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JEL Cassification: D31, H24

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1. Introduction

It is an honour to have this opportunity to salute Nanak Kakwani and his many significant contributions to the analysis of income distribution and redistribution. In this paper, we focus on one of those areas, redistributive effect and the progressivity of taxes and benefits, bringing the distinctive Kakwani approach to bear on four decades of UK data.

Kakwani's (1997*a*, *b*) important insight was that the vertical redistribution effect of income taxes could be neatly expressed in terms of two components, the average tax rate (summarising the overall tax level) and a measure of tax progression (summarising how individual tax payments deviated from proportionality), and each component could change independently of the other. There is an analogous relationship for the vertical redistribution of cash benefits. Kakwani's 1984 article enriched the picture by showing that overall redistributive effect – the difference between the inequality of the pre- and post-tax income distributions measured by differences in Gini coefficients – was equal to the sum of vertical redistribution and a measure of how much re-ranking there was between the pre- and post-tax distributions. Again, there are results for cash benefits and taxes separately, and for taxes and benefits combined (Lambert 1985, Jenkins 1988).

The foundation of these results is Kakwani's intimate knowledge of the properties of Lorenz and concentration curves and of their relationships to each other and to the Gini coefficient of income inequality. Although income distribution researchers sometimes point out that the Gini coefficient is a rather special inequality index, it is testimony to Kakwani's insights that his approach has stood the test of time. There are measures of tax progression besides Kakwani's, notably that of Suits (1977) which can also be related to the vertical redistribution of taxes using an area-type measure (Pfähler 1983) but this decomposition has not been used as much. Moreover, the Kakwani approach can be readily extended to the case when redistributive effect is summarized using differences in generalized Gini coefficients, i.e., incorporating a wider range of inequality aversion attitudes. See, for example, Lambert (1993), and Palme (1996) for a Swedish application. The Kakwani approach can also be used to examine effects on overall social welfare when there are progressivity changes that affect the tax yield by using abbreviated social welfare functions: see for example Lambert (1993, pp. 187–188). For a more extensive discussion of normative measures of tax progression related to individualistic social welfare functions, see Kakwani and Son (2021).

The aim of the current paper is to illustrate the usefulness of the original Kakwani (1984) approach for summarizing the redistributive effects of taxes and benefits in the UK

using yearly data covering 1977 through 2018. We provide a complement to the annual reports on the 'Effects of taxes and benefits on household incomes' (ETB) published by the UK Office of National Statistics (ONS) annually since 1977. (See, e.g., ONS 2019.) As far as we know, no other national statistical agency provides similar annual reports or the detail that ONS provides. The ONS analysis refers to not only income taxes and cash benefits but also indirect taxes and in-kind benefits from publicly provided services such as education and health care.

The Kakwani decomposition approach provides a straightforward and succinct way of summarizing changes in redistribution and progressivity over the longer run. This is useful because, although the ETB series is long running, each year's report tends to focus on aspects of redistribution and progressivity in the most recent financial year. In addition, while focusing on the key redistributive components, i.e., (changes in) average tax rates, progressivity, and reranking, the Kakwani approach provides a direct link with the ETB analysis because that also employs Gini coefficients to summarize inequality and redistributive effect. Surprisingly few academic researchers refer to the ONS's pioneering analyses. Through the lens of the Kakwani approach, we hope to make the ONS analysis better known.

Our analysis is based on unit-record data from the UK Living Costs and Food Survey (LCFS) and its predecessor, the Family Expenditure Survey, that form the basis of the ONS's analyses. Although some of the ONS's tax and benefit incidence assumptions might be questioned (as they acknowledge), employing the ONS's variables means that we can focus on showing how application of the Kakwani approach provides a complementary perspective to theirs. Moreover, having the ONS unit record data means that we can derive estimates on a consistent individual-level basis for the whole period, i.e., we can circumvent any intertemporal comparability issues that arise because the ETB reports recently switched from using the household as the unit of analysis to the individual.

Our paper provides a Kakwani-type perspective on redistribution trends that covers more years than earlier (non-ONS) articles while also being relatively up to date. Kakwani (1977*b*) is a pioneering study of progressivity trends, with estimates for three or four consecutive years in the late-1960s for each of Australia, Canada, the UK, and the USA. Later studies of trends employing the Kakwani approach include Kim and Lambert (2009) using data for 1994, 1999, and 2004 for the USA; Verbist and Figari (2014) provide decompositions for 1998 and 2008 for each of fifteen EU member states; and Hérault and Azpitarte (2015) study Australia for ten years between 1994 and 2009. A previous study for

the UK, also based on ETB unit record data, by Jenkins (1988), provided Kakwani-approach decompositions but for only one year, 1971.

A further contribution of our paper, in addition to the granular study of UK trends, is its consideration of the reference ('pre-fisc') distribution when examining the progressivity of taxes. As we explain later, some researchers have defined the pre-tax distribution to be that of original (market) income whereas others use gross income (original income plus cash benefits). We discuss which definition is appropriate and analyse whether it makes a difference empirically for direct taxes.

We review the Kakwani approach to the decomposition of the redistributive effect of taxes and benefits in Section 2 and introduce the ETB unit record data and the variables that we use in Section 3. We report the results of applying the approach to our yearly UK data covering from 1977 to 2018 in Section 4. For each of cash and in-kind benefits, direct and indirect taxes, we decompose redistributive effect into average rate, progressivity, and reranking components year by year. To assess the relative importance of average rates and progressivity we use an innovative counterfactual calculation approach. We show that average rate changes are the major factor behind trends in the redistributive effect of cash benefits but trends in the redistributive effects of direct and indirect taxes are mostly associated with changes in progressivity. For in-kind benefits, changes in the average benefit rate and progressivity each played the major roles at different times.

In Section 5, we discuss issues related to the definition of the reference distribution. In addition, and to provide an empirical perspective on the discussion, we compare estimates of Kakwani decompositions of redistributive effect for direct taxes using original income as the reference distribution rather than gross income (as used for Section 4's analysis.) We show that changing the reference distribution provides very similar perspectives on trends in the redistributive effect, and its average rate and progressivity components, but quite a different perspective on the level of redistributive effect in any given year.

Section 6 contains a summary and conclusions. There were many benefit and tax changes in the UK over the four decades we study, and we do not attempt to identify the contributions of every policy change, an impossible task. Instead, Section 6 discusses some of the major changes over the period that are likely to explain the results about average rates and progressivity that we report in Section 5. The numerical estimates underlying the charts we show in Section 4 are reported in Appendix Tables A1–A4.

2. The Kakwani approach to decomposing redistributive effect

Let X refer to the distribution of 'pre-fisc' income and Y to the distribution of 'post-fisc' income in a population of individuals. X is the reference distribution we referred to in the Introduction. The post-fisc distribution refers variously to the pre-fisc distribution after the deduction of taxes (T), or after the inclusion of benefits (B), or after both. We provide specific definitions of X, taxes, and benefits later.

Following Kakwani (1977*a*, 1977*b*, 1984), we summarise the redistributive effect I of taxes or benefits by the difference between the pre- and post-fisc Gini coefficients, G_X and G_Y.

$$R = G_X - G_Y. \tag{1}$$

The redistributive effect of taxes can be decomposed into two terms:

$$R_T = [t/(1-t)]\, K_T + D_Y. \tag{2}$$

The first term, vertical redistribution, $V = [t/(1-t)]\, K_T$, has two components. The first depends on the average tax rate, t, which is equal to total amount of taxes paid expressed as a fraction of total pre-fisc income in the population. This summarizes the tax level. (Equivalently, t is the ratio of the average tax payment to average pre-fisc income.) Second, the distribution of taxes is summarized by the Kakwani index of tax progressivity, K_T. This equals zero in the case when everyone's tax payment is the same (common) proportion of their pre-fisc income and is larger – taxes are more progressive – the greater the deviation from proportionality. Greater vertical redistribution can arise through either a larger average tax rate or a more progressive tax (or both).

$D_Y \leq 0$ equals $C_Y - G_Y$, the difference between the concentration and Gini indices for post-fisc incomes. This is a measure of the reranking of individuals between the pre- and post-fisc distributions. (C_Y is calculated using individuals' post-fisc incomes but ranked according to their position in the pre-fisc distribution.) The more reranking there is, the lower is redistributive effect. There is a literature about the relationship between reranking and normative concepts of horizontal inequity. See, e.g., the critique by Kaplow (1989), a proposed refinement of the decomposition by Aronson, Johnson, and Lambert (1994) to better capture horizontal inequity, and surveys of the issues by Jenkins and Lambert (1999) and Urban (2009). In the current paper, we eschew discussion of horizontal inequity; we simply refer to reranking.

There is an analogous decomposition for benefits, with the post-fisc distribution appropriately redefined:

$$R_B = [b/(1+b)]\,|K_B| + D_Y. \quad (3)$$

Here, b is the average benefit rate, equal to total amount of benefits received expressed as a fraction of total pre-fisc income in the population. K_B is Kakwani's benefit progressivity index with more negative values indicating greater progressivity, i.e., more vertical redistribution for a given average rate, b. $|K_B|$ is used in (3) for consistency with (2). Here, $V = [b/(1+b)]\,|K_T|$.

For the combined effects of taxes and benefits, i.e., 'net taxes' (N), and correspondingly redefined post-fisc distribution, the decomposition is (Lambert 1985, Jenkins 1988):

$$R_N = [\,tK_T + b|K_B|\,]/(1 - t + b) + D_Y. \quad (4)$$

We refer in Section 5 to some issues that arise in applying (4) in practice.

3. The ONS's ETB data, income concepts, and reference distributions

Our analysis is based on the historical series of ETB unit-record data deposited by the ONS at the UK Data Service (ONS 2020). The income variables are the same as those used by the ONS in their annual ETB articles. The data are derived from the Living Costs and Food Survey (LCFS, from 2008) and its predecessor, the Family Expenditure Survey (FES, to 2007). These are general purpose continuous household surveys with a focus on household spending and income, each intended to be nationally representative of the UK private household population. The annual sample size is approximately 5,000 households. Survey years refer to financial years (12-month periods starting 5 April each year) from 1993/94 onwards and to calendar years before that. (For brevity we label financial years by the first part: '2016' refers to financial year 2016/17, etc.) The FES and LCFS include sample weights from 1997 onwards and we use these to calculate all our estimates.

We examine redistributive effect of various components of the UK tax-benefit system using the income concepts shown in Table 1. These steps from original income (**O**) through to final income (**F**) correspond to the 'stages of redistribution' defined by the ONS: see Section 5 for details. Original income is also known as market income; disposable income is also known as net income. The definitions of original, gross, and disposable income correspond closely to those set out by the Canberra Group's (2011) guidelines. As in all the leading UK household surveys, the survey questions refer to 'current' incomes for almost all components. The data producers use responses about the last income amount received and the period to which it refers to derive an annual amount pro rata.

Table 1. ETB income concepts

Label	Income concept	Definition	Relationships
O	Original	Income from the labour market, investments and savings, including private pension income	
G	Gross	Original *plus* **B** (cash benefits including state retirement pensions)	**G = O + B**
D	Disposable	Gross *minus* **T** (direct income taxes, i.e., income tax payments, employee National Insurance contributions, local taxes such as Council Tax)	**D = G – T,** i.e., **D = O + B – T**
P	Post-tax	Disposable *minus* **I** (indirect taxes, i.e., estimated payments of VAT, excise duties, intermediate taxes, etc.)	**P = D – I,** i.e., **P = O + B – T – I**
F	Final	Post-tax income *plus* **S** (in-kind benefit income from education, health and social care, and assorted other sources such as transport subsidies)	**F = P + S,** i.e., **F = O + B – T – I + S**

Notes. For a detailed list of the components included in each income concept, see e.g. ONS (2019*b*).

The income variables are defined in the same way over the whole of the period we are considering (1977–2018), with two exceptions. First, the ONS recently incorporated an adjustment in the ETB data to address issues of under-coverage at the top of the income distribution. The ONS now replaces a very small fraction of the very highest survey incomes with individual pre-tax incomes derived from personal income administrative data (and then recalculates total household income), combining this with an adjustment to the survey weights. For further details, see ONS (2020) and Webber, Tonkin, and Shine (2020). The top-income adjustment has been implemented retrospectively and is included in our ETB unit-record data for all years from 2001 onwards. The other main change to the data is that the ONS revised the way it calculated income from in-kind benefits (**S**), and the updated method has been implemented in the data for 2005 and following years (see ONS 2012 for details). The two changes led us to be alert to potential discontinuities in series around 2001 and 2005. The former change may affect all income concepts, but the latter change is of course only relevant to assessment of the final stage of redistribution (from **P** to **F**). Inspection of the charts we report in Section 4 suggests that the discontinuities introduced by the latter change are negligible. Notwithstanding this general conclusion, there are jumps in Gini coefficients in 2001 concomitant with the introduction of the top income adjustments, though these jumps are not the largest ones in the various series.

The definitions of the reference (pre-fisc) distributions that we use in our main analysis are shown in Table 2. These definitions are consistent with recent academic literature and ONS practice, but alternative definitions are defensible. We discuss reference period issues further in Section 5 and present additional empirical analysis in which we compare estimates for the redistributive effect of direct taxes and its components using original income rather than gross income.

Table 2. Reference distributions for the assessment of redistributive effects

Tax-benefit instrument	Reference (pre-fisc) distribution	Average income of reference distribution (£ per year), 2018
Cash benefits (**B**)	Original income (**O**)	28,034
Direct taxes (**T**)	Gross income (**G**)	31,760
Indirect taxes (**I**)	Disposable income (**D**)	24,442
In-kind benefits (**S**)	Post-tax income (**P**)	20,387

Notes. The definitions of income concepts and income components are provided in Table 1 and the main text. The 2018 average incomes refer to incomes equivalised using the modified-OECD scale (see below), and distributed among all individuals. The average of Final income (**F**) is £37,878. Source for average incomes: authors' calculations from ETB unit record data.

All our income concepts use the household as the income-receiving unit, but the unit of analysis is the individual throughout: we employ the conventional assumption that each individual receives the income of the household to which s/he belongs. The ONS recently changed the unit of analysis from the household to the individual in its annual ETB reports but, with our access to unit record data, we use the individual as the unit of analysis throughout the 1977–2018 period.

We adjust all household incomes and income components for differences in household size and composition using the modified-OECD equivalence scale. The ONS uses the same scale but our calculation of it differs slightly from theirs. This is because the modified-OECD scale defines children to be individuals aged 14 or under. We cannot identify children thus in the dataset we have. We only know whether an individual is a 'dependent child', i.e., aged 15 or less, or aged 16–19 and in full-time education. Thus, our equivalence scale calculations count slightly more children than the ONS do, but we expect the effects to be negligible. In addition, the ONS rescales the modified-OECD scale to use two-adult households instead of one-adult households as the reference household type with scale rate equal to 1. Although this adjustment has no effect on (relative) inequality measures

and Kakwani redistribution components, it matters for the average incomes reported in Table 2.

For calculations, we use the *progres* module for Stata by Peichl and Van Kerm (2007). This excludes any negative values for reference (pre-fisc) incomes, but the number of these is negligible even for original income.

4. Empirical analysis

Figures 1 and 2 summarize trends in inequality and redistributive effects year by year over the period 1977–2018. Figure 1 displays estimates for the six income concepts described in Table 1, ranging from original income through to final income. Regardless of income concept, the general picture is for an increase in income inequality over the period as a whole, with a relatively sharp rise between the late 1970s (when UK income inequality was at its lowest value since the early 1960s) and the start of the 1990s. Thereafter, in the period up to the onset of the Great Recession, the rate of increase in inequality is smaller, followed by little or no change or even a small fall. The net result is that income inequality at the end of the period is little different from the start of the 1990s. Clearly, there is also year-on-year variability in each series reflecting the use of household survey data.

<Figure 1 near here>

This picture of inequality trends is conditional on the use of the Gini coefficient to summarize inequality. If more top-sensitive inequality indices are used, arguably disposable income inequality continued to increase after 1990: see Jenkins (2021). Put differently, use of inequality indices other than the Gini coefficient which underpins the Kakwani approach, may lead to different perspectives on redistributive effect, and this should be remembered in what follows.

Overall redistributive effect, the combined effect of all taxes and benefits given by $G_{\mathbf{F}} - G_{\mathbf{O}}$, is substantial. Figure 1 shows that the difference between the series at the top of the chart ($G_{\mathbf{O}}$) and the series at the bottom ($G_{\mathbf{F}}$) is a reduction of around 20 percentage points throughout the period. To go below this headline result, we break the path from **O** to **F** into smaller steps and look at each of these. Observe that overall redistributive effect is the sum of four redistributive effects:

$$G_{\mathbf{F}} - G_{\mathbf{O}} = (G_{\mathbf{G}} - G_{\mathbf{O}}) + (G_{\mathbf{D}} - G_{\mathbf{G}}) + (G_{\mathbf{P}} - G_{\mathbf{D}}) + (G_{\mathbf{F}} - G_{\mathbf{P}}) \quad (5)$$

where the income concept labels are those shown in Table 1.

Estimates of redistributive effects of the component taxes and benefits, the four components shown on the right-hand side of (5), are shown in Figure 2 and are consistent with our definitions of reference distributions set out in Table 2. For example, the redistributive effect of cash benefits in 2018 is the difference between the Gini coefficients for original and gross income: $G_{\mathbf{G}} - G_{\mathbf{O}}$ = 49.8% – 39.7% = 10.1 percentage points ('ppt'). Inequality is reduced by 10.1 Gini ppt.

Figure 2 shows that cash and in-kind benefits have larger redistributive effects than direct and indirect taxes throughout the period. The reduction in the Gini coefficient associated with cash benefits is around 10 ppt on average over the period. In contrast, direct taxes are associated with a reduction in the Gini coefficient of between 2 ppt and 5.5 ppt, and indirect taxes have an inequality increasing effect of roughly the same magnitude.

<Figure 2 near here>

Figure 2 also shows that the trends in the various redistributive effects differ. There are large increases in the redistributive effect of cash benefits during recession periods: observe the sharp upward 'bumps' around the start of the 1980s, the start of the 1990s, and after 2007, with the decline in the 'bumps' lasting up to five years in each case before returning to the previous trend. The net result is that the redistributive effect of cash benefits is much the same in 2018 as it was at the end of the 1970s. There is much less of an association between redistributive effect and the business cycle for in-kind benefits and indirect taxes and a barely discernible association for direct taxes.

The inequality-reducing redistributive effect of in-kind benefits increased steadily over the period as a whole, from around 5.5 ppt at the start to around 8 ppt at the end with small year-to-year fluctuations.

The inequality-reducing effect of direct taxes also trended upwards over the period, from around 2 ppt at the start to 5.5 ppt at the end, with the increase concentrated in the period after 2000.

The redistributive effect of indirect taxes also increased in absolute magnitude over the period, but the greatest change appears to be prior to the late-1980s. Indirect taxes increased the Gini coefficient by around 2 ppt in the late 1970s, but by around 4 ppt from then until the end of the 2000s, with a small decrease in the mid-2010s (3.3 ppt in 2018).

The value of the Kakwani approach is that we can relate these changes in redistributive effect to changes in average rates, progressivity, and reranking. Figures 3–5 present information about these aspects in turn, for the various tax-benefit components.

Figure 3 shows average tax and benefit rates, as defined in Sections 2 and 3, and hence each series uses a different income concept for the income total. We need to be careful when comparing the magnitudes of the different rates across instruments (the heights of the series in the charts). For example, the average rates for cash benefits, which appear relatively small (ranging between 13% and 19%) are calculated as shares of total original income, but the average rates for in-kind benefits (ranging between around 20% and 30%) are calculated as shares of total post-tax income. But average original income is substantially larger than average post-tax income (Table 2), so the difference between the two average benefit rates is partly due to the different denominators. Average in-kind benefits (26.4% in 2018) are much larger than average cash-benefits (13.3% in 2018), but the former is expressed relative to a smaller reference income average than the latter.

<Figure 3 near here>

Trends over time in an average rate can also result from a combination of changes in the numerator or the denominator. This is clear from the variations in the average cash benefit rate. Rises and falls correspond closely with the business cycle, being highest in recession times (early 1980s, early 1990s, late 2000s) before falling back again. Nonetheless, this cannot be the whole story as the pattern of decline differs after each peak. Variations over time in the average in-kind benefit rates are also cyclical, with peaks and troughs at almost the same times as those for average cash benefit rates – but not quite thus. For example, the first peak in the average in-kind benefit rate series is a few years earlier than the corresponding peak for the average cash-benefit rate. Perhaps more interestingly, the main difference in trends between the two series is that, net of cyclical changes, the average cash benefit rate declines by a few percentage points between the early 1980s and 2018, whereas the average in-kind benefit rate trend is more J-shaped over the same period. That is, net of cyclical effects, average in-kind benefits from education and health and social care have become more important over time (assessed against the benchmark of average post-tax income) whereas average cash benefits have become slightly less important (assessed against the benchmark of average gross income).

Trends in the average rate series for taxes differ from trends in the two series for benefits. For direct taxes, the average rate ranges between around 19% and 24% over the period as a whole and cyclical features are not as pronounced as for the benefit rate series. The amplitude of variations is smaller, and the timing of peaks and troughs differs. Overall, there is a slight decline in the average direct tax rate in the 15 years after 1977 (from around 22% to 19%) but, from the early 1990s, there is a steady increase through the onset of the

Great Recession in 2007/2008 to an average rate of around 24%, with a small fall-off thereafter. The net result is that the average direct tax rate in 2018 (23%) is little different from the corresponding rate in 1977 (22.8%).

The most distinctive trend is for the average indirect tax rate. This is the only series which trends downwards over the period as a whole, from around 22% at the start of the 1980s to around 17% in the late 2010s. The declines are concentrated into two periods, one in the late 1980s, and another in the first half of the 2000s. The two increases in the series coincide with relatively large increases in the standard rate of Value Added Tax (VAT), from 8% to 15% in 1979 and from 15% to 17.5% between 2009 and 2010.

What about the progressivity of taxes and benefits as summarized by Kakwani's deviation-from-proportionality indices? Look at Figure 4. A positive value of *K* for taxes means that taxes are progressive (average tax rates rise with income) whereas a positive value for benefits implies benefits are regressive (average benefit rates rise with income). Correspondingly, a negative value of *K* for taxes means that taxes are regressive (average tax rates fall with income) whereas a negative value for benefits implies benefits are progressive (average benefit rates fall with income).

<Figure 4 near here>

Figure 4 shows that direct taxes, cash benefits, and in-kind benefits are progressive, but indirect taxes are regressive. It also shows that cash benefits are substantially more progressive than in-kind benefits or direct taxes. The absolute value of the Kakwani index (× 100) for direct taxes is never greater than 20, for in-kind benefits the maximum is around 50 but, for cash benefits, the absolute value is never smaller than around 80. Put differently, cash benefits are strongly targeted against income and to a greater extent than in-kind benefits (the levels of which are strongly correlated with age and household composition rather than income). Relative to these benchmarks, the regressivity of indirect taxes is of roughly the same magnitude as the progressivity of direct taxes (or slightly less, at the beginning and end of the period).

Trends over time in the *K* indices are intriguing. For indirect taxes, cash benefits, and in-kind benefits, there appears to be a distinct difference before and after the mid-2000s. Progressivity of cash and in-kind benefits and regressivity of indirect taxes decreased from the start of the 1980s up to the mid-2000s but, thereafter, increased slightly and then plateaued. In contrast, the progressivity of direct taxes was much the same between the end of the 1970s and the late-1980s (around 10). Between the late-1980s and the late-1990s, progressivity rose a little before falling back to around 10 again. And then it increased

steadily from the start of the 2000s to around 20 around 2011 and remained constant thereafter.

The final piece of the jigsaw is the information about reranking and its trends over time. See Figure 5. The vertical axis shows $-D$, and the scale is the same as for the redistributive effect estimates shown in Figure 2, i.e., ppt ('Gini points'). At first glance, there appears to be substantial differences in the magnitude of reranking for the various benefits and taxes and also in how they have varied over time. At one extreme is in-kind benefits for which reranking seems relatively large, fluctuating between around 1.0 and 1.8 ppt with no clear relationship to the business cycle. At the other extreme, reranking for direct taxes is much smaller, declining sharply at the start of the period, declining more slowly over the 1980s and then roughly flat for the rest of the period (at around 0.3 ppt). However, these contrasts ignore the fact that the magnitude of redistributive effect also differed for the various taxes and benefits (Figure 2).

<Figure 5 near here>

We therefore switch to Figure 6 which shows yearly series for each of four reranking indices expressed as a percentage of redistributive effect for the corresponding tax or benefit. This fraction is an 'Atkinson-Plotnick' index of reranking, specifically the AP2 index used by Jenkins (1988) in his UK analysis of ETB data for 1971. The values for indirect taxes are negative because the redistributive effect of indirect taxes is disequalizing. The other three income components are associated with inequality reduction – they are equalizing – and so have positive values.

<Figure 6 near here>

From the perspective of Figure 6, impressions of the magnitudes of reranking across income components and over time differ from those derived from Figure 5. Interestingly, all series are relatively flat from the early- to mid-1990s until 2018. Over this period, the reranking share of redistributive effect is greatest in absolute magnitude for indirect taxes and in-kind benefits (at around 20%) and about half as large or smaller (between 5% and 10%) for cash benefits and direct taxes. Jenkins (1988) reports an estimate for 1971 of 6.2% for cash benefits and so not too different from what is shown for the late 1970s. (There are no other comparable estimates because Jenkins uses original income as the reference distribution for all calculations.) We do not have an explanation for why the reranking shares for all income components except direct taxes declined in absolute magnitude at the start of the period. We do not know of specific policy or data changes over the period that would explain this and so we leave this as a topic for further research.

Because overall redistributive effect equals vertical redistribution (*V*) plus reranking (eqq. 2, 3), Figure 6 is also informative about trends and magnitudes of *V* for the different components. From eqq. 2 and 3, we have:

$$\frac{-D}{R} = \left(\frac{r^*|K|}{R}\right) - 1 = \left(\frac{V}{R}\right) - 1 \qquad (5)$$

where r^* is a transformation of the average rate, i.e., $t/(1-t)$ or $b/(1+b)$, depending on whether we are considering taxes or benefits. Because the reranking share of *R* is less than one, (*V*/*R*) is greater than one. When the reranking share declines (as in the 1980s), vertical redistribution becomes a larger fraction of overall redistributive effect. When the reranking share is constant (from the 1990s onwards), vertical redistribution is a stable fraction of overall redistributive effect.

The analysis so far shows that vertical redistribution accounts for most of redistributive effect and its trends over time. Reranking is non-negligible but is also not the major factor in the decomposition of redistributive effect. But vertical distribution depends on an average rate and progressivity. We therefore ask: which of these two components accounts for the changes in redistributive effect that we have described, or have both played a role?

We know of no formal analytical method to decompose the non-linear equation summarizing the relationship between (changes in) redistributive effect on the one hand and (changes in) the average rate and progressivity (and reranking) on the other hand. Our approach to this task is simple but turns out to be illuminating.

We employ a counterfactual calculation method in which we (re)calculate *R* under scenarios that fix the average rate or, alternatively, fix progressivity and compare the resulting *R* values with the actual series. The idea is that if, when one of the two factors is fixed (the average rate, say), the counterfactual *R* series tracks the actual series, we can conclude that the changes in the other factor (progressivity) accounts for trends in actual *R*.

To be more specific, and taking cash benefits as the example, we consider a first scenario, (a), in which *R* calculated by fixing the average rate (*b*) and reranking (*D*) at their 1977–2018 average values and setting K_B at the observed values ('fixed average rate'). In the second scenario, (b), *R* is calculated by fixing progressivity (K_B) and reranking (*D*) at their 1977–2018 average values and setting the average rate (*b*) at the observed values ('fixed progressivity'). The calculations use the relationships summarized in eq. (3). We fix *D* in the calculations for simplicity's sake and because this term is relatively small by comparison with *V* and *D*/*R* changed little over time for most of the period.

Figure 7 shows that when K_B (and D) is fixed at the period-average and b takes on the observed values, counterfactual R tracks actual R remarkably closely. In contrast, fixing b (and D) but allowing K_B to take the observed values implies a counterfactual R series that differs substantially from actual R series. We conclude that the trends in redistributive effect of cash benefits over the period are largely accounted for by changes in the average benefit rate over time rather than by changes in progressivity. As observed earlier, the b series is clearly cyclical, as is the R series: see Figures 2 and 3. Original (market) income levels vary with the economic cycle, and cash benefits respond as a consequence – they are a vital automatic stabilizer of household incomes.

<Figure 7 near here>

For direct taxes, the situation differs. Figure 8 shows that when K_T (and D) are fixed at the period-average and t takes on the observed values, the counterfactual R series is quite different from the actual R series. In contrast, fixing t (and D) but allowing K_T to take the observed values, counterfactual R tracks actual R series very well. Applying our earlier logic, we conclude that trends in the redistributive effect of direct taxes over the period are largely accounted for by changes in progressivity rather than by changes in the average tax rate. Direct taxes have an automatic stabilization role which would impact t but in the current context (decomposition of redistributive effect trends), it is progressivity that is more important. We return in Section 6 to discuss specific policy changes over the period that could have led to the changes in progressivity.

<Figure 8 near here>

For indirect taxes, we have a situation that parallels that for direct taxes: see Figure 9. It is the 'fixed average rate' counterfactual series that tracks the actual R series relatively closely, not the 'fixed progressivity' one. Thus, it appears that it is changes in progressivity that underpin the observed changes in the redistributive effect of indirect taxes.

<Figure 9 near here>

For in-kind benefits, see Figure 10. For this component, changes in progressivity appear to underpin the trends in the redistributive effect for most of the period but not all of it. There are two sub-periods when changes in the average rate appear to play an important role: the first is in the early 1990s (1991–1995) and the second is in the decade after 2007. In these two sub-periods, the 'fixed progressivity' series for R tracks the observed R series better than the 'fixed average rate' series. Revisiting Figure 3, we see that these two sub-periods coincide with when the average rate rose sharply after periods of decline. There is a subsequent decline but not to previous levels.

<Figure 10 near here>

The explanations for the in-kind benefits results are unclear. The beginnings of the two sub-periods when the average rate played an important role coincide with the start of recession, suggesting that automatic stabilization is playing a role. But this does not explain why changes in the average rate do not have a similar role at the start of the 1980s (the onset of a major recession), nor why the average rate continued to play a role for a decade after 2007, i.e., over a period of economic recovery as well.

5. The definition of pre-fisc income and a sensitivity analysis for direct taxes

5.1 The definition of the reference (pre-fisc) distribution

A question for empirical implementation that has received relatively little attention is: what is the reference distribution – the 'pre-fisc' distribution – that should be used when looking at the roles of taxes and benefits? Early applications of the Kakwani approach assumed the pre-fisc distribution was of original (market) income when considering the redistributive effects of both income taxes and cash benefits. See Kakwani (1977*a*, 1977*b*, 1984, 1986), Jenkins (1988) and Kim and Lambert (1995). In several more recent studies, researchers have taken the reference distribution for cash benefits to be original income but, for income taxes, their reference distribution is gross income, i.e., original income plus cash benefits. See, e.g., Palme (1996), Hérault and Azpitarte (2015), and Verbist and Figari (2015).

Our view is that, for assessing the role of income taxes, the ideal 'pre-fisc' distribution is 'pre-tax taxable income', where the components entering this definition vary depending on the tax system being considered. Correspondingly, for assessing the role of cash benefits, the ideal 'pre-fisc' distribution is the 'pre-benefit' distribution of income, where the definition corresponds to the one used to assess eligibility for benefit receipt. Real-world complications militate against these ideals. For example, most countries have multiple types of taxes (e.g., income tax per se and social insurance contributions) and multiple types of cash benefits, each of which uses different income bases to assess liabilities and eligibilities. In addition, the unit of assessment for income taxes and cash benefits may differ. For example, in the UK, the tax unit was a married couple or unmarried single adult prior to 1990 and the individual adult thereafter. Benefit eligibility is assessed using the nuclear family (essentially the pre-1990 tax unit definition, also taking account the presence of

dependent children). Survey data such as ours release income variables that refer to households not to tax units or benefit units.

The net result is that there is an almost inevitable mismatch in practice between any ideal pre-fisc distribution and the pre-fisc distributions that can be straightforwardly derived using the data typically available. This is regardless of whether the ideal definition indicates that the pre-fisc distributions for assessing taxes or benefits (or their combination) should be the same or not.

There are several arguments in favour of using gross income as the reference pre-fisc distribution to assess the role of income taxes. One is that using the same pre-fisc distribution to assess both income taxes and cash benefits leads to difficulties in assessing their contributions separately and in combination. Lambert (1985) argued with reference to the decomposition of the combined effects of taxes and benefits (cf. eq. 4 above), and using empirical illustrations from the UK and USA, that:

> "taxes which are regressive on original income may be progressive on (the less unequally distributed) income including benefits. … These (perhaps surprising) results … point clearly to a problem of progressivity measurement. The supposedly regressive taxes are playing a vital part in redistribution … Clearly, a better picture of the true rôle of taxes would emerge if progressivity were measured with respect to a wider income base, namely income including the benefits of government expenditure." (Lambert 1985, 45–46.)

If one uses different reference distributions for taxes and benefits, eq. (4) no longer provides a suitable basis for decomposing the combined effects of taxes and benefits, and so we do not use it.

A second argument for using gross income is that cash benefits (included in gross income) may be taxable. However, in practice only some but not all cash benefits are taxable. This is the case in the UK, where the most important taxable cash benefit is the state retirement pension: see the list of taxable and non-taxable benefits at https://www.gov.uk/income-tax/taxfree-and-taxable-state-benefits.

The ONS's ETB articles have always assumed a specific order in which income components are combined to make up total household income. See the 'Stages in the redistribution of income' chart presented in their annual articles (e.g., ONS 2018, Figure 2) and Tables 1 and 2 earlier. Thus, the ONS assess the redistributive effect of benefits by comparing the inequalities of original and gross income, and the redistributive effect of direct

taxes by comparing the inequalities of gross income and disposable income (i.e., gross income less direct taxes). This is the model we have followed so far.

This appeal to a 'natural' order is harder to make for income components such as indirect taxes and in-kind benefit income because the amounts estimated to be paid or received are not dependent on income in the same way as for direct taxes and cash benefits. There is also a literature that argues that the progressivity of indirect taxes should be assessed using the distribution of expenditure, not income: see, e.g., Thomas (2021) and references therein. ONS (2019*a*) report some expenditure-related progressivity calculations for indirect taxes too.

In sum, the ONS approach (and ours in this paper so far) is consistent with recent analysis which has taken gross income to be the reference 'pre-fisc' distribution but inconsistent with earlier research, including Kakwani's, which used original income instead. This observation motivates us to check whether the choice makes a difference empirically. We contrast estimates for direct taxes using gross income as the reference distribution (as in Section 4) with those using original income.

5.2 The redistributive effect of direct taxes: a sensitivity analysis

Figures 11 and 12 summarize our sensitivity analysis. The estimates using gross income are as shown in earlier charts though observe that the vertical axis scales differ. Hence, for example, the upward blip associated with the ONS's introduction of the new top-income adjustment is more apparent now.

Figure 11 shows redistributive effects, average rates of direct tax, and progressivities. On the one hand, changing the reference income distribution has a relatively large impact on the levels of the different components in any given year. For example, when original income is the reference, redistributive effect is smaller in magnitude and, prior to the 2000s, fluctuates around zero and is sometimes negative (i.e., direct taxes are disequalizing rather than equalizing). Progressivity is smaller in magnitude but average tax rates are larger in magnitude, with the latter reflecting the smaller denominator in the calculation of them when original incomes are used. On the other hand, trends over time in corresponding series are remarkably similar. In this sense, changing the reference distribution makes no difference.

<Figure 11 near here>

Figure 12 compares redistributive effects and reranking indices for the two reference distributions. (Again, the vertical axis scale differs from previous charts.) The figure shows that reranking is much the same magnitude, plays a relatively minor role in redistributive effect, and there is no obvious trend, regardless of reference distribution definition.

What the figure does highlight instead is that the definitional change alters the magnitude of redistributive effect (as also shown in Figure 11). Note that when original income is the reference distribution, it makes little sense to express reranking as a fraction of redistributive effect (as in Figure 6) because the latter is often very close to zero, in which case there are huge spikes in the fractions (notably negative ones in 1979 and 1993 and a positive one in 2000).

<Figure 12 near here>

Such numerical instabilities aside, Figures 11 and 12 imply that changing the reference distribution for direct taxes has negligible impact on trends in redistribution components: corresponding pairs of series track each other closely over time. Hence, counterfactual calculations of the kind employed in Section 4 come to the same conclusion about the factor most associated with trends in the redistributive effect of direct taxes, namely changes in average tax rates.

What is not robust are estimates of redistributive effect levels and the relative importance of the different components for any specific year. Whether direct taxes have a major equalizing effect (as when using gross income as the reference distribution) or hardly any or a disequalizing effect (as when original income is the reference distribution) is an issue of great policy relevance. This point highlights our arguments in the previous sub-section that reference distribution definition issues need greater discussion. Our own preference for analysis of direct taxes in the UK is gross income but this may not be appropriate in other contexts. And, also as we pointed out earlier, similar issues arise for indirect taxes and in-kind benefits as well.

6. Summary and conclusions

We have shown how the Kakwani decomposition approach provides a straightforward and succinct way of summarizing changes in redistribution and progressivity over a long period of time – in this application the UK yearly over the period 1977–2018. For each tax-benefit instrument, redistributive effect for each year can be expressed in terms of three constituent

components: an average rate, a progressivity index summarising deviation from proportionality, and an index of reranking. Our calculations show that reranking generally plays a relatively minor role throughout, but our counterfactual analysis shows that whether changes in average rates or changes in progressivity plays the major role depends on the component being considered. Our headline results are as follows.

For *cash benefits*, redistributive effect at the end of the period was much the same as at the start. Most noticeable is the cyclical nature of redistributive effect over the period. This is largely accounted for by changes in average rates rather than by changes in progressivity. This reflects the crucial automatic stabilisation role of cash benefits. When the economy goes into recession, cash benefit spending for workless people rises, and cash benefits form a larger fraction of household incomes on average. When the economy recovers, cash benefit spending declines in total and as a fraction of average household income. Although there has been a long-run decline in the real value of benefits for workless people in the UK relative to average earnings (Brewer et al. 2021, section 3), this factor does not show up as a driver of trends in redistributive effect.

For *direct taxes*, redistributive effect was relatively stable from the end of the 1970s until the 1990s (at 2 to 3 Gini points) but thereafter increased to reach nearly 6 Gini points by 2018. The counterfactual calculations indicate that these changes primarily reflect changes in progressivity, i.e., average direct tax rates rise with income to a greater extent than previously. The trends can be related to changes in tax rates on earned income and employee National Contribution rates (NICs). We draw on Pope and Waters (2016) for historical information.

Between 1978 and 1991, the basic rate of tax on earned income (the marginal rate for most taxpayers) was reduced in steps from 33% to 25% but there were offsetting effects on progressivity at the same time. The starting rate of tax, 25%, applicable at the start of the period was abolished in 1980, and the top ('higher') rate of tax which ranged between 40% and 60% (depending on income source) up to 1988 was then capped at 40%.

After 1990, the basic rate of tax was reduced further in steps, reaching 20% in 2008. Between 1992 and 2007, there was a 20% starting rate of income tax, which was then abolished. The top marginal rate remained capped at 40% until 2010, but thereafter the maximum rate depending on income source was 50% (2010–2012) or 45% (2013 onwards). Changes in NICs reinforced these changes particularly in the 2000s and 2010s. NIC rates increased gradually from 5.75% in 1977 to 12% by 2018, but a greater progressivity-enhancing impact was likely to have been the new higher marginal rate of NICs (1%) that

was introduced in 2003 and increased to 2% in 2011. When we look at the average direct tax rate for each decile group of gross income (graph not shown), we find that in the 2000s and 2010s the average rate for the second lowest decile group was much the same as that for the bottom decile group rather than distinctly greater as in the 1970s and 1980s. Moreover, in the 2000s and 2010s, the gap in average tax rate between ninth and top decile group increased markedly by comparison with earlier decades.

For i*ndirect taxes*, redistributive effect grew in magnitude – inequality increased – from the late 1970s (when it was around –2 Gini points) to the beginning of the 2000s and was thereafter relatively constant (at around –4 Gini points). Again, the counterfactual calculations indicate that these changes primarily reflect changes in progressivity. Associating specific policy changes with these patterns is difficult to do, especially since indirect tax payments depend on spending rather than income. The increase in regressivity that started in 1984 (and continued until around 1990) coincides with the extension of VAT to cover domestic fuel and power from 1994 which may have hit low-income households to a greater extent than high-income households. We conjecture that the next increase in regressivity (see Figure 4), over the 1990s and 2000s, relates to increases in excise duties especially on petrol and diesel (see Pope and Waters 2016, pp. 58–59).

For *in-kind benefits*, redistributive effect increased by around 4 Gini points (from 4 ppt to 8 ppt) between the end of the 1970s and the start of the 2000s and thereafter remained constant. Increases in progressivity played the most important role, apart from 1991–1995 and after 2007 when changes in average rates were relatively important. Again, it is difficult to confidently associate these patterns with specific policy measures. The progressivity trends are consistent with a move towards greater selectivity in the targeting of publicly provided services since the late 1970s. (Recall that Mrs Thatcher's Conservative party took power in 1979. The Labour party was in power 1997–2010.) When we look at average in-kind benefit rates by decile group of post-tax income (graph not shown), what is most apparent is the increase in the average rate for the bottom decile group relative to that for the second decile group for each successive decade over the period. One might be tempted to interpret the greater role of (higher) average rates of in-kind benefits from 2007 onwards as an automatic stabilizer effect, analogous to our discussion of cash benefits. However, this story is not persuasive because in-kind benefits of education and of health and social care are more closely related to age and the presence of children in a household than to income.

This summary discussion highlights the strengths and potential weaknesses of the Kakwani approach to summarizing trends in redistribution and understanding their drivers.

We have shown how the approach provides a succinct way to relate headline changes in redistributive effect yearly over four decades to changes in average rates and progressivities of different tax and benefit instruments. However, the analysis is only suggestive about how these relate to policy changes. Doing this more conclusively is likely to require reducing breadth in terms of time span and tax-benefit components in favour of focus on specific policy changes and components. For this, counterfactual analysis based on tax-benefit microsimulation models are useful, as demonstrated by, e.g., Palme (1996), Verbist and Figari (2014), and Hérault and Azpitarte (2015). In addition, changes in average rates and progressivity depend on changes in the pre-fisc distribution, and the Kakwani approach does not tell us about what underlies these. We have argued that, for cash benefits in particular, changes in the distribution of original income related to the business cycle have been particularly important, but we have not provided any deeper explanation. Nor have we considered any potential behavioural responses to changes in taxes or benefits.

Our article also highlights that the definition of the reference ('pre-fisc') distribution needs greater discussion than it has received in the past. Earlier discussions of the combined effects of taxes and benefits on redistributive effect assumed the same reference distribution for both instruments (original income), and yet there are good arguments for using different reference distributions for different instruments. Taking the case of direct taxes, we have shown that estimates of redistributive effect levels are very different when one uses gross income rather than original income as the reference distribution. If different reference distributions should be used for different instruments, we also need a new framework for assessing the combined effects of taxes and benefits on redistributive effect. This is one way in which Nanak Kakwani's pioneering contributions in this area can be taken forward.

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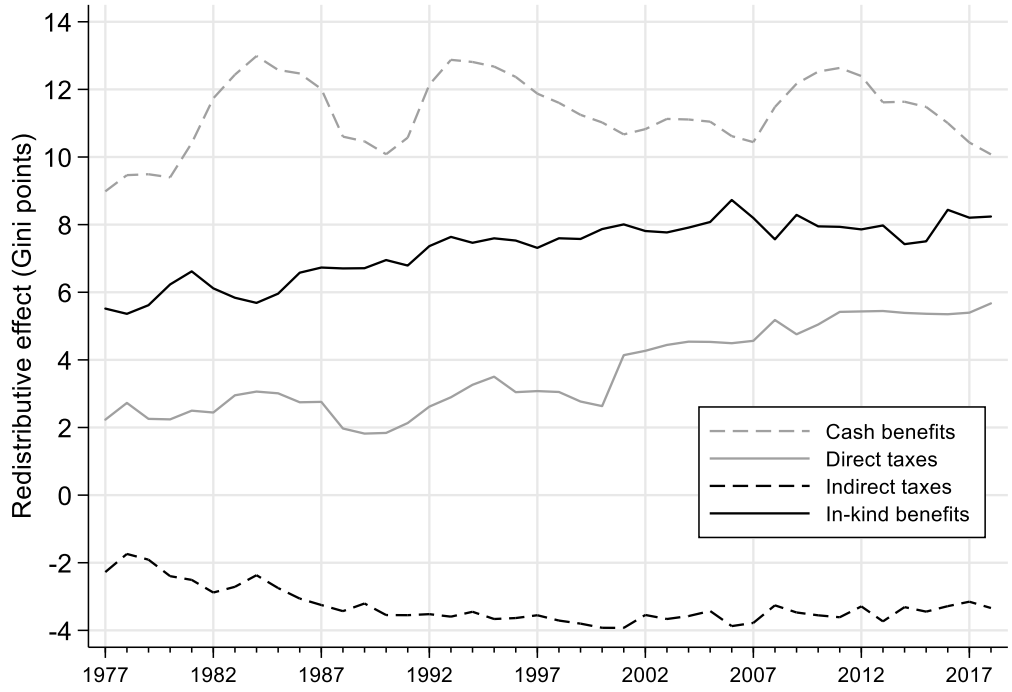
Figure 1. Gini coefficients (%) for five income concepts, UK, 1978–2018

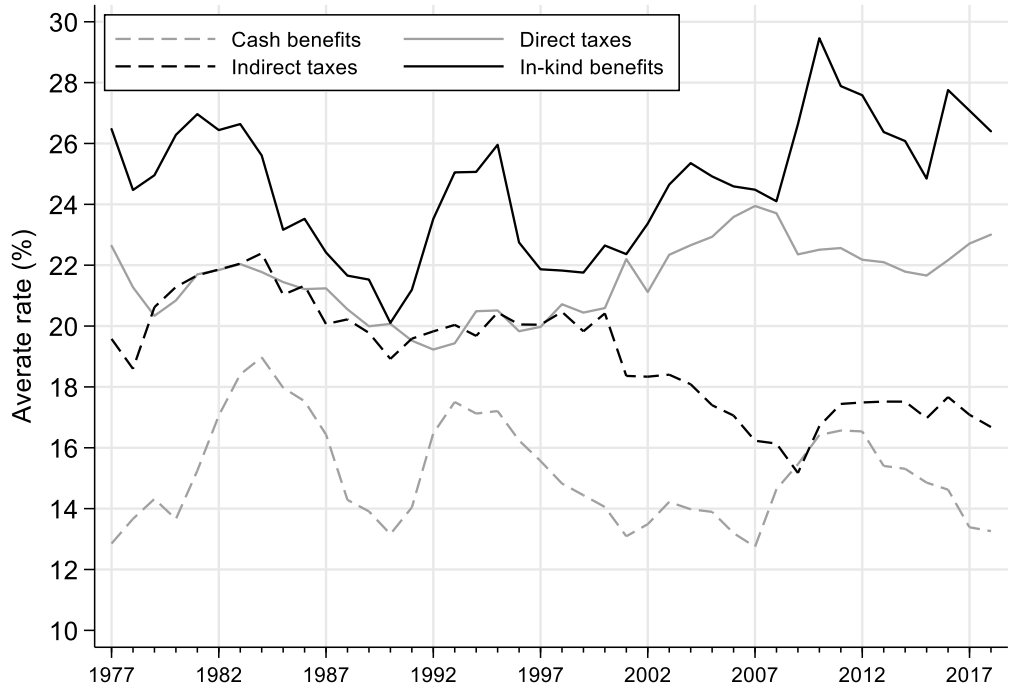
Notes. Income definitions are explained in Section 3. For each series, the distribution is of equivalised household income among all individuals. Gini coefficients are multiplied by 100.
Source. Authors' calculations from ETB unit record data.

Figure 2. Redistributive effects of taxes and benefits, UK, 1977–2018



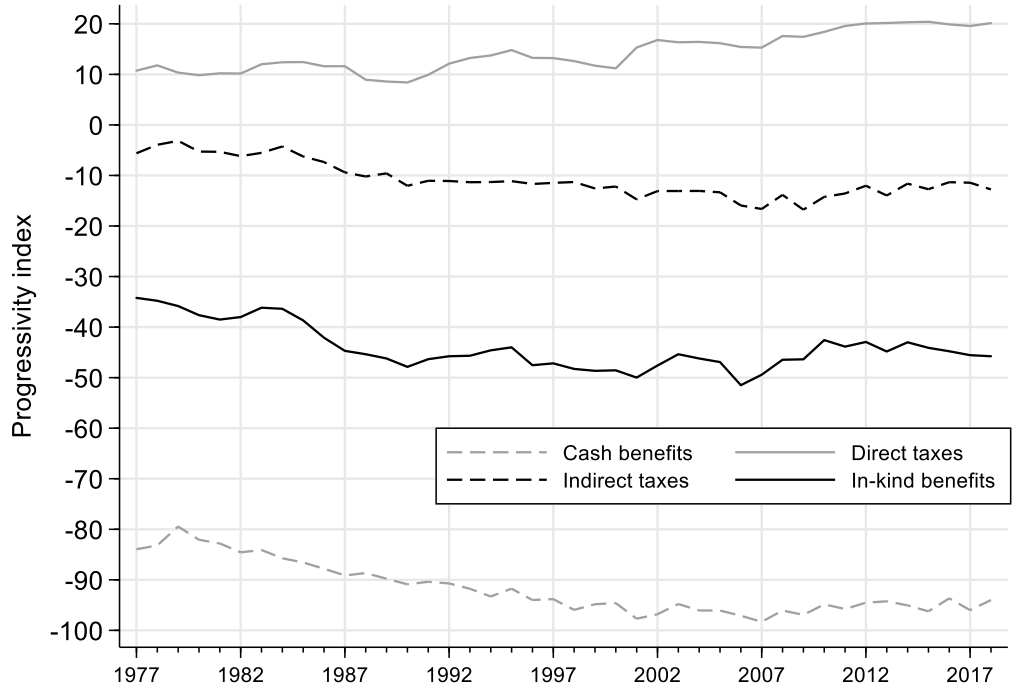
Notes. As for Figure 1. Redistributive effect is the percentage point difference between the pre-fisc and post-fisc Gini coefficients ('Gini points'), where the definitions of pre- and post-fisc distributions for each income component are shown in Table 2. Positive values correspond to inequality reduction and negative values to inequality increases. Figure 1 shows the Gini coefficients.
Source. Authors' calculations from ETB unit record data.

Figure 3. Average tax and benefit rates, UK, 1977–2018



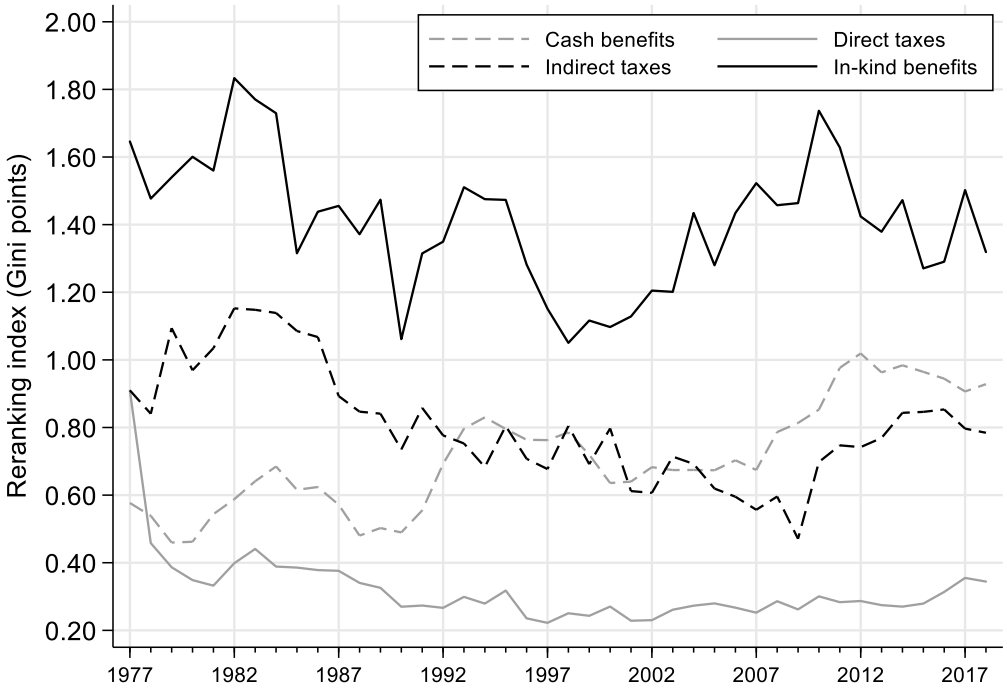
Notes. The figure shows estimates of average rates for taxes and benefits, i.e., *t* and *b* in eqq. (2) and (3). The reference (pre-fisc) distributions for each tax or benefit are shown in Table 2. That is, total cash benefits are expressed as a percentage of total original income; total direct taxes are expressed as a percentage of total gross income; total indirect taxes are expressed as a percentage of total disposable income; and total in-kind benefits are expressed as a percentage of total post-tax income.
Source. Authors' calculations from ETB unit record data.

Figure 4. Kakwani progressivity indices, UK, 1977–2018



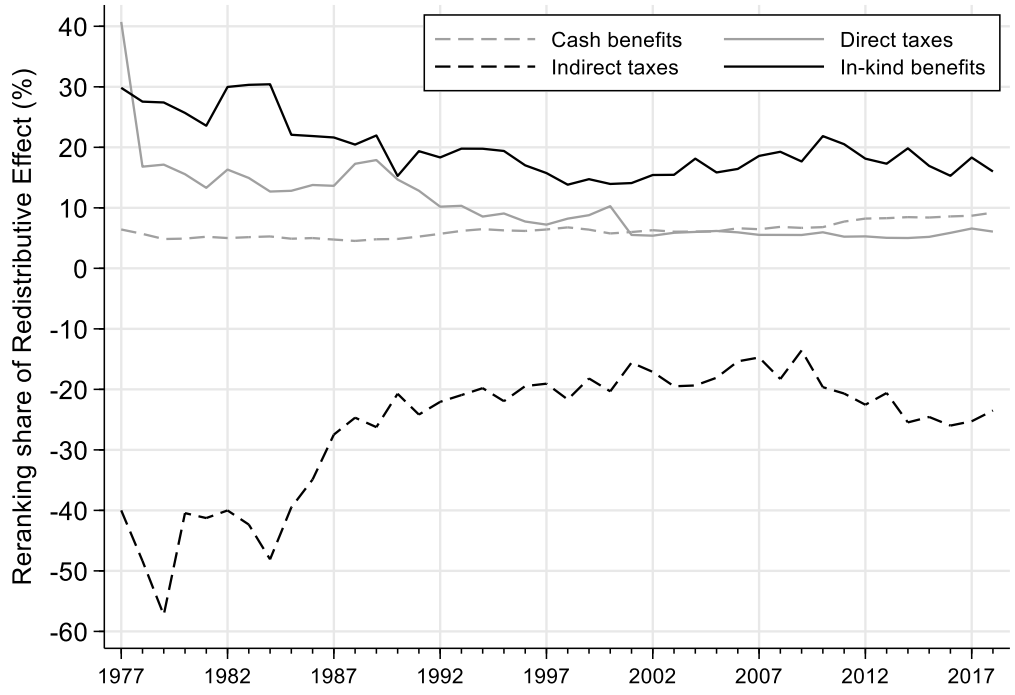
Notes. The figure shows estimates of Kakwani progressivity indices, in percent, i.e., $100K_T$ and $100K_B$, as described in eqq. (2) and (3). The reference (pre-fisc) distributions for each tax or benefit distributions are shown in Table 2.
Source. Authors' calculations from ETB unit record data.

Figure 5. Reranking indices, UK, 1977–2018



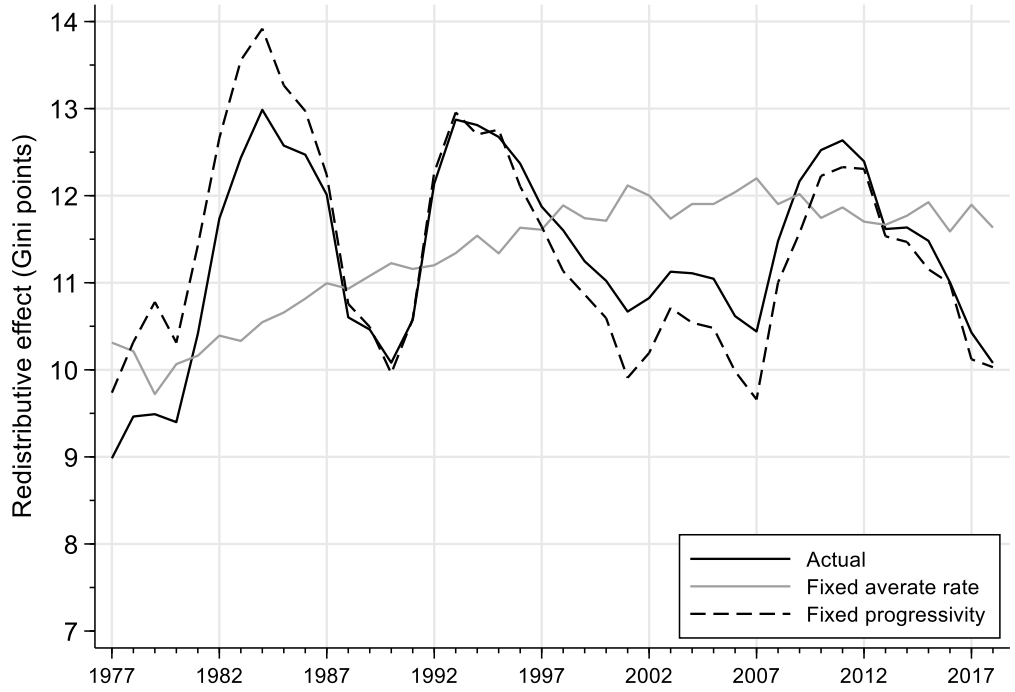
Notes. The figure shows yearly estimates of reranking indices. These are the *–D* terms in eqq. (2) and (3), in ppt, i.e., the same units as the redistributive effects displayed in Figure 2. The more reranking there is, the less is redistributive effect. The reference (pre-fisc) distributions for each tax or benefit distributions are shown in Table 2.
Source. Authors' calculations from ETB unit record data.

Figure 6. Reranking as a percentage of redistributive effect, UK, 1977–2018



Notes. The figure shows reranking (as in Figure 5) expressed as a percentage of redistributive effect, i.e., $-100D/R = 100[(r^*K/R) - 1]$, where $r^* = t/(1-t)$ or $b/(1+b)$ as appropriate. See eqq. (2), (3). The reference (pre-fisc) distributions for each tax or benefit distributions are shown in Table 2.
Source. Authors' calculations from ETB unit record data.

Figure 7. Counterfactual calculations of the redistributive effect of cash benefits, UK, 1977–2018

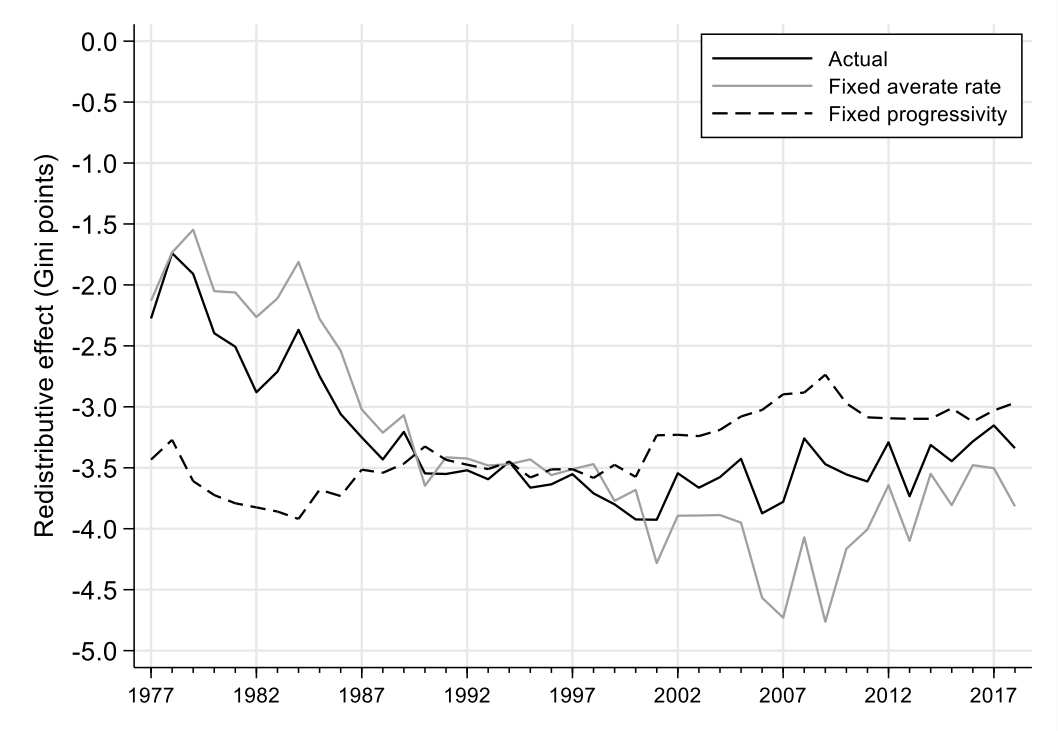


Notes. For cash benefits, the figure compares yearly observed redistributive effect (as in Figure 2) with two counterfactual calculations of redistributive effect: (a) *R* calculated by fixing the average rate (*b*) and reranking (*D*) at their 1977–2018 average values and setting K_B at the observed values ('fixed average rate'); and (b) *R* calculated by fixing progressivity (K_B) and reranking (*D*) at their 1977–2018 average values and setting the average rate (*b*) at the observed values ('fixed progressivity'). See eq. (3).
Source. Authors' calculations from ETB unit record data.

Figure 8. Counterfactual calculations of the redistributive effect of direct taxes, UK, 1977–2018

Notes. For direct taxes, the figure compares yearly observed redistributive effect (as in Figure 2) with two counterfactual calculations of redistributive effect: (a) R calculated by fixing the average rate (t) and reranking (D) at their 1977–2018 average values and setting K_T at the observed values ('fixed average rate'); and (b) R calculated by fixing progressivity (K_T) and reranking (D) at their 1977–2018 average values and setting the average rate (t) at the observed values ('fixed progressivity'). See eq. (2).
Source. Authors' calculations from ETB unit record data.

Figure 9. Counterfactual calculations of the redistributive effect of indirect taxes, UK, 1977–2018

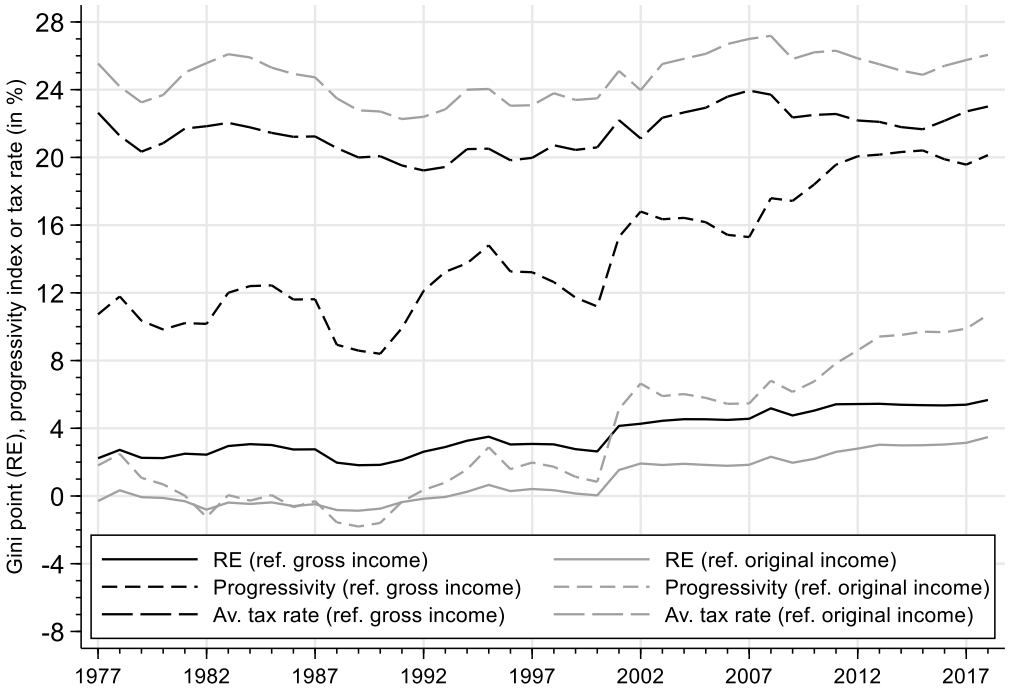


Notes. For indirect taxes, the figure compares yearly observed redistributive effect (as in Figure 2) with two counterfactual calculations of redistributive effect: (a) R calculated by fixing the average rate (t) and reranking (D) at their 1977–2018 average values and setting K_T at the observed values ('fixed average rate'); and (b) R calculated by fixing progressivity (K_T) and reranking (D) at their 1977–2018 average values and setting the average rate (t) at the observed values ('fixed progressivity'). See eq. (2).
Source. Authors' calculations from ETB unit record data.

Figure 10. Counterfactual calculations of the redistributive effect of in-kind benefits, UK, 1977–2018

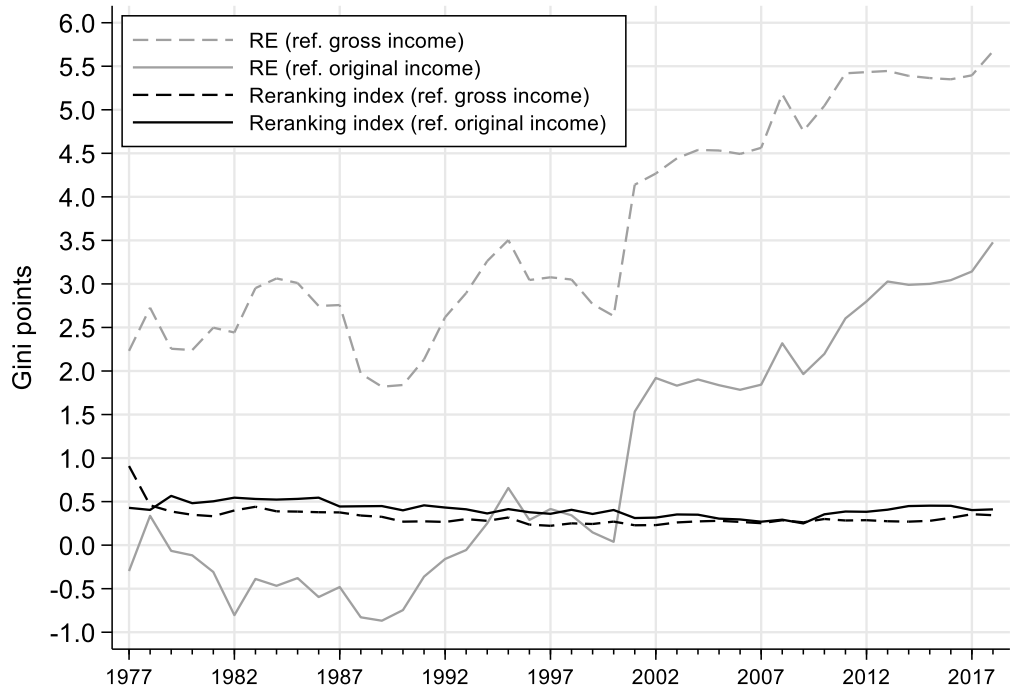
Notes. For in-kind income, the figure compares yearly observed redistributive effect (as in Figure 2) with two counterfactual calculations of redistributive effect: (a) R calculated by fixing the average rate (t) and reranking (D) at their 1977–2018 average values and setting K_T at the observed values ('fixed average rate'); and (b) R calculated by fixing progressivity (K_T) and reranking (D) at their 1977–2018 average values and setting the average rate (t) at the observed values ('fixed progressivity'). See eq. (3).
Source. Authors' calculations from ETB unit record data.

Figure 11. Direct taxes, redistributive effect, average tax rate, and progressivity: sensitivity to the definition of the reference distribution, UK, 1977–2018



Notes. The chart shows redistributive effects, average tax rates, and progressivity using two different reference (pre-fisc) distributions: (i) gross income (as earlier in the paper), and (ii) original income.
Source. Authors' calculations from ETB unit record data.

Figure 12. Direct taxes, redistributive effect, and reranking: sensitivity to the definition of the reference distribution, UK, 1977–2018



Notes. The chart shows redistributive effects and reranking indices using two different reference (pre-fisc) distributions: (i) gross income (as earlier in the paper), and (ii) original income.
Source. Authors' calculations from ETB unit record data.

Table A1. Gini coefficients, redistributive effect (RE), progressivity, average rate and reranking index for cash benefits, UK, 1977–2018

Year	Gini (original income)	Gini (gross income)	RE	Progressivity	Average benefit rate (in %)	Reranking index
1977	36.3	27.3	9.0	–83.9	12.9	0.6
1978	36.9	27.4	9.5	–83.2	13.7	0.5
1979	37.0	27.5	9.5	–79.4	14.3	0.5
1980	38.1	28.7	9.4	–82.1	13.7	0.5
1981	39.9	29.5	10.4	–82.8	15.2	0.5
1982	41.5	29.7	11.7	–84.6	17.1	0.6
1983	42.3	29.8	12.4	–84.1	18.4	0.6
1984	42.7	29.7	13.0	–85.7	19.0	0.7
1985	43.8	31.2	12.6	–86.6	18.0	0.6
1986	45.0	32.5	12.5	–87.8	17.5	0.6
1987	46.0	34.0	12.0	–89.1	16.4	0.6
1988	45.4	34.8	10.6	–88.7	14.3	0.5
1989	44.6	34.1	10.5	–89.8	13.9	0.5
1990	46.4	36.3	10.1	–90.9	13.2	0.5
1991	46.3	35.7	10.6	–90.4	14.0	0.6
1992	47.7	35.6	12.1	–90.7	16.5	0.7
1993	49.1	36.2	12.9	–91.8	17.5	0.8
1994	48.2	35.3	12.8	–93.3	17.1	0.8
1995	47.8	35.1	12.7	–91.8	17.2	0.8
1996	48.1	35.8	12.4	–94.0	16.2	0.8
1997	47.9	36.0	11.9	–93.8	15.6	0.8
1998	48.4	36.8	11.6	–95.9	14.8	0.8
1999	48.3	37.1	11.2	–94.8	14.4	0.7
2000	47.5	36.4	11.0	–94.6	14.1	0.6
2001	49.8	39.1	10.7	–97.7	13.1	0.6
2002	49.0	38.2	10.8	–96.8	13.5	0.7
2003	48.8	37.7	11.1	–94.8	14.2	0.7
2004	49.2	38.1	11.1	–96.1	14.0	0.7
2005	50.7	39.7	11.0	–96.1	13.9	0.7
2006	51.6	41.0	10.6	–97.1	13.2	0.7
2007	52.8	42.4	10.4	–98.3	12.7	0.7
2008	51.7	40.2	11.5	–96.1	14.6	0.8
2009	52.9	40.7	12.2	–96.9	15.5	0.8
2010	51.1	38.6	12.5	–94.8	16.4	0.9
2011	51.3	38.6	12.6	–95.8	16.6	1.0
2012	51.4	39.0	12.4	–94.5	16.5	1.0
2013	51.4	39.8	11.6	–94.2	15.4	1.0
2014	51.0	39.4	11.6	–95.0	15.3	1.0
2015	51.3	39.9	11.5	–96.2	14.9	1.0
2016	49.1	38.1	11.0	–93.7	14.6	0.9
2017	49.5	39.0	10.4	–96.0	13.4	0.9
2018	49.8	39.7	10.1	–94.0	13.3	0.9

Notes: Income definitions are explained in Section 3. For each series, the distribution is of equivalised household income among all individuals. Gini coefficients are multiplied by 100.
Source. Authors' calculations from ETB unit record data.

Table A2. Gini coefficients, redistributive effect (RE), progressivity, average rate and reranking index for direct taxes, UK, 1977–2018

Year	Gini (original income)	Gini (gross income)	RE	Progressivity	Average tax rate (in %)	Reranking index
1977	27.3	25.1	2.2	10.7	22.6	0.9
1978	27.4	24.7	2.7	11.8	21.3	0.5
1979	27.5	25.2	2.3	10.4	20.3	0.4
1980	28.7	26.5	2.2	9.8	20.8	0.3
1981	29.5	27.0	2.5	10.2	21.7	0.3
1982	29.7	27.3	2.4	10.2	21.8	0.4
1983	29.8	26.9	3.0	12.0	22.0	0.4
1984	29.7	26.7	3.1	12.4	21.8	0.4
1985	31.2	28.2	3.0	12.4	21.4	0.4
1986	32.5	29.8	2.7	11.6	21.2	0.4
1987	34.0	31.3	2.8	11.6	21.2	0.4
1988	34.8	32.8	2.0	8.9	20.6	0.3
1989	34.1	32.3	1.8	8.6	20.0	0.3
1990	36.3	34.4	1.8	8.4	20.1	0.3
1991	35.7	33.6	2.1	9.9	19.5	0.3
1992	35.6	33.0	2.6	12.1	19.2	0.3
1993	36.2	33.3	2.9	13.2	19.4	0.3
1994	35.3	32.1	3.3	13.7	20.5	0.3
1995	35.1	31.6	3.5	14.8	20.5	0.3
1996	35.8	32.7	3.0	13.3	19.8	0.2
1997	36.0	32.9	3.1	13.2	20.0	0.2
1998	36.8	33.8	3.1	12.6	20.7	0.3
1999	37.1	34.3	2.8	11.7	20.4	0.2
2000	36.4	33.8	2.6	11.2	20.6	0.3
2001	39.1	35.0	4.1	15.3	22.2	0.2
2002	38.2	33.9	4.3	16.8	21.1	0.2
2003	37.7	33.2	4.4	16.3	22.3	0.3
2004	38.1	33.5	4.5	16.4	22.7	0.3
2005	39.7	35.1	4.5	16.2	22.9	0.3
2006	41.0	36.5	4.5	15.4	23.6	0.3
2007	42.4	37.8	4.6	15.3	23.9	0.3
2008	40.2	35.1	5.2	17.6	23.7	0.3
2009	40.7	36.0	4.8	17.4	22.4	0.3
2010	38.6	33.5	5.0	18.4	22.5	0.3
2011	38.6	33.2	5.4	19.6	22.6	0.3
2012	39.0	33.6	5.4	20.1	22.2	0.3
2013	39.8	34.4	5.4	20.2	22.1	0.3
2014	39.4	34.0	5.4	20.3	21.8	0.3
2015	39.9	34.5	5.4	20.4	21.7	0.3
2016	38.1	32.8	5.4	19.9	22.2	0.3
2017	39.0	33.6	5.4	19.6	22.7	0.4
2018	39.7	34.0	5.7	20.1	23.0	0.3

Notes: As for Table A1. Source. Authors' calculations from ETB unit record data.

Table A3. Gini coefficients, redistributive effect (RE), progressivity, average rate and reranking index for indirect taxes, UK, 1977–2018

Year	Gini (original income)	Gini (gross income)	RE	Progressivity	Average tax rate (in %)	Reranking index
1977	25.1	27.4	–2.3	–5.6	19.6	0.9
1978	24.7	26.4	–1.7	–3.9	18.6	0.8
1979	25.2	27.1	–1.9	–3.1	20.6	1.1
1980	26.5	28.9	–2.4	–5.3	21.3	1.0
1981	27.0	29.5	–2.5	–5.3	21.7	1.0
1982	27.3	30.2	–2.9	–6.2	21.9	1.2
1983	26.9	29.6	–2.7	–5.5	22.1	1.1
1984	26.7	29.0	–2.4	–4.3	22.4	1.1
1985	28.2	30.9	–2.7	–6.2	21.0	1.1
1986	29.8	32.8	–3.1	–7.3	21.3	1.1
1987	31.3	34.5	–3.3	–9.4	20.1	0.9
1988	32.8	36.3	–3.4	–10.2	20.2	0.8
1989	32.3	35.5	–3.2	–9.6	19.8	0.8
1990	34.4	38.0	–3.5	–12.0	18.9	0.7
1991	33.6	37.1	–3.6	–11.1	19.6	0.9
1992	33.0	36.5	–3.5	–11.1	19.8	0.8
1993	33.3	36.9	–3.6	–11.3	20.0	0.8
1994	32.1	35.5	–3.4	–11.3	19.7	0.7
1995	31.6	35.3	–3.7	–11.1	20.4	0.8
1996	32.7	36.4	–3.6	–11.7	20.1	0.7
1997	32.9	36.5	–3.6	–11.5	20.0	0.7
1998	33.8	37.5	–3.7	–11.3	20.5	0.8
1999	34.3	38.1	–3.8	–12.6	19.8	0.7
2000	33.8	37.7	–3.9	–12.2	20.4	0.8
2001	35.0	38.9	–3.9	–14.7	18.4	0.6
2002	33.9	37.5	–3.5	–13.1	18.3	0.6
2003	33.2	36.9	–3.7	–13.1	18.4	0.7
2004	33.5	37.1	–3.6	–13.1	18.1	0.7
2005	35.1	38.6	–3.4	–13.3	17.4	0.6
2006	36.5	40.4	–3.9	–15.9	17.1	0.6
2007	37.8	41.6	–3.8	–16.6	16.2	0.6
2008	35.1	38.3	–3.3	–13.8	16.1	0.6
2009	36.0	39.5	–3.5	–16.8	15.2	0.5
2010	33.5	37.1	–3.6	–14.2	16.7	0.7
2011	33.2	36.8	–3.6	–13.6	17.4	0.7
2012	33.6	36.9	–3.3	–12.0	17.5	0.7
2013	34.4	38.1	–3.7	–14.0	17.5	0.8
2014	34.0	37.3	–3.3	–11.6	17.5	0.8
2015	34.5	37.9	–3.4	–12.7	17.0	0.8
2016	32.8	36.0	–3.3	–11.3	17.7	0.9
2017	33.6	36.8	–3.2	–11.4	17.1	0.8
2018	34.0	37.4	–3.3	–12.8	16.7	0.8

Notes: As for Table A1. Source. Authors' calculations from ETB unit record data.

Table 4. Gini coefficients, redistributive effect (RE), progressivity, average rate and reranking index for in-kind benefits, UK, 1977–2018

Year	Gini (original income)	Gini (gross income)	RE	Progressivity	Average transfer rate (in %)	Reranking index
1977	v	27.4	–2.3	–5.6	19.6	0.9
1978	24.7	26.4	–1.7	–3.9	18.6	0.8
1979	25.2	27.1	–1.9	–3.1	20.6	1.1
1980	26.5	28.9	–2.4	–5.3	21.3	1.0
1981	27.0	29.5	–2.5	–5.3	21.7	1.0
1982	27.3	30.2	–2.9	–6.2	21.9	1.2
1983	26.9	29.6	–2.7	–5.5	22.1	1.1
1984	26.7	29.0	–2.4	–4.3	22.4	1.1
1985	28.2	30.9	–2.7	–6.2	21.0	1.1
1986	29.8	32.8	–3.1	–7.3	21.3	1.1
1987	31.3	34.5	–3.3	–9.4	20.1	0.9
1988	32.8	36.3	–3.4	–10.2	20.2	0.8
1989	32.3	35.5	–3.2	–9.6	19.8	0.8
1990	34.4	38.0	–3.5	–12.0	18.9	0.7
1991	33.6	37.1	–3.6	–11.1	19.6	0.9
1992	33.0	36.5	–3.5	–11.1	19.8	0.8
1993	33.3	36.9	–3.6	–11.3	20.0	0.8
1994	32.1	35.5	–3.4	–11.3	19.7	0.7
1995	31.6	35.3	–3.7	–11.1	20.4	0.8
1996	32.7	36.4	–3.6	–11.7	20.1	0.7
1997	32.9	36.5	–3.6	–11.5	20.0	0.7
1998	33.8	37.5	–3.7	–11.3	20.5	0.8
1999	34.3	38.1	–3.8	–12.6	19.8	0.7
2000	33.8	37.7	–3.9	–12.2	20.4	0.8
2001	35.0	38.9	–3.9	–14.7	18.4	0.6
2002	33.9	37.5	–3.5	–13.1	18.3	0.6
2003	33.2	36.9	–3.7	–13.1	18.4	0.7
2004	33.5	37.1	–3.6	–13.1	18.1	0.7
2005	35.1	38.6	–3.4	–13.3	17.4	0.6
2006	36.5	40.4	–3.9	–15.9	17.1	0.6
2007	37.8	41.6	–3.8	–16.6	16.2	0.6
2008	35.1	38.3	–3.3	–13.8	16.1	0.6
2009	36.0	39.5	–3.5	–16.8	15.2	0.5
2010	33.5	37.1	–3.6	–14.2	16.7	0.7
2011	33.2	36.8	–3.6	–13.6	17.4	0.7
2012	33.6	36.9	–3.3	–12.0	17.5	0.7
2013	34.4	38.1	–3.7	–14.0	17.5	0.8
2014	34.0	37.3	–3.3	–11.6	17.5	0.8
2015	34.5	37.9	–3.4	–12.7	17.0	0.8
2016	32.8	36.0	–3.3	–11.3	17.7	0.9
2017	33.6	36.8	–3.2	–11.4	17.1	0.8
2018	34.0	37.4	–3.3	–12.8	16.7	0.8

Notes: As for Table A1. Source. Authors' calculations from ETB unit record data.