends by the Institute for Fiscal Studies (e.g. Bourquin et al., 2019). Thus, the data can be considered as the "golden" benchmark for distributional analysis in the UK and are the perfect data source to analyze the interactions between person's characteristics, such as the level of education, gross market incomes and the tax-benefit rules.

To mitigate the risk of measurement error at the bottom of the income distribution (Brewer *et al*., 2017), we trim the sample by dropping the poorest 4 percent in each survey year. Jenkins (2017) shows that Households Below Average Incomes (HBAI) estimates, derived entirely from the FRS data, do not capture changes at the top of the income distribution. Therefore, we also drop the richest 1 percent in each survey year to reduce measurement error at the top of the distribution. For similar approaches, see Belfield *et al*. (2017) and Brewer and Wren-Lewis (2015). Thus, our analysis focuses on the middle 95 percent of the distribution and ignores inequality at the tails. Furthermore, households from Northern Ireland were included in the survey only from 2002/03 onwards and so, we restrict the sample to Great Britain.

To derive household net incomes, we combine information on gross market incomes from the FRS with information on benefit entitlements, income tax liabilities and NI contributions obtained from a tax-benefit microsimulation model. We use the model EUROMOD to calculate benefits, income tax and NI contributions for the actual as well as counterfactual income distributions. This is a standard

practice in the decomposition literature which separates changes in the income distribution into direct policy effect (i.e. changes to tax and benefit policies) and population characteristics and market income effect (using EUROMOD, see e.g. Bargain and Callan, 2010; using IFS TAXBEN, see e.g. Joyce and Sibieta, 2013). EUROMOD contains syntax of functions which determine a) who—e.g. a family with certain characteristics/market incomes—is entitled to receive a certain benefit or liable to pay an income tax/NI and b) the size of the benefit entitlement/personal tax/NI. The syntax reflects the policy rules (design, percentage rates and amounts) on 30th of June in 2001, 2007, 2011 and 2017. EUROMOD reads the FRS micro-data on market incomes and socio-economic characteristics and based on the policy rules it calculates individual/household benefit entitlements, income tax and NI liabilities.

To ensure EUROMOD calculations (given the policy rules and FRS data) reflect the actual income distribution in a given year, the model is regularly tested and validated against official statistics on benefit spending and recipients/tax revenues and payers, and the income distribution. The quality control checks are carried out by a team of researchers at the University of Essex, UK responsible for the maintenance and updating of EUROMOD. The model is publicly available for research purposes and user feedback is fed into the validation process. For more information on the UK model see the Country Report by De Agostini (2018). For a model description and a literature review of research applications with EUROMOD, see Sutherland and Figari (2013) and Figari *et al*. (2015).

The measure of household net income in this analysis is cash income and is the sum of gross market incomes, national insurance benefits, means-tested benefits, state pensions minus direct income taxes and NI contributions. To account for household composition and economies of scale, we equivalise household net incomes using the commonly used modified OECD equivalence scale.

For more information on the data (i.e. education and ethnicity variables, definition of household net income and sample adjustments), see Appendix B.

4. Results

We begin by documenting the broad distributional changes in the pre-crisis (2001–07), crisis (2007–11) and post-crisis (2011–17) periods, showing that our results using simulated incomes are consistent with the existing evidence. In the second part of the section, we analyze how much of the income changes along the distribution were attributed to changes to population characteristics and market incomes (PCMI) and its components—in particular education changes—and to changes to tax-benefit policies (TBP). In the final part of the section, we look at the contribution of education changes to changes in aggregate measures of income inequality.

4.1. *Trends in income inequality*

We first replicate the broad inequality trends (between 2001 and 2017) that have been documented elsewhere (e.g. Belfield et al., 2014; Jenkins, 2017; Bourquin et al., 2019), using our simulated incomes derived from EUROMOD model based

TABLE 2
Level of and Changes (in % Points) to Inequality

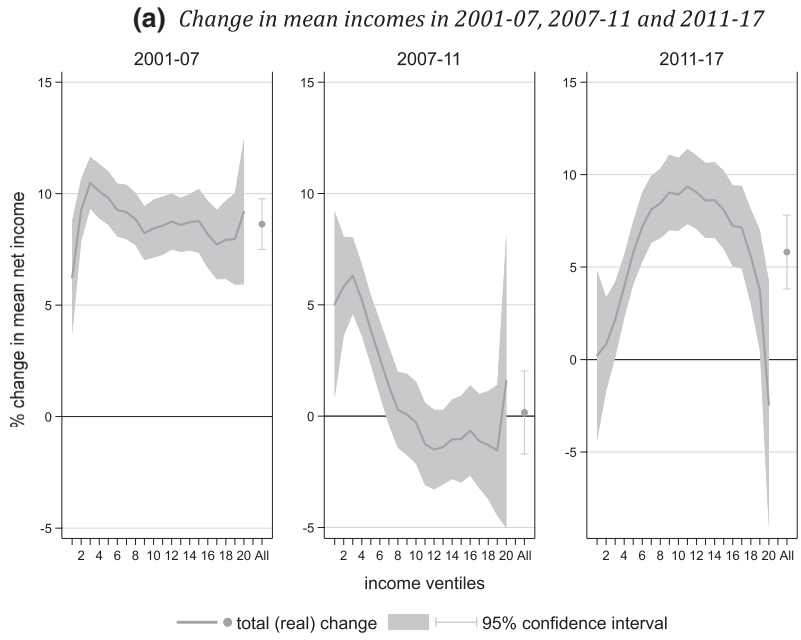
	Gini	Atkinson (0.5)	Atkinson (1)	Atkinson (2)	CV
Observed 2001	0.277***	0.060***	0.114***	0.206***	0.532***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)
Observed 2007	0.275***	0.059***	0.112***	0.202***	0.530***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.006)
Observed 2011	0.268***	0.056***	0.106***	0.190***	0.526***
	(0.003)	(0.002)	(0.003)	(0.004)	(0.012)
Observed 2017	0.262***	0.053***	0.103***	0.189***	0.495***
	(0.002)	(0.001)	(0.002)	(0.003)	(0.006)
Total change	−0.002	−0.001	−0.002	−0.004	−0.001
in 2001–07	(0.003)	(0.001)	(0.002)	(0.003)	(0.008)
Total change	−0.007*	−0.003	−0.006**	−0.012**	−0.004
in 2007–11	(0.004)	(0.002)	(0.003)	(0.004)	(0.012)
Total change	−0.006	−0.003	−0.004	−0.001	−0.031**
in 2011–17	(0.004)	(0.002)	(0.003)	(0.005)	(0.013)

Notes: Significance levels indicated as $*p < 0.1$, $**p < 0.05$, $***p < 0.01$ and standard errors shown in parentheses. Bootstrapped standard errors after 400 replications.
Source: Author's calculations using EUROMOD and the Family Resources Survey.

on FRS data. Table 2 shows the change in five measures of inequality in 2001–07, 2007–11 and 2011–17, focusing on the middle 95 percent of the income distribution.

Inequality remained broadly unchanged in the first part of the 2000s (2001–07). In 2007–11, there was a small, statistically significant drop in inequality for the Gini coefficient (statistically significant at the 10 percent level) and for the Atkinson index with aversion parameters of 1 and 2 (statistically significant at the 5 percent level). In 2011–17, we estimate a statistically significant drop in inequality only for the coefficient of variation. In 2017, the last year of observation, the Gini coefficient was 0.26; the Atkinson index with aversion parameter of 0.5, 1 and 2 was 0.05, 0.10 and 0.19, respectively; the coefficient of variation was 0.5.

To understand better what is behind the inequality changes, Figure 1a shows the real change in mean household net income by ventiles (1–20) and for the whole population (*All*) in each period. (We return to Figure 1b in Section 4.2.) Mean incomes (*All*) grew by 8.6 percent between 2001 and 2007. Incomes rose at all points of the distribution although the poorest ventile saw its income grow less than the rest of the distribution. The 3rd and 4th ventiles enjoyed the strongest income growth. Between 2007 and 2011, the population mean (*All*) did not change but that masked different trends along the distribution: income growth was pro-poor with the largest income gains at the bottom of the distribution. Incomes increased for the first 6 ventile groups, with the strongest growth enjoyed by the 1st to 4th income ventiles. The richest 20th ventile also experienced a small income gain, although this was not statistically significantly different from zero. For the rest of the distribution incomes fell, although again these changes were not statistically significant. Between 2011 and 2017, incomes grew by 5.8 percent on average (*All*). The change in incomes across the distribution was reverse U-shaped: with no statistically significant changes for the bottom two ventiles; a drop for the 20th ventile, although not statistically significant; and gains along the rest of the distribution.



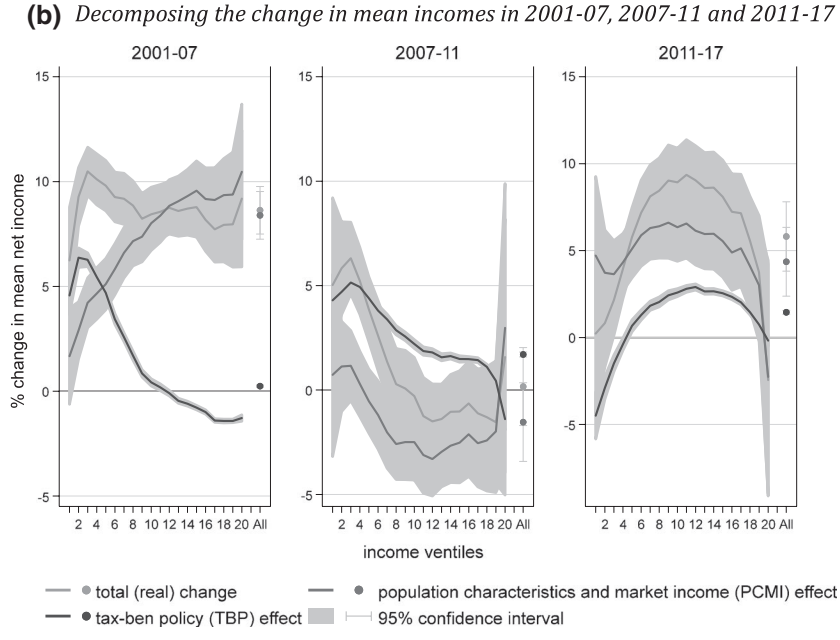


Figure 1. (a) Change in Mean Incomes in 2001–07, 2007–11 and 2011–17. (b) Decomposing the Change in Mean Incomes in 2001–07, 2007–11 and 2011–17.

Notes: (a) Shows the % change in 2007 mean net income in 2001–07 and 2007–11 and in 2011 mean net income in 2011–17. (b) Decomposes the total change into the PCMI and TBP effects. Changes to incomes are in real terms. Household ranking is not fixed, based on the respective (actual or counterfactual) distribution of equivalized household net income. Confidence intervals are estimated after 400 bootstrap replications.

Source: Author's calculations using EUROMOD and the Family Resources Survey.

Appendix C provides evidence that our conclusions about the changes in the income distribution broadly hold, regardless of whether we use simulated incomes (based on EUROMOD and FRS data) or FRS reported incomes.

4.2. *Decomposing income changes along the distribution*

In this section, we decompose changes in net income at different points of the distribution, for the boom (2001–07), crisis (2007–11) and post-crisis (2011–17) periods separately. Our aim is to understand what was the effect of education changes on household incomes. We begin by investigating how much of the income changes were attributed to changes to PCMI and its components focusing on education composition changes and changes in the returns to HE. At the end of the section we also show the contribution of the TBP effect.

To summarize the main results, we find that the total PCMI effect had a different shape across the income distribution in the three periods of analysis, leading to gains and losses at different parts of the distribution. Nevertheless, what was common across the three periods is that the largest share of the PCMI effect in each period went to changes to wages and the education composition. Education composition changes on the whole benefited the upper part of the income distribution more than the bottom, increasing the gap between rich and poor. On the other hand, we find limited evidence for an education compression effect on the income distribution as the wage returns to HE remained broadly the same: the returns to HE for white British women only fell down slightly, reducing mean household net income. But the returns to HE for men and non-white-British women remained broadly unchanged and so, had no effect on the income distribution.

4.2.1. Income Changes in 2001–07

Figure 2 shows the results from the decomposition set out in equation (4), decomposing the real change in mean net income between 2001 and 2007 into the different PCMI components.[6] The change in mean income is estimated by income ventiles (1–20) and for the whole population (*All*). Each graph corresponds to a different component of the PCMI effect, i.e. the contribution to income changes of: iv) changes to wages, excluding the returns to HE; v) to viii) changes to the HE wage premia by sex and ethnicity; ix) compositional changes to education; and x) a residual. In each graph, the PCMI component is illustrated in black (a black line for the income change across ventiles and a black circle for the income change for the whole population). The total change (a light grey line/circle) and the total PCMI effect (a dark grey line/circle) are illustrated repeatedly in each graph. Noteworthy, as we are comparing different household samples, households position in the income distribution is not fixed.

Starting with the total PCMI effect, we find that it accounts for nearly all of the total change in mean income (light and dark grey circles above *All* nearly overlap in each graph). However, looking across the income distribution, the PCMI effect led to income gains that were almost linearly increasing in ventile groups,

[6]To estimate the impact of changes to wages and the returns to HE, we estimate equation (5): the estimated coefficients are broadly as expected and full results are given in Appendix D.

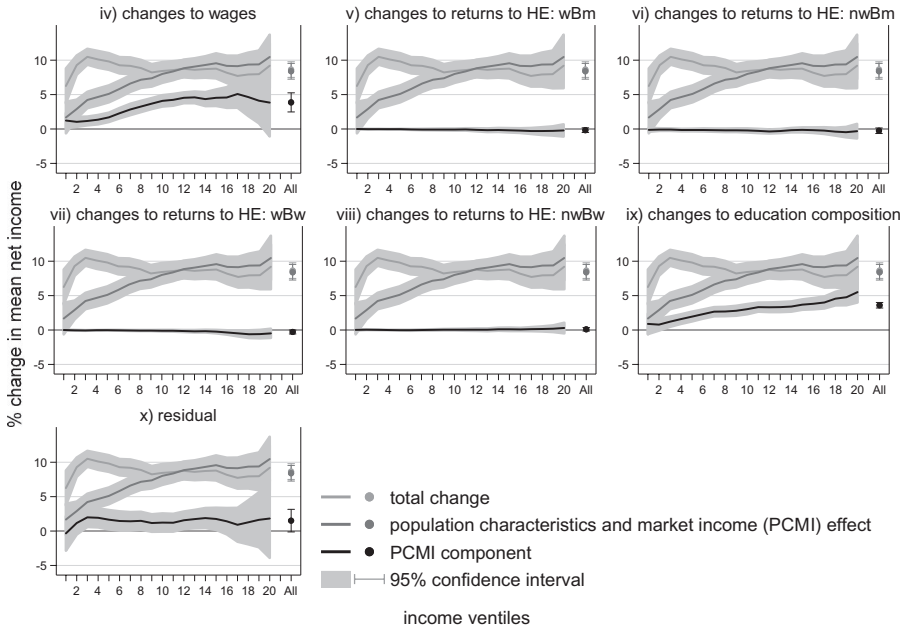


Figure 2. Decomposing the Change in Mean Incomes Between 2001 and 2007

Notes: HE = higher education; wBm = white British men; nwBm = non-white-British men; wBw = white British women; nwBw = non-white-British women. The total change and the total PCMI effect are illustrated repeatedly in each graph. What differs across graphs is the change in net income due to the PCMI component. The PCMI components sum up to the total PCMI effect. Changes to incomes are in real terms. Household ranking is not fixed, based on the respective (actual or counterfactual) distribution of equivalized household net income. Confidence intervals are estimated after 400 bootstrap replications.

Source: Author's calculations using EUROMOD and the Family Resources Survey.

whereas the total change in net income was highest for the 3rd and 4th ventiles. Thus, the PCMI effect was pro-rich, with very small gains for the poorest ventiles and the largest gains concentrated in the top 12th–20th ventiles.

The main factors that contributed to the pro-rich income gains due to the PCMI effect were changes to wages (graph iv) and compositional changes to education (graph ix). The changes to wages led to gains in net income that were larger for the second than the first half of the distribution, and the gains due to education expansion (i.e. education composition changes) were monotonically increasing with income. The increases in net income due to education expansion, especially at the higher end of the distribution, exceeded those from the changes to wages. Thus, it was mainly the composition changes to education which led to increased gap between the top and bottom of the distribution.

When we break down the change in mean net income by income sources, we find that education expansion (ix) led to increases in net income mainly through earnings but also other market incomes: there were statistically significant increases in mean earnings (4 percent), self-employment income (0.5 percent) and other types of market incomes such as private pensions (0.8 percent) and investment income (0.4 percent). The gains from earnings, self-employment and investment income

due to education composition changes were larger for the upper part of the distribution while the gains from private pensions were somewhat more equal across the distribution. For results from this break-down, see Appendix E and Figure E.1.

Moving on to changes in the HE returns, we find a small drop of 0.28 percent in average household net income (for *All*), statistically significant at the 5 percent level, due to a reduction in the HE wage premium among white British female workers (component vii in Figure 2). But we do not find any changes to the HE wage premium among male workers or non-white-British female workers and hence, they do not have any impact on the income distribution (components v, vi and viii). This is broadly consistent with the evidence of constant graduate wage premia (Walker and Zhu, 2008; Machin, 2011).

Some of the income changes along the distribution are not explained by the changes to education and wages and are captured in the residual (component x in Figure 2). The break-down by income source (Figure E.1) shows that there were income gains from earnings and self-employment income for the bottom ventile groups as part of the residual. This is consistent with Belfield *et al*. (2017) and Blundell *et al*. (2018) who document a reduction in the number of men working full-time and an increase in part-time (less than 30 hours per week) employment which is attributed to increased inequality of male earnings. Belfield *et al*. (2017) find an increase in self-employment, in the number of one-earner households and their relative size at the bottom of the distribution.

4.2.2. Income Changes in 2007–11

We now present results from repeating the above analysis for the crisis (2007–11) period. Between 2007 and 2011 and in contrast to the earlier period, the PCMI effect on net incomes led to an average loss of 1.5 percent (for *All*), although this was not statistically significantly different from zero (Figure 3). The income changes were U-shaped with small gains at the bottom and top ventiles and losses along the rest of the distribution.

As in 2001–07, the main components contributing to the PCMI effect during the crisis were changes to wages and the education composition. Changes to wages (component iv) contributed to a small reduction in average net incomes of 1.3 percent (statistically significant at the 10 percent level). They led to income losses along the entire distribution apart from the 17th to 20th ventiles where incomes changes were not statistically significant.

On the other hand, education expansion (component ix) continued to raise net incomes—by 3 percent on average—during the crisis: as the amount of education increased on average across all ventiles, there were income gains at all parts of the distribution. These were somewhat larger for the first and last ventiles and were overall more equally distributed across ventile groups, compared to 2001–07. Breaking down the change in net income in 2007–11 by income source (Figure E.2) shows that education expansion contributed to statistically significant increases in mean earnings (2.5 percent) and other market incomes, in particular private pensions (1 percent). Increases in investment income were smaller, at 0.2 percent.

The wage returns to HE (by sex and ethnicity) (components v-viii in Figure 3) remained constant in the crisis despite the continuous increase in the number of

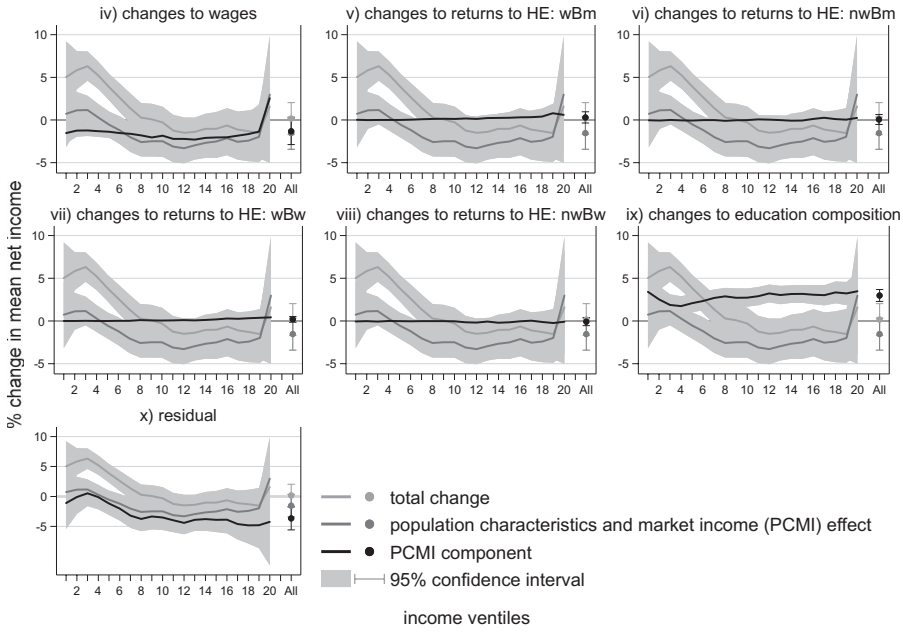


Figure 3. Decomposing the Change in Mean Incomes Between 2007 and 2011

Notes: HE = higher education; wBm = white British men; nwBm = non-white-British men; wBw = white British women; nwBw = non-white-British women. The total change and the total PCMI effect are illustrated repeatedly in each graph. What differs across graphs is the change in net income due to the PCMI component. The PCMI components sum up to the total PCMI effect. Changes to incomes are in real terms. Household ranking is not fixed, based on the respective (actual or counterfactual) distribution of equivalized household net income. Confidence intervals are estimated after 400 bootstrap replications.

Source: Author's calculations using EUROMOD and the Family Resources Survey.

university graduates. Blundell *et al*. (2016) document the same pattern. They suggest that firms have responded to the increased supply of graduates through a decentralization of the organization structure.

The remaining changes in net income, which are not explained by the education and wages changes, are shown in the residual (component x in Figure 3): they were pro-poor resulting in smaller income losses at the bottom than the rest of the distribution. These losses can be largely attributed to the increase in unemployment during the crisis. In the first to fourth ventiles there were also further relative increases in the number of one-earner households (compared to no-earner households).

4.2.3. Income Changes in 2011–17

Next, we repeat the decomposition analysis for the post-crisis period (2011–17). Similar to 2001–07, changes to PCMI led to net income gains of 4.4 percent on average (for *All* in Figure 4). Across the bottom 19 ventiles, the income gains ranged between 3 percent (19th ventile) and 6.6 percent (9th ventile). Only for the richest income ventile, net income fell by 2.3 percent, although this was not a statistically significant change.

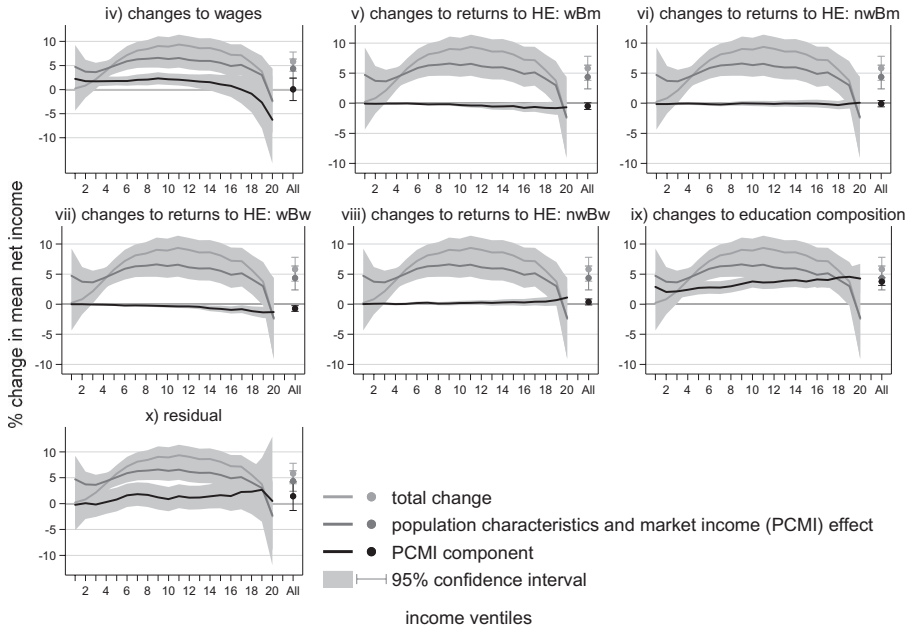


Figure 4. Decomposing the Change in Mean Incomes Between 2011 and 2017

Notes: HE = higher education; wBm = white British men; nwBm = non-white-British men; wBw = white British women; nwBw = non-white-British women. The total change and the total PCMI effect are illustrated repeatedly in each graph. What differs across graphs is the change in net income due to the PCMI component. The PCMI components sum up to the total PCMI effect. Changes to incomes are in real terms. Household ranking is not fixed, based on the respective (actual or counterfactual) distribution of equivalized household net income. Confidence intervals are estimated after 400 bootstrap replications.

Source: Author's calculations using EUROMOD and the Family Resources Survey.

As with the previous periods, the two main components of the PCMI effect that contributed to income changes were changes to wages (component iv) and the education composition (component ix). Although changes to wages did not have an effect on the overall mean, average net income went up in the bottom 15 ventiles, and fell in the richest three ventiles (though the loss was not statistically significantly different from zero).

In the post-crisis period, net income continued to go up due to the education expansion (component ix), with an increase of 3.8 percent on average. Education expansion led to income gains across the entire distribution, similar to the changes in 2007–11. These gains were primarily due to earnings which went up on average by 3.6 percent but also to self-employment income which increased by 0.6 percent on average (Figure E.3).[7]

[7]Appendix F includes results for the change in income by age group, based on equivalized household incomes. In summary, we find that in each period education expansion led to income gains along the age distribution which were largest for the age groups of 30–34, 35–39, 40–44. There were large income gains due to education expansion also among the younger age groups of 0–19 (due to shared income gains within the household).

We find a small drop in mean net income of 0.7 percent due to changes in the HE returns for white British women (component vii in Figure 4). The income reduction was biggest (more than 1 percent) for the richest three ventiles. When we break down the change in net income by income source (Figure E.3), we estimate a loss in mean earnings of 2 percent–3 percent in those richest three ventiles. Part of this loss was offset by automatic reductions in tax liabilities, leading to the smaller loss in overall net income. We do not find any evidence for changes in the HE returns for male and non-white-British female workers and so, household net incomes remain unchanged (components v, vi and viii in in Figure 4).

The residual (component x) captures increases in mean net income across most of the distribution, although none of these changes were statistically significantly different from zero.

4.2.4. Tax-Benefit Policy Changes

We now return to Figure 1b which presents the TBP effect (in black) and compares it with the PCMI effect (in dark grey). In summary, policy changes in the 2000s were pro-poor, benefiting mostly the bottom of the income distribution and offsetting the increased disparities due to education composition changes (and changes to wages in 2001–07). But unlike in the 2000s, the TBP effect in 2011–17 had a reverse-U shape: offsetting some of the income gains due to education expansion at the bottom of the distribution and reinforcing the gains in the middle.

In more detail, between 2001 and 2007, changes to TBP led to clear income gains for the first half of the distribution, with the largest gains for the poorest ventiles. This was in stark contrast with the regressive PCMI effect due to education expansion and changes to wages. The pro-poor policy changes were the result of increased generosity in tax credits and means-tested benefits. In the top ventiles, on the other hand, mean incomes fell by a small but statistically significant share, due to increased tax liabilities and NI contributions. Between 2007 and 2011, the shape of the TBP effect was again progressive although less so compared to the earlier period. The TBP effect led to gains along the entire distribution, apart from the last ventile (due to the introduction of the top 50 percent marginal tax rate). This result is again different from the U-shaped and mostly negative PCMI effect. The analysis by Paulus *et al*. (2020) provides an in-depth discussion of the TBP effect in the UK in 2001–07 and 2007–11.

It is worth noting that incomplete take-up of means-tested benefits had an effect for the TBP results. In 2001–07, if means-tested benefits were taken up by all entitled families, the gains for the poorest ventiles due to the TBP effect would have been larger than with incomplete take-up. Furthermore, the gains for the first ventile would have been larger than those for the following, richer ventile groups. However, in 2007–11, due to the erosion to the real value of means-tested benefits and incomplete take-up of these benefits, the net income gain (mixture of changes to means-tested benefits, non-means-tested benefits and pensions, income taxes and national insurance contributions) for the bottom two ventiles was bigger than it would have been had all eligible families have taken up their means-tested benefit entitlements.

TABLE 3
Decomposing Inequality Changes (in % Points) Between 2001 and 2007

	Gini	Atkinson (0.5)	Atkinson (1)	Atkinson (2)	CV
Total change	−0.002	−0.001	−0.002	−0.004	−0.001
	(0.003)	(0.001)	(0.002)	(0.003)	(0.008)
PCMI effect	0.010***	0.004***	0.009***	0.016***	0.019**
	(0.003)	(0.001)	(0.002)	(0.003)	(0.008)
iv) changes to wages	0.005	0.002	0.004	0.008	0.006
	(0.005)	(0.002)	(0.004)	(0.005)	(0.012)
v) changes to returns to HE: wBm	−0.001	−0.000	−0.000	−0.001	−0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
vi) changes to returns to HE: nwBm	−0.000	−0.000	−0.000	−0.001	−0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
vii) changes to returns to HE: wBw	−0.001*	−0.000*	−0.001*	−0.001*	−0.002
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
viii) changes to returns to HE: nwBw	0.000	0.000	0.000	0.001	0.001
	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
v) to viii) changes to returns to HE: all	−0.002	−0.001	−0.001	−0.002	−0.003
	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)
ix) changes to education composition	0.007***	0.003***	0.006***	0.010***	0.015***
	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)
x) residual	0.000	0.000	0.000	0.000	0.002
	(0.005)	(0.002)	(0.004)	(0.006)	(0.013)
TBP effect	−0.013***	−0.005***	−0.010***	−0.020***	−0.021***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)

Notes: HE = higher education; wBm = white British men; nwBm = non-white-British men; wBw = white British women; nwBw = non-white-British women; PCMI = population characteristics and market incomes; TBP = tax-benefit policies. Significance levels indicated as $*p < 0.1$, $**p < 0.05$, $***p < 0.01$ and standard errors shown in parentheses. Bootstrapped standard errors after 400 replications.
Source: Author's calculations using EUROMOD and the Family Resources Survey.

Between 2011 and 2017, the TBP effect had a reverse U-shape (somewhat similar to the PCMI effect), leading to income losses at the bottom of the distribution, no change for the richest ventile and gains for the remaining ventile groups (see also De Agostini *et al*., 2018; Bourquin et al., 2019). The income losses at the bottom were the result of cuts to means-tested and other benefits, which completely offset the gains due to education expansion. The gains in the middle of the distribution were due to reductions in income taxes (as the personal allowance increased), reinforcing the gains from wages and education expansion captured in the PCMI effect.

4.3. *Decomposing Inequality Changes*

In this section, we turn to decomposing changes in aggregate measures of income inequality by period. For the *composition effect* of education changes on inequality, we find that education expansion led to higher income inequality in the 2000s and this was mainly driven by changes in the pre-crisis period. In 2001–07 (Table 3), our results show that education expansion (ix) is the main component of the PCMI effect that explains the rise in net income inequality. In 2007–11 (Table 4), the gains from education expansion were more equally distributed than in 2001–07. Thus, education changes continued to widen the gap between rich and poor but to a smaller extent and the effect was no longer statistically significant. In 2011–17 (Table 5), education expansion increased further disparities in income

TABLE 4
Decomposing Inequality Changes (in % Points) Between 2007 and 2011

	Gini	Atkinson (0.5)	Atkinson (1)	Atkinson (2)	CV
Total change	−0.007*	−0.003	−0.006**	−0.012**	−0.004
	(0.004)	(0.002)	(0.003)	(0.004)	(0.012)
PCMI effect	0.001	0.001	0.001	−0.002	0.015
	(0.004)	(0.002)	(0.003)	(0.004)	(0.013)
iv) changes to wages	0.003	0.002	0.002	0.002	0.015
	(0.004)	(0.002)	(0.003)	(0.005)	(0.012)
v) changes to returns to HE: wBm	0.001	0.000	0.001	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.005)
vi) changes to returns to HE: nwBm	0.000	0.000	0.000	0.001	0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)
vii) changes to returns to HE: wBw	0.001	0.000	0.001	0.001	0.002
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
viii) changes to returns to HE: nwBw	−0.000	−0.000	−0.000	−0.000	−0.001
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
v) to viii) changes to returns to HE: all	0.002	0.001	0.002	0.002	0.005
	(0.002)	(0.001)	(0.001)	(0.002)	(0.005)
ix) changes to education composition	0.002	0.001	0.002	0.003	0.004
	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)
x) residual	−0.006	−0.002	−0.005	−0.009*	−0.009
	(0.004)	(0.002)	(0.003)	(0.005)	(0.014)
TBP effect	−0.008***	−0.003***	−0.006***	−0.011***	−0.019***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)

Notes: HE = higher education; wBm = white British men; nwBm = non-white-British men; wBw = white British women; nwBw = non-white-British women; PCMI = population characteristics and market incomes; TBP = tax-benefit policies. Significance levels indicated as $*p < 0.1$, $**p < 0.05$, $***p < 0.01$ and standard errors shown in parentheses. Bootstrapped standard errors after 400 replications.
Source: Author's calculations using EUROMOD and the Family Resources Survey.

according to most inequality indicators (apart from the coefficient of variation for which the change was not statistically significant).

We find limited evidence for a *compression effect* of education changes on inequality since the 2000s: in the growth period of 2001–07 (Table 3), changes to the returns for white British women (vii) were slightly equalizing (the inequality drop was statistically significant at the 10 percent level) for all measures, apart from the coefficient of variation. The returns to HE among men and non-white-British women remained, however, broadly unchanged and hence, did not affect income inequality. Changes to the returns to HE for all workers (v to viii) also did not have any impact on inequality. In the crisis years (2007–11) (Table 4), the continued absence of changes to the HE wage premia led to no effect on inequality. In 2011–17 (Table 5), as in 2001–07, we find a reduction in inequality due to changes in the returns to HE for white British female workers. But changes to the HE wage premia for men and non-white-British women, as well as changes to the HE returns for all workers, had no statistically significant impact on the inequality indicators.[8]

[8]To test if our results are sensitive to the trimming of the bottom 4 percent and top 1 percent of the income distribution, we repeated the decomposition analysis including all household observations. Our conclusions for the education composition and compression effects continue to broadly hold. Results are available from the author upon request.

TABLE 5
Decomposing Inequality Changes (in % Points) Between 2011 and 2017

	Gini	Atkinson (0.5)	Atkinson (1)	Atkinson (2)	CV
Total change	−0.006	−0.003	−0.004	−0.001	−0.031**
	(0.004)	(0.002)	(0.003)	(0.005)	(0.013)
PCMI effect	−0.007*	−0.003*	−0.005*	−0.006	−0.027**
	(0.004)	(0.002)	(0.003)	(0.005)	(0.013)
iv) changes to wages	−0.010	−0.004	−0.008	−0.011	−0.029
	(0.007)	(0.003)	(0.005)	(0.008)	(0.018)
v) changes to returns to HE: wBm	−0.001	−0.000	−0.001	−0.002	−0.002
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
vi) changes to returns to HE: nwBm	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
vii) changes to returns to HE: wBw	−0.002**	−0.001**	−0.002**	−0.003**	−0.005**
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
viii) changes to returns to HE: nwBw	0.001	0.001	0.001	0.001	0.003
	(0.001)	(0.000)	(0.001)	(0.001)	(0.002)
v) to viii) changes to returns to HE: all	−0.002	−0.001	−0.002	−0.003	−0.003
	(0.002)	(0.001)	(0.001)	(0.002)	(0.004)
ix) changes to education composition	0.003**	0.001**	0.002**	0.004**	0.005
	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)
x) residual	0.002	0.001	0.001	0.003	0.000
	(0.007)	(0.003)	(0.006)	(0.008)	(0.022)
TBP effect	0.001***	0.000**	0.002***	0.005***	−0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)

Notes: HE = higher education; wBm = white British men; nwBm = non-white-British men; wBw = white British women; nwBw = non-white-British women; PCMI = population characteristics and market incomes; TBP = tax-benefit policies. Significance levels indicated as $*p < 0.1$, $**p < 0.05$, $***p < 0.01$ and standard errors shown in parentheses. Bootstrapped standard errors after 400 replications.

Source: Author's calculations using EUROMOD and the Family Resources Survey.

Looking at earlier periods (1978 to 1991 and 1991 to 2008), Brewer and Wren-Lewis (2015) decompose changes to income inequality by different factors one of which is the education level of the highest earner in the household and their partner. In comparison, we account for changes in education in the whole (working-age) population since the early 2000s. They find that changes to the distribution of education have raised inequality, consistent with our evidence for 2001–17. For changes to the returns to education, they find they contributed to an inequality increase in 1978–91 and an inequality reduction in 1991–2008. In comparison, we estimate that changes to the HE returns for white British women only have lowered slightly inequality.

Our results for increased income inequality due to education expansion in the pre-crisis period are also consistent with the evidence on increased wage inequality (Lindley and Machin, 2013). Lindley and Machin (2013) suggest a key explanation for rising wage inequality in the UK is the increased relative demand for educated workers driven by technological change.

Furthermore, the increase in income inequality due to education expansion is likely to stem from inequality in education attainment. In the 1980s and 1990s, UK HE participation among children from richer families rose faster than among children from poorer backgrounds (Blanden and Machin, 2004). Although education

inequality fell in the 2000s, there is less evidence for a reduction in inequality at higher levels of education attainment (Crawford, 2012, Blanden and Macmillan, 2014).[9]

For the other PCMI components, we find that wage changes (iv) did not have any statistically significant effect on inequality in any of the periods, although in 2011–17 their inequality-reducing effect was relatively sizeable (Table 5). The residual (x) led to a statistically significant (at the 10 percent level) reduction in inequality only in 2007–11 for the Atkinson index with aversion parameter of 2 (Table 4). It did not have any other statistically significant impact on inequality in the other two periods.

Finally, despite the upward pressure on inequality due to education expansion, the reason why we see no change or even a small reduction in inequality in the 2000s is due to the TBP effect, especially in the boom period. This result is in line with the literature on the redistributive effect of policy changes (see e.g. De Agostini *et al.*, 2016; Paulus *et al.*, 2020). However, in 2011–17, while tax-benefit policy changes reduced the level of the coefficient of variation, they increased inequality measured by the Gini and Atkinson indices; thus, offsetting part of the reductions achieved in the 2000s and reinforcing the inequality-increasing effect of education expansion.

5. Conclusions

Education attainment in Great Britain increased substantially between 2001 and 2017. This paper analyses how this recent education expansion affected the distribution of household net incomes.

We find that, between 2001 and 2017, education expansion led to higher living standards mostly through higher earnings, but the effect was not the same across the income distribution. As income gains in the middle and the top of the distribution were larger than the income gains at the bottom, the *education composition effect* raised income inequality (mostly through more unequal earnings distribution).

We find limited evidence for an *education compression effect* on inequality: we estimate a small drop in inequality due to a reduction in the HE wage premia among white British women only, in 2001–07 and 2011–17. We find no change to the returns to HE for this group in 2007–11. As the wage returns to HE among male and non-white-British female workers remained broadly unchanged in all periods, they had no impact on the distribution of household incomes.

As education expansion worsens income inequality, there may be implications for equality of opportunity and social mobility. An important policy concern for equality of opportunity is whether education expansion benefits disproportionally

[9]An important aspect of education changes is the increase in educational assortative mating in the UK and other countries, documented elsewhere. Nevertheless, the evidence suggests that changes to educational assortative mating explain little of the changes in income inequality (see e.g. Breen and Salazar, 2010, Boertien and Permanyer, 2019, Eika *et al.*, 2019). In our paper, although we do not identify separately the impact of changes to assortative mating they are part of the education composition effect (as our control totals in the re-weighting procedure include household composition).

children from more affluent families. Our data do not allow us to answer directly this question and so, we draw on the related literature: although, as the average level of education attainment increased, education inequality fell in the 2000s (compared to an increase in the 1980s and 1990s), there is little evidence showing that inequality at higher levels of education attainment has fallen (Crawford, 2012; Blanden and Macmillan, 2014). Furthermore, the positive link between education expansion and income inequality may have implications for social mobility. International comparisons suggest low levels of intergenerational income mobility in the UK linked to the relatively high level of income inequality (Corak, 2013; Jerrim and Macmillan, 2015). There is also evidence suggesting that social mobility in the UK is falling (Nicoletti and Ermisch, 2007; Gregg *et al*., 2017) although the links to changes to income inequality have not been studied so far.

However, in 2007–11 and 2011–17 we find that the income gains due to education composition changes were more equally distributed than in 2001–07. This suggests that further education expansion may start lowering inequality as fewer low-educated people remain. Furthermore, it is likely that the expansion of HE will eventually push down the education wage differential for all types of worker and, with it, income inequality. It remains to be seen how the changing education distribution will play out on income inequality in the future.

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Supporting Information

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