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Arun Advani, Andy Summers & Hannah Tarrant

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Measuring top income shares in the UK

Arun Advani* Andy Summers† Hannah Tarrant‡

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Abstract

Information about the share of total income held by the richest 1%, or other top income groups, is increasingly used to discuss inequality levels and trends within and between nations. A top income share is the ratio of the total income held by the top income group divided by total personal income (the 'income control total'). We compare two approaches to estimating income control totals: the 'external' approach used by the World Inequality Database, and an augmented 'internal' approach. We argue in favour of the latter, with reference to five desirable properties that a top share series would ideally possess. The choice matters: our augmented 'internal' approach yields estimates of the UK top 1% share that are around 2 percentage points higher than the 'external' approach.

Keywords: income inequality, measurement, national accounts, top shares

*University of Warwick, CAGE Research Centre, the Institute for Fiscal Studies (IFS), and the LSE International Inequalities Institute (LSE III), all in the United Kingdom. The authors thank Facundo Alvaredo, Richard Burkhauser, Stephen Jenkins, Jeff Larrimore, Marc Morgan, David Splinter, and Thomas Piketty for helpful comments. This research was supported by a grant from the CAGE Research Centre, which is supported by the ESRC (Grant No: ES/L011719/1), and by the ERC Synergy Grant 'Towards a System of Distributional National Accounts' (DINA). This work contains statistical data from Department for Work and Pensions (2019, 2020), HM Revenue and Customs (2019), and Office for National Statistics (2019), which are Crown Copyright. The research data sets used may not exactly reproduce HMRC or ONS aggregates. The use of HMRC and ONS statistical data in this work does not imply any endorsement of these organisations in relation to the interpretation or analysis of the information. Correspondence: Dept of Economics, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL. Email: economics@arunadvani.com.

†London School of Economics, LSE III, CAGE and IFS, all in the United Kingdom.

‡LSE III, United Kingdom.

1 Introduction

Top income shares – the amount of income earned by some fraction of the population, say the top 1%, divided by total income in the population – provide an important insight into the unequal distribution of resources. As well as being a matter of increasing public concern in itself, the share of income captured by the top is also used by economists to understand the dynamics of entrepreneurship, innovation, growth and other macroeconomic outcomes (Gabaix et al., 2016; Jones and Kim, 2018; Aghion et al., 2019). Early work by Atkinson (2005b), later extended to produce the UK top share series in the widely-cited *World Inequality Database* (WID), illustrated how such income inequality in the UK has evolved over time.

Subsequent developments in measurement, both in the UK and elsewhere, have focused on the accurate quantification of the incomes of the richest (Atkinson, 2007; Piketty and Saez, 2003, 2020; Auten and Splinter, 2019), i.e. the numerator of a top income share calculation. These incomes are poorly measured in survey data, through a combination of lower response rates by the rich and weaker coverage of the types of income sources received by the rich (Burkhauser et al., 2018a,b; Advani et al., forthcoming(b)). This has motivated the use of administrative data to replace or augment survey responses. By contrast, relatively little attention has been paid to measurement issues affecting the income control total, i.e. the corresponding income total for the entire population (the denominator of a top income share calculation).

In this paper, we examine the alternative methods and data sources that can be used to construct the income control total, and the quantitative importance of these choices. After showing that the two approaches we consider provide income control totals that differ by 15%, we explain why we favour one approach over the other, with reference to five desirable properties which help us to structure our discussion.

In principle the income control total should be straightforward to measure: once we have a target definition of income, and a way to measure it among top individuals, the same approach can be extended to the rest of the population, creating an 'internal' control total. This approach was taken in the main UK top share series produced by Atkinson (2005b), henceforth referred to as the 'Atkinson series'. However, administrative tax data, which are most appropriate for capturing top incomes, exclude very low income individuals who fall below the minimum threshold required to pay tax, known in the UK as the 'personal allowance'. This is not only an issue in the UK, but also in US studies which rely on tax return data. In the UK, this 'missing income' problem has become more pressing over time as the personal allowance has increased, tripling over the past 20 years.

Since 2010, an alternative 'external' income control total constructed from National Accounts (NA) data has instead been used for the Atkinson series (Atkinson, 2012, 2013, 2014; Atkinson and Ooms, 2015; Alvaredo, 2017, extending Atkinson, 2005b). We compare the merits of using an 'augmented internal' control total – using survey data to augment the missing administrative tax data – to using an external control total as has become the standard in the UK.

Consistent with the Atkinson series, we focus on assessable income, defined as all income that is assessable for personal income taxation. The Atkinson series is currently published as the 'fiscal' income series on the WID. Extensions of the series beyond 2010 have also used assessable income as their reference point, even though they have used National Accounts data rather than tax data: see Atkinson (2012, 2013, 2014); Atkinson and Ooms (2015); Alvaredo (2017). By contrast, the headline top share series currently featured on the WID is based on a National Accounts-consistent income definition. For a brief comparison of these approaches, see Table A1.

We construct our augmented internal control total by summing the income assessed by tax authorities, obtained from tax data, and adding to this an estimate of total income among the non-taxpaying population using survey data. For our alternative external control total, we use information from the National Accounts, retaining components of National Income which have a counterpart in assessable income.

Our main finding is that choice of income control total is quantitatively important: aggregate income is 15% (£119bn) higher on average using the external approach, relative to the augmented internal total. We frame our discussion of which approach is preferable around five desirable properties that – conditional on having chosen a particular income definition – any top share series would ideally possess. These are (i) comparability between the numerator and denominator (income control total); (ii) comparability over time; (iii) international comparability; (iv) statistical performance; and (v) practical considerations. In the case of our assessable income series, we argue that our augmented internal approach has favourable attributes when it comes to (i), (ii), and (v), while our external approach lacks four of these properties and cannot be assessed on (iv).

Measurement choices in the income control total affect the level of top share estimates: the income share of the top 1% rises by 2 percentage points when an augmented internal income total is used relative to an external total. Along with this higher level, our augmented internal control total exhibits a smaller drop in top shares following the Financial Crisis relative to the Atkinson series. We find that the top 1% share of assessable income rose from 12.2% in 1996-97 to 15.2% in 2007-08. Top shares fell in the aftermath of the Financial Crisis, and have risen slightly in recent years, with the top 1% receiving 14.3% of assessable income in 2018-19. The 0.8 percentage point

post-Crisis rise in our series between 2010-11 and 2014-15 (from 13.4% to 14.2%) compares with a 1.3 percentage point rise (from 12.6% to 13.9%) in the Atkinson series.

The purpose of this paper is not to argue in favour of one income definition above all others. Indeed, the principles and methods we set out are complementary to a recent strand of literature on measuring top income inequality, which focuses on measuring top shares using income definitions that are harmonised across countries (Atkinson, 2005a, 2007; Alvaredo et al., 2013, 2020; Fesseau and Mattonetti, 2013; ONS, 2015; Garbinti et al., 2018; Piketty et al., 2018; Tonkin et al., 2020). There are different definitions of income that one could use to measure inequality. Historically, the two most widely-used have been assessable income, and Canberra income: a broader definition of income including all receipts received at annual or more frequent intervals, typically measured using surveys. More recently, we have witnessed the development of inequality series using National Accounts-consistent income definitions. These 'Distributional National Accounts (DINA)' methods seek to allocate components of National Income to households based on the distribution of observable income flows. The authors of the WID have been instrumental in popularising these methods (Alvaredo et al., 2020; Garbinti et al., 2018; Piketty et al., 2018), though several separate research teams have developed their own DINA series in recent years (Fesseau and Mattonetti, 2013; ONS, 2015; Auten and Splinter, 2022; Batty et al., 2017; Tonkin et al., 2020). For some supporters of this approach, the appeal of National Accounts-consistent measures of income inequality lies in their consistency with macroeconomic aggregates and the possibility of harmonisation across countries (Chancel et al., 2021), although achieving the latter is far from guaranteed.

At the same time, assessable income remains an important definition for several reasons: it is consistent with the best data source for measuring the incomes of the richest; it has, in the UK and several other countries, the longest historical availability; it is the income concept targetted by tax authorities for redistribution; and it continues to be widely used by economists as the foundation for producing inequality series using more comprehensive income definitions, including the DINA series published in the WID (Burkhauser et al., 2018b,a; Advani and Summers, 2020; Atkinson and Jenkins, 2019; Jenkins, 2017; Piketty et al., 2018). Despite the addition of DINA series to the WID, assessable income series continue to be published. The Atkinson series remains the longest-running time series for the UK, and has recently been extended based on our 'augmented internal' estimates (Advani et al., 2021). In this paper, we present our arguments for revising the methods used to construct the UK's assessable income series. Through our discussion of which approach is preferable in this specific case, we provide a framework for thinking about how one might construct an income control total when using an alternative income definition.

Our reasoned argument for favouring one approach over the other offers a resolution to an issue that has held up the production of UK top share statistics in recent years. The use of National Accounts to construct income control totals for estimating top shares dates back to Kuznets (1953), and has been widely adopted since (Piketty, 2003; Piketty and Saez, 2003). Until 2009, the Atkinson series relied on the augmented internal control method. Subsequently, Atkinson switched to using the external control method, using National Accounts data. When this change was implemented, estimates for previous years were *not* revised. The year 2009 is therefore both the year in which the methodology changed, and the year from which the series produced by the new methodology commenced. This switch passed without much attention, partly because the two approaches produced similar results at the time of the switch. More recently however, delays in producing the series have partly been driven by a need to reconcile the growing gap between the two approaches, as also highlighted by Burkhauser et al. (2018b). The desirable properties we set out to aid comparison of the alternative options can be revisited as data availability evolves in the UK, and be applied to decisions about the choice of income control total in other countries.

The remainder of the paper is organised as follows. Section 2 outlines the data sources. Section 3 describes the methodology used to construct our numerator. Section 4 describes the two approaches we use to construct the income control total. Section 5 sets out our arguments for favouring the augmented internal approach with reference to five desirable properties any top share series ought to possess. Section 6 presents our updated series for top assessable income shares in the UK. Section 7 concludes. Throughout the paper, we refer to supplementary tables that can be found in the Online Appendix. These tables and figures are identified by having a letter before their figure number, denoting the relevant Appendix section.

2 Data and income definitions

The goal of this paper is to examine how best to construct the income control total when estimating top income shares. We therefore remain close to the existing literature in the remainder of our choices around defining the income measure and units, to allow a sharp focus on the specific effects of income control total choice.

In particular, our target measure of income inequality is the share of assessable income that goes to particular top shares of the population, for example the top 1%, before the deduction of taxes on income. In the UK, assessable income includes earned income from employment, self-employment, partnerships, rental income, interest, dividends, pension income (from private and social security

pensions), and certain types of welfare payment. It excludes capital gains and some tax-exempt forms of investment income. In Online Appendix C, we present estimates of *post-tax* top shares, which we construct by deducting Income Tax and employee National Insurance (social security) Contributions from assessable income.

Consistent with work in the UK and elsewhere (Piketty and Saez, 2003; Atkinson, 2005b; Atkinson and Piketty, 2007; Burkhauser et al., 2018b,a; Jenkins, 2017), our definition of assessable income follows the statutory definition of receipts that are chargeable to Income Tax on individuals. This excludes, for example, employer payroll tax contributions and corporation tax paid on dividends by owner-managers.

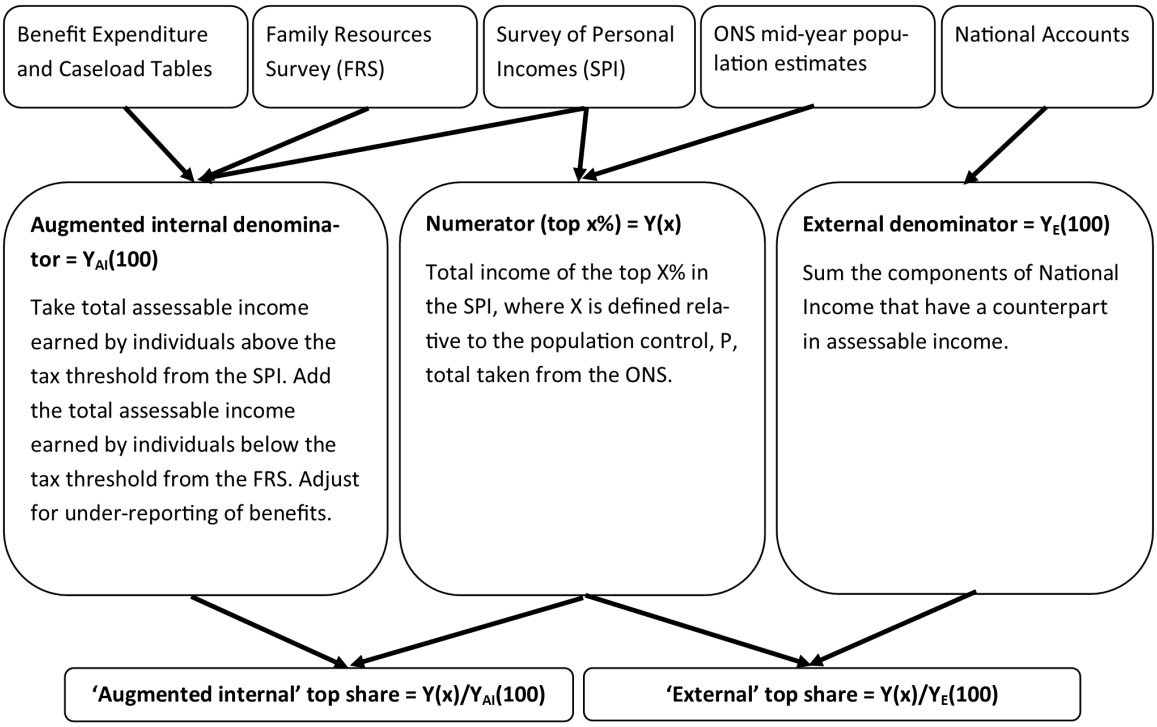
We use individuals as our unit of analysis throughout, as individuals have been the tax unit for UK Income Tax purposes in all of the years for which we have microdata (since 1996-97). Atkinson (2005b) produces assessable income shares covering years as far back as 1908, though as the tax unit in the UK changed from married couples to individuals in 1990, so too did the unit of analysis used by Atkinson to construct top shares. In the WID, the UK assessable income series therefore only extends as far back as 1990, over which period the unit of analysis is comparable.

Figure 1 illustrates the key data sources that we use to construct our top share estimates and how these feed into the different estimates we present. In each series, we use administrative tax microdata from the Survey of Personal Incomes (SPI), produced by HM Revenue and Customs, KAI Data, Policy and Co-ordination (2021), combined with external population control totals from the Office for National Statistics (ONS), to construct the numerator (see Section 3). The difference between the top share estimates we present therefore stems entirely from the methods and data used to construct the income control total. Our 'augmented internal' control total combines the tax data used to construct the numerator – the SPI – with household survey data from the Family Resources Survey (FRS), produced by Department for Work and Pensions, Office For National Statistics, NatCen Social Research (2021). Our 'external' control total draws on the Households sector balance sheet in the UK National Accounts. For further details on how our methodology and series coverage compares to the Atkinson series, as well as to the DINA series published in the WID, see Table A1.

2.1 Survey of Personal Incomes

The SPI Public Use Tapes are released annually by His Majesty's Revenue and Customs (HMRC). The data are a stratified random sample of administrative tax records drawn from the universe of UK income taxpayers, and cover the tax years 1996-97 to 2018-19, although no data were published

Figure 1: **Data and methodology flowchart**



for 2008-09. Henceforth, we refer to tax years by the later year, i.e. we refer to 2018-19 as 2019. This is consistent with the terminology practiced by HMRC, but differs from the WID database which refers to the earlier year. We exclude UK taxpayers who are not resident in the UK. The tax unit is the individual.

The SPI sample size increased rapidly over the first decade, from 61,000 in 1997 to 566,000 in 2007, and has subsequently increased steadily, reaching 766,000 by 2019. Weights are provided in the microdata, which reflect the sampling probabilities for each individual (see Online Appendix B for further details on the sampling design). We use these weights throughout our analysis, both in allocating observations to quantile groups and constructing income totals.

The data contain information on all income assessable for Income Tax. For individuals with incomes exceeding the tax exemption threshold (the standard personal allowance, set at £12,500 in 2021), the SPI "provides the most comprehensive and accurate official source of data on personal incomes" (HMRC, 2021). For this reason, we use the SPI as our main source of information on incomes above the personal allowance. The key SPI variable used to compute the total income of those earning above the personal allowance is *total income* (TI), subject to harmonisation of the treatment of dividends (see Online Appendix B for details).

2.2 Family Resources Survey

Tax data do not comprehensively capture individuals with incomes below the personal allowance. This presents a growing challenge to the construction of top income *shares*, which require a good estimate of the total personal income in the economy. Historically, the personal allowance was relatively low, so the small amount of income going to people with income below the threshold was ignored in the production of the Atkinson series, with the exception of an adjustment for pension income (Atkinson, 2005b, 2007). However, the personal allowance has risen substantially, almost tripling over the past 20 years – from £4,195 in 1998-99 to £11,850 in 2018-19. Moreover, as the personal allowance has increased, so has the average income of each individual below the threshold. This means that income totals based only on the taxpaying population miss a growing proportion of total personal income. In 2018-19, 38% of adults had incomes below the personal allowance, covering 8% of total income. Though the SPI does capture a significant number of individuals with income below the personal allowance, HMRC note that "the SPI is not a representative data source for this part of the population" (HMRC, 2021). To capture income below the tax threshold, we supplement our tax data with information drawn from the Public Use Files of the Family Resources Survey (FRS), an annual cross-sectional survey of British households.

The sample size has varied over time, ranging from just over 33,000 adults in 2019 to 51,000 in 2004. The sampling frame consists of addresses of all UK private dwellings, and excludes individuals living in institutional settings (e.g. prisons, care homes, and student accommodation) (see Online Appendix B for further details on the sampling design). Weights are provided which account for both the sampling probability of each observation, and differential non-response. We use the individual-level weights provided to construct our aggregate income estimates. Although in principle, the FRS is representative of the population in private dwellings when the survey weights are used, there is known under-coverage at the top of the income distribution (Burkhauser et al., 2018a,b; Jenkins, 2017). Hence, the SPI is a preferable data source for this segment of the population.

Assessable income is not directly measured in the FRS. However, the Public Use Files contain cleaned and weeklyised income receipts from different sources at an individual level, enabling us to construct a measure of assessable income which corresponds closely to the tax code. We convert weekly assessable income receipts to an annual basis by applying a multiplier of 365/7 (366/7 in leap years).

We include all individuals with assessable income below the standard personal allowance in our sample, regardless of whether they are likely to pay Income Tax or not (some individuals may pay

tax if they are not entitled to the standard personal allowance). We thus use the standard personal allowance as the nominal cutoff for joining our SPI and FRS samples. In Figure A1 we show, for a plausible range of joining thresholds, that this choice makes little difference to the income control total.

2.3 Benefit Expenditure and Caseload Tables

There is known under-reporting of benefit income in the FRS (Corlett et al., 2018). As benefit income is mostly received by those on low incomes, this could lead to the under-estimation of income below the personal allowance if not addressed. To correct for this, we use administrative data on benefit expenditure from the UK government's Benefit Expenditure and Caseload Tables (Spring 2020), which are released with each budget. Note that although investment income is also poorly captured in the FRS (Ooms, 2019; Advani et al., forthcoming(b)), this will only have a small impact on our estimates since those with incomes below the personal allowance receive only a small fraction of total investment income.

2.4 National Accounts

Our external control total is constructed using information contained in the 'Households' sector account of the most recent Blue Book publication (2021) – the annual publication of the UK National Accounts – which includes disaggregated components of household sector income as far back as 1987.

To define our income variable, we draw predominantly on the primary and secondary distribution of income accounts of the household sector (Tables 6.2.3 and 6.2.4S). Primary income of the household sector consists of total income from employment (compensation of employees), self-employment income (gross mixed income), imputed rent of owner-occupiers (gross operating surplus), and property income received (e.g. interest and dividends) net of interest payments. The secondary distribution of income account contains information on all social contributions and transfers paid and received by the household sector. We supplement this with information contained in the secondary distribution of income account for General Government (Table 5.2.4S), which provides a breakdown of government expenditure on social transfers by benefit type, allowing us to obtain estimates of total expenditure on taxable benefits only. In Section 4.2 we set out precisely what components of these data we include to most closely harmonise the definition with assessable income, as well as the limitations in our ability to do this.

The National Accounts are published on a calendar year basis. To convert our estimates to tax

years (as the SPI, and hence our numerator, is published on this basis), we follow Atkinson (2012, 2013, 2014); Atkinson and Ooms (2015) and take 3/4 of the total for the earlier calendar year and 1/4 of the total for the later calendar year. This approximates the UK tax year, which runs from the 6th April to the following 5th April.

2.5 ONS mid-year population estimates

For our population control we use data from the ONS mid-year population estimates for the UK adult population aged 15 and over (Table A2). This is the same population control as is used to construct the Atkinson series. Unlike the weighted population totals obtained in survey data, which omit individuals living in institutional settings, the ONS mid-year population estimates provide a comprehensive measure of the entire UK resident population. Since the SPI captures all income taxpayers – including those living in institutional settings – using a population control which includes all UK residents is more appropriate than using a survey-based population control for estimating the numerator.

3 Numerator: Total income held by the top x%

To construct the numerator of our top share series, we use microdata on individual incomes from the SPI. Aggregate income of the top x% is estimated as the total income of the top N individuals whose survey weights sum to x% of P, where P is our population control total. To estimate this, we first rank individuals according to their total assessable income, y_i^{spi}. Let P_i be the cumulative sum of individual survey weights w_i^{spi} for individuals with income above y_i^{spi} such that $P_i = \sum_{j:y_j^{spi} \geq y_i^{spi}} w_j^{spi}$. Let $j(x), k(x)$ be the two consecutive sample individuals in the ranking for whom the cumulative sum of individual survey weights lie either side of the population target $\frac{X}{100} \cdot P$, i.e. $P_{j(x)} < \frac{X}{100} \cdot P \leq P_{k(x)}$. Then we estimate our numerator by summing the weighted incomes of individual $k(x)$ and higher, adjusting the survey weight of individual $k(x)$ such that the sum of (adjusted) survey weights hits our population target exactly, i.e.

$$Y(x) = \sum_{i:y_i^{spi} \geq y_{j(x)}^{spi}} w_i^{spi} y_i^{spi} + \bar{w}_{k(x)}^{spi} y_{k(x)}^{spi} \tag{1}$$

where $\bar{w}_{k(x)}^{spi}$ is the partial weight of individual $k(x)$ such that $\sum_{i:y_i^{spi} \geq y_{j(x)}^{spi}} w_i^{spi} + \bar{w}_{k(x)}^{spi} = \frac{X}{100} \cdot P$.

This differs from Atkinson's approach, which applied Pareto interpolation methods to tabulations of SPI data (Atkinson, 2005b). Access to microdata allows us to calculate the numerator without

needing to make assumptions on the underlying shape of the income distribution, and without missing high income individuals who have zero tax liability.

The magnitude of the numerator depends on the choice of population control, as the adult population implied by our combined SPI/FRS sample is lower than the ONS estimate for the UK adult population. This is particularly important in the early years of our sample, with around 9% of individuals missing from the SPI/FRS in 1997-2003 relative to the ONS population control total. We believe that this is the result of under-coverage in the SPI/FRS, rather than overestimation by the ONS for two main reasons. First, by construction the FRS omits individuals living in institutional settings. Many of those individuals are likely to be below the personal allowance, since students, prisoners, and people in care typically have low assessable incomes. They will therefore be missing from our SPI/FRS sample. Second, tax evasion could result in some individuals with incomes above the personal allowance being absent from the tax data, or falsely reporting income below the personal allowance in the tax data.

A priori, it is unclear how population under-coverage impacts top share estimates. If the SPI/FRS sample has perfect coverage of individuals in the top $x\%$ and only misses those further down the income distribution, the estimate of the numerator will be correct when we use the ONS population control total. Top shares will nevertheless be overstated because of under-coverage of incomes that should be included in the income control total.

On the other hand, if there is also population under-coverage at the top of the distribution, then whether or not top shares are over- or under-stated depends on the shape of the income distribution. In Online Appendix D we discuss this issue further and illustrate how top shares differ when an internal population control – taken from the count of individuals in the grossed up data – is used instead. In either case, the choice of population control only affects top shares through the numerator, regardless of the the approach used for the income control total, so has no bearing on the comparison between the income control total options that is at the heart of this paper.

4 Denominators: Total income held by the whole population

We next describe how we construct our augmented internal and external income control totals, before providing a comparison of the estimates. We postpone a discussion of how to select between them until Section 5.

4.1 Augmented internal control total

To construct an estimate of total income, we augment the internal income control from the SPI with information on incomes below the personal allowance from the FRS. Precisely, we sum the (weighted) incomes of individuals with income above the personal allowance in the SPI with the (weighted) assessable income of those below the personal allowance in the FRS.

Our construction of an (augmented) internal control total departs from the prior Atkinson methodology for an internal total in three ways. First, our approach systematically adds in all sources of income for individuals with total assessable income below the personal allowance, rather than only adjusting for omitted pension income as in the Atkinson series (see Online Appendix E.1 for further details).

Second, we are also able to include individuals with incomes above the personal allowance who do not pay Income Tax, for example those with large incomes but also large deductions and/or reliefs. Were we to omit these individuals from our sample, their incomes would be missing altogether from the income control total and (where the income is sufficiently large) the numerator. We are able to do this through the use of the SPI microdata, whereas the tabulations used by Atkinson covered only the *taxpaying* population.

Third, we use administrative data on benefits to adjust for under-coverage and/or under-reporting of benefit income that is assessable for Income Tax. This is known to be an issue in the FRS: Corlett et al. (2018) find a gap of up to 42% for some taxable benefits. These missing benefits affect the income control total, but are unlikely to affect the numerator, as the vast majority of benefit receipts are concentrated at the bottom of the income distribution. Even with under-coverage, 94% of total benefit income in 2018-19 went to those below the personal allowance, estimated using the SPI and FRS combined; by contrast they received only 8% of all assessable income. We adjust the augmented internal income total by adding the difference between what the government report spending on taxable benefits (including state pension) according to the Benefit Expenditure and Caseload Tables, and the total amount received according to the SPI and FRS combined. This adjustment increases the income total slightly (Figure E1), but by less than 1% in recent years.

The formula used for our augmented internal control total is given in Equation 2:

$$Y_{AI}(100) = \sum_{i:y_i^{spi}>\bar{y}} w_i^{spi} y_i^{spi} + \sum_{j:y_j^{frs}\leq\bar{y}} w_j^{frs} y_j^{frs} + \left(B - \sum_{i:y_i^{spi}>\bar{y}} w_i^{spi} b_i^{spi} - \sum_{j:y_j^{frs}\leq\bar{y}} w_j^{frs} b_j^{frs} \right) \quad (2)$$

where y_i^{data} is the assessable income of individual i in the data, where *data* may be SPI or FRS;

w_i^{data} is the survey weight assigned to individual i in the data; $\bar{y}$ is the personal allowance; b_i^{data} denote total taxable benefits received by individual i in the data; and B denotes aggregate taxable benefits as reported in the Benefit Expenditure and Caseload Tables.

While our top shares account for under-reporting of benefit income, we do not adjust for evasion. Evidence from representative audits finds that tax evasion as a share of reported income is higher towards the bottom of the reported income distribution, both in the UK (Advani et al., forthcoming(a); Advani, forthcoming) and US (Johns and Slemrod, 2010; DeBacker et al., 2020). Recent evidence suggests that *offshore* tax evasion specifically – the deliberate under-reporting or hiding of wealth overseas – is highly concentrated among the wealthy (Guyton et al., 2020). The latter is much less well picked up in representative audits, and is based on wealth rather than income, so the direction of the net effect on top income shares is unclear.

4.2 External control total

We construct our external income control total by retaining the components of National Income that are assessable for Income Tax. This is the same principle as used in constructing the post-2009 Atkinson control total series, which is also based on National Accounts. Our external control total differs from this in two ways.

First, from the outset we include only the household sector, excluding the Non-Profit Institutions Serving Households (NPISH) sector i.e. charitable organisations, trade unions, religious organisations, political parties, universities and further education establishments. Data limitations meant the Atkinson series included NPISH, as this had previously been combined with households in the UK National Accounts. To account for this, the Atkinson series had previously made an ex-post adjustment, removing 10% from the income control total as (what was seen as) a plausible estimate of the share of NPISH. As we show in E.3.2, this estimate was too large, though this could not have been known at the time.

Second, we refine the external income control formula to be more closely aligned with the target definition of income. The Atkinson method included several income components that are not assessable for Income Tax, including a deduction for interest payments made by the household sector and many non-taxable benefits. In Appendix E, we discuss precisely how to obtain our external income total using the Atkinson series as the point of departure. The set of income components included in our external control total are shown in Box 1.

Box 1: components of National Income that are assessable for Income Tax

Wages and salaries (Table 6.2.3)
Gross mixed income (self-employment income) (Table 6.2.3)
Interest before Financial Intermediation Services Indirectly Measured (Table 6.2.3)
Dividends (Table 6.2.3)
Withdrawals from the income of quasi-corporations (Table 6.2.3)
Earnings on property investment (Table 6.2.3)
Rent (from natural resources) (Table 6.2.3)
Social security pension benefits in cash (Table 6.2.4S)
Other social insurance pension benefits (Table 6.2.4S)
Incapacity benefit (Table 5.2.4S)
Carer's allowance (Table 5.2.4S)
Job Seeker's Allowance (Table 5.2.4S)
Widow's and Guardian's allowance (Table 5.2.4S)
Statutory sick pay (Table 5.2.4S)
Statutory maternity pay (Table 5.2.4S)
Unemployment benefit (Table 5.2.4S)

Notes: The table numbers refer to the Blue Book table in which the income component is recorded (Office for National Statistics, 2021).

The formula used to construct our external income total can therefore be formalised as follows:

$$Y_E(100) = \sum_{c \in F \subset C} NatInc_c \tag{3}$$

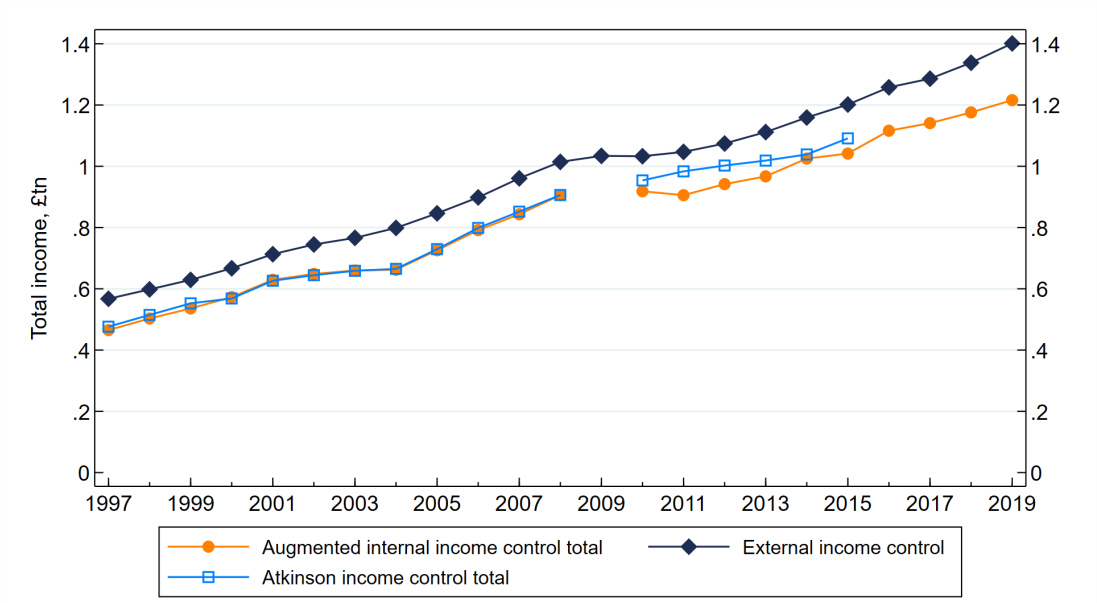
where C denotes all components of National Income, and F is the strict subset of components that are assessable for Income Tax. The Atkinson series included some components that are not assessable for Income Tax (i.e. some $c \in C \setminus F$), while the DINA estimates published in the WID (which target a different income definition) include all components of National Income (i.e. all $c \in C$).

Although it is possible to make some progress in aligning National Accounts income components with assessable income, conceptual differences preclude any attempt to achieve this in full. This is a significant drawback of the National Accounts approach. For example, the National Accounts concept of income from employment makes various adjustments to employment income as measured in the SPI to account for forms of income not subject to taxation, such as rent-free dwellings and meal vouchers provided to employees. Moreover, all income components reported in the National Accounts are subject to a final adjustment during a reconciliation exercise which balances estimates of GDP obtained using the three different approaches (production, expenditure, and income). Conceptual differences between the National Accounts and SPI definitions thus plague all categories of income, even if the income source is assessable for tax in principle.

4.3 Comparing our income control totals

Applying the methods described in the previous two sections, we find that the income total obtained via the augmented internal approach is substantially smaller than the income total obtained using

Figure 2: **Aggregate assessable income using our augmented internal method, our external method, and the Atkinson series**



Notes: 'Augmented internal income control total' is constructed by summing individual incomes above the standard personal allowance (based on the Survey of Personal Incomes, SPI); individual incomes below the standard personal allowance (based on the Family Resources Survey, FRS); and an adjustment for under-reported benefit income based on administrative Benefit Expenditure and Caseload Tables (as outlined in Section 4.1). 'External income control total' is constructed by summing income components in the 'Households' sector of the National Accounts (NA) 2021 Blue Book (as outlined in Section 4.2). 'Atkinson total' is the income total developed by Atkinson (2005b) and subsequently extended in Atkinson (2012, 2013, 2014); Atkinson and Ooms (2015); Alvaredo (2017).
Source: Authors' calculations based on the SPI, FRS, and Benefit Expenditure and Caseload Tables (augmented internal); the UK National Accounts (external); and WID (Atkinson).

the National Accounts (Figure 2). The difference between our external total and our augmented internal total is primarily a level difference: total income is 15% (£119bn) higher on average over the period using the external measure. The two series largely follow similar time trends, although the external total has grown slightly faster in recent years.

The trends in both of our series diverge from the Atkinson series from 2010 onwards, following Atkinson's methodological switch. Both our income control series grow faster than the Atkinson total after 2010, with implications for the growth in top shares. The growth rates of our two income control total series are much more aligned with one another than with the Atkinson series, which we find reassuring given the steps we take to reconcile the National Accounts with the assessable income definition (see Appendix E).

5 Desirable properties in income share series

In this section, we set out five desirable properties for a 'good' top share series, which are conditional on having chosen a target definition. These facilitate our discussion of which approach we think is preferable for measuring top assessable income shares.

5.1 Comparability between numerator and denominator

For top income share measures to be meaningful, the definition of income must be consistent between the numerator and denominator (income control total). If all incomes were reported to a single authority using a consistent definition, top income shares could be constructed by simply taking the share of reported income accruing to the richest $x\%$ of those individuals. In practice, no such data exist. Constructing income control totals for top share estimates which are representative of the whole population therefore requires combining multiple sources of data, reconciling income definitions between these data sources as far as possible with one's chosen definition.

By taking the data source used for the numerator as the main data source for our income control total, our augmented internal approach allows for comparability between the numerator and denominator. Though we supplement this with external survey data, the incomes measured in the FRS are sufficiently granular to produce a measure consistent with our target definition. By contrast, external totals from the National Accounts cannot be fully reconciled with assessable income.

5.2 Comparability over time

While comparability between the numerator and denominator ensures that top income shares are meaningful at a given point in time, much of the value in estimating income inequality comes from observing what happens over time. There are challenges to interpreting trends in assessable income shares as changes in income inequality. First, the definition of assessable income changes naturally as the tax code evolves (Burkhauser et al., 2012, 2015; Splinter, 2018). Variation in which sources of income are included in the tax base may affect the distribution of income assessed for tax purposes, but not the distribution of income measured according to a more comprehensive definition. This issue must be borne in mind by users of top share statistics. For our purposes the goal is not to have an accurate measure of living standards, but to have an accurate measure of the assessable income series itself, which is then the starting point from which more welfare-relevant income inequality measures can be produced.

However, this property of assessable income – that the definition changes over time – creates the

following measurement issue: data sources and methods used to construct top shares must be flexible to definitional changes. This is particularly difficult in light of the fact that top share estimation must draw on multiple sources of data in order to be representative of the whole population.

Income tax data lend themselves naturally to the measurement of top income shares according to an assessable income definition: income measured by the tax authorities automatically follows changes in the tax code. However, any alternative sources of data used to construct the series, such as the National Accounts or survey data, must be sufficiently disaggregated into specific income components in order to construct a measure of income which is closely related to the target definition. This is true of the survey data we use to supplement tax data in our augmented internal control total, but it is not true of the National Accounts. The latter are neither sufficiently disaggregated nor is the procedure for constructing them sufficiently well documented to ensure consistency with tax data definitions.

Our augmented internal series also aids the study of inequality trends over a longer time horizon. The series we present in this paper covers years since 1997, for which microdata are available. The Atkinson series in WID goes further back, to 1990 (since when the tax unit has been individual), by using tabulations of Income Tax data. To produce estimates that can be interpreted as an extension of this longer-run historical series, it is preferable to use similar data sources and definitions over time.

5.3 Comparability across countries

Valuable insight can be gained from comparisons of income inequality across countries and recent work has pushed the frontiers of inequality measurement with a particular focus on international comparability (Fesseau and Mattonetti, 2013; ONS, 2015; Piketty et al., 2018, 2019; Garbinti et al., 2018; Alvaredo et al., 2020; Tonkin et al., 2020).

In the context of the current exercise, an important question to ask is whether or not it is sensible to compare trends in *assessable* income inequality at all. What is included in assessable income varies across countries as tax codes differ. For example, the Netherlands includes the imputed rent of owner-occupiers in its Income Tax base and therefore its assessable income series (Salverda, 2013), whereas the UK does not. Changes in the tax code from one year to the next could affect the relative trends in inequality across countries even if inequality as measured using a more comprehensive income definition remains unchanged. A dramatic change in assessable income inequality occurred in the US following the 1986 tax reform, which broadened the tax base and lowered the marginal rate. This

incentivised individuals to shift their business income in order to report this through the personal tax system – i.e. as part of their assessable income – rather than the corporate tax system (Feenberg and Poterba, 1993, 2000; Gordon and Slemrod, 2000; Piketty and Saez, 2003; Auten and Splinter, 2019). In the UK, changes in dividend tax rates prompted dividend forestalling responses which are reflected in the changes in assessable inequality observed in the aftermath of the Financial Crisis. Comparisons of such changes in inequality trends across countries must be interpreted with great care.

Assessable income series can be made comparable across countries to the extent that the methods used to construct them abide by the same principles. However, comparability of the income control total alone does not ensure the international comparability of the series as a whole, as both the numerator and the tax code remain highly country-specific. Thus, no matter what approach one uses to construct the income control total, we argue that no top share series which uses a target definition that is itself incomparable across countries can possess this property. This includes both the augmented internal and external series presented in this paper.

5.4 Statistical performance

A desirable property of any top share estimator is good statistical performance. For example, one may be willing to accept a more biased estimator if it has substantially lower sampling variability. Unfortunately, standard measures of uncertainty cannot be produced for the National Accounts-based income control total, ruling out a comparison of the statistical performance of our alternative approaches. This is both because we do not have access to the underlying microdata which go into the National Accounts, and because the construction of the National Accounts involves many adjustments to ensure consistency in the aggregate numbers across the three alternative approaches to estimating GDP. This rules out any analytical approach to constructing standard errors. However, it is worth noting that regardless of the approach used to estimate the income control total, uncertainty in our estimation of the numerator will likely dominate overall uncertainty in our top share estimates. The standard error of the augmented internal income control total, which we can estimate since the control total is constructed as a weighted sum of individual incomes observed in microdata (see Equation 2), was only 0.5% of the estimated value of that control total in 2019. This uncertainty as a share of the total value is relatively low compared with uncertainty in the numerator. For example, the standard error of the numerator in the top 1% share was 2.0% of the estimated value of aggregate income for that group in 2019.

5.5 Practical considerations

Developing a top share series which works well in theory is important, but it also needs to work in practice. We identify two desirable practical properties. First, the series should be easy to update using the chosen methods and definitions, and in a timely manner. This means that any sources of data used to construct the numerator and the income control total must be easy to obtain, clean, and aggregate if the series is to be sustainable.

Second, the series would ideally be produced and interpreted using data available at a given point in time, without requiring any updating of the past. Neither tax nor survey data, once collected and released, are subject to revisions in general. This means that an assessable income series which draws only upon these data sources will be fixed from the point of estimation. In contrast, National Accounts figures are subject to frequent revisions, an outcome of the trade-off between timeliness and accuracy. These revisions can be quantitatively important: cumulative revisions made to the Blue Book estimates for 2015 between the publications of the 2016 and 2021 Blue Books resulted in a 3.6% increase in the income control total based on the Atkinson series method (see Figure E3), implying a 0.5 percentage point fall in the top 1% share for 2015. In the Blue Book, the ONS warn that "expectations of accuracy and reliability in early estimates are often too high" (Office for National Statistics, 2021). An assessable income series which draws on the National Accounts thus ought to, in the interest of accuracy, be updated as previous Blue Book figures are revised.

Our 'augmented internal' approach better satisfies the practical considerations set out above. In part, this is because we already use the SPI to construct the numerator, and so using this as a data source for the denominator comes at limited additional cost. One argument commonly put forward against using SPI data in general is that the SPI Public Use Tapes are released with a longer time lag relative to the National Accounts, causing a delay in the availability of policy-relevant statistics. For instance, the SPI dataset covering 2016-17 was only released in November 2019, whereas initial National Accounts estimates for 2017 were released in July 2018. However, in our setting, use of the National Accounts does not help since producing the numerator already relies on the release of SPI data.

Supplementing the SPI with survey data requires an additional time investment. However, we argue that this is a necessary burden. In the absence of this step, there is a risk that the income total obtained from the SPI will continue to diverge from the true income total as the personal allowance increases, giving rise to a top income share series which is superficially steep (see Figure E1). Adding the adjustment for missing benefit incomes using admin data imposes little extra work as these

tabulations are readily available and user-friendly, though in practice this step makes only a small difference to total income. Both the FRS and expenditure tabulations are made available well ahead of the SPI Public Use Tapes, so these adjustments do not come at the expense of timeliness.

6 Estimates of top income shares

To construct our two alternative top share series, we divide the numerator, $Y(x)$, which is the same in both series, by either the augmented internal control total, $Y_{AI}(100)$, or the external control total, $Y_E(100)$.

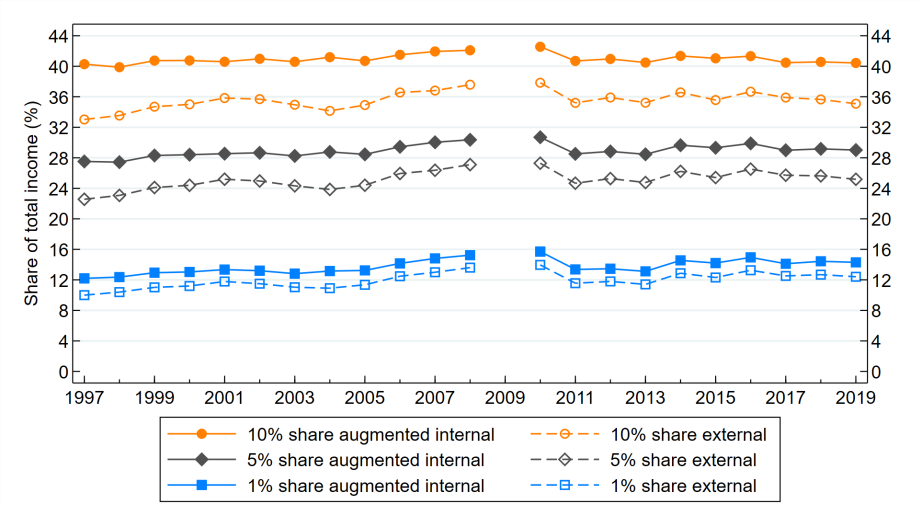
Figure 3 illustrates how the choice of income control total affects top assessable income shares. The predominant difference is in the levels: the assessable income share of the top 1% is 1-2 percentage points higher using the augmented internal control total than the external total. This means that by using an income control total which diverges from the assessable income definition, we under-state the extent of income inequality in the UK.

Using an augmented internal control total, the income share of the top 1% rose in the lead up to the Financial Crisis, from 12.2% in 1996-97 to 15.2% in 2007-08, an increase of 25%. This was followed by a steep decline immediately after the Financial Crisis, though this is likely to reflect income-forestalling and income-delaying responses to the increase in the top rate of Income Tax (Seely, 2014; Browne and Phillips, 2017). Between 2010-11 and 2018-19, the top 1% share rose slightly from 13.4% to 14.3%. Using an external control total implies a slightly steeper rise in inequality in the late 1990s, but since then the two series follow similar trends.

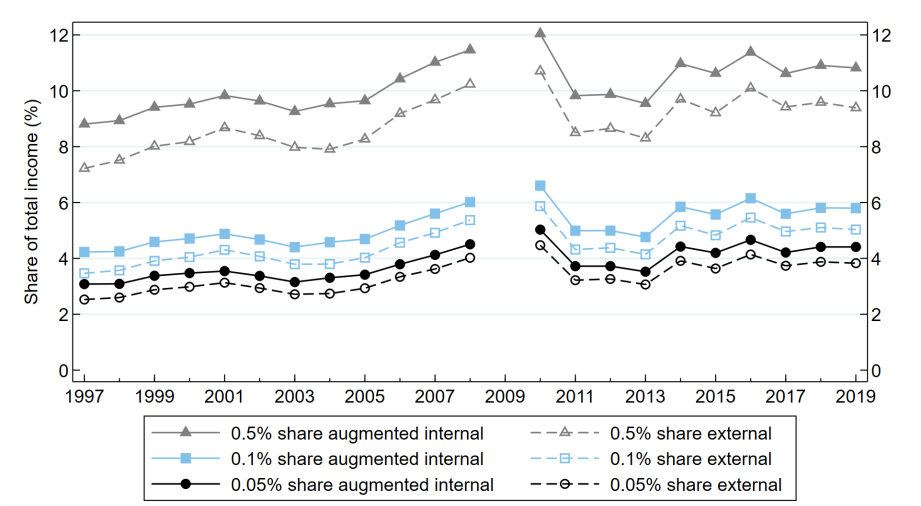
Since 2009-10, our series diverges from the Atkinson top income share series (Figure 4). The top 1% share rose by 1.3 percentage points between 2010-11 and 2014-15 according to the Atkinson series, but by just 0.8 percentage points according to our augmented internal series. Our results therefore affect our understanding of what has been happening to UK inequality in recent years. Atkinson's series implies that in the aftermath of the Financial Crisis, income inequality dropped below levels observed since the beginning of the 21st Century, before rising again from 2013-14 onwards. By contrast, our estimates imply that top shares dropped less sharply, down to levels observed immediately prior to the Financial Crisis in 2005-07.

Figure 3: **Top assessable income shares using our augmented internal and external income control totals**

(a) **Top 10%, 5%, and 1% shares**



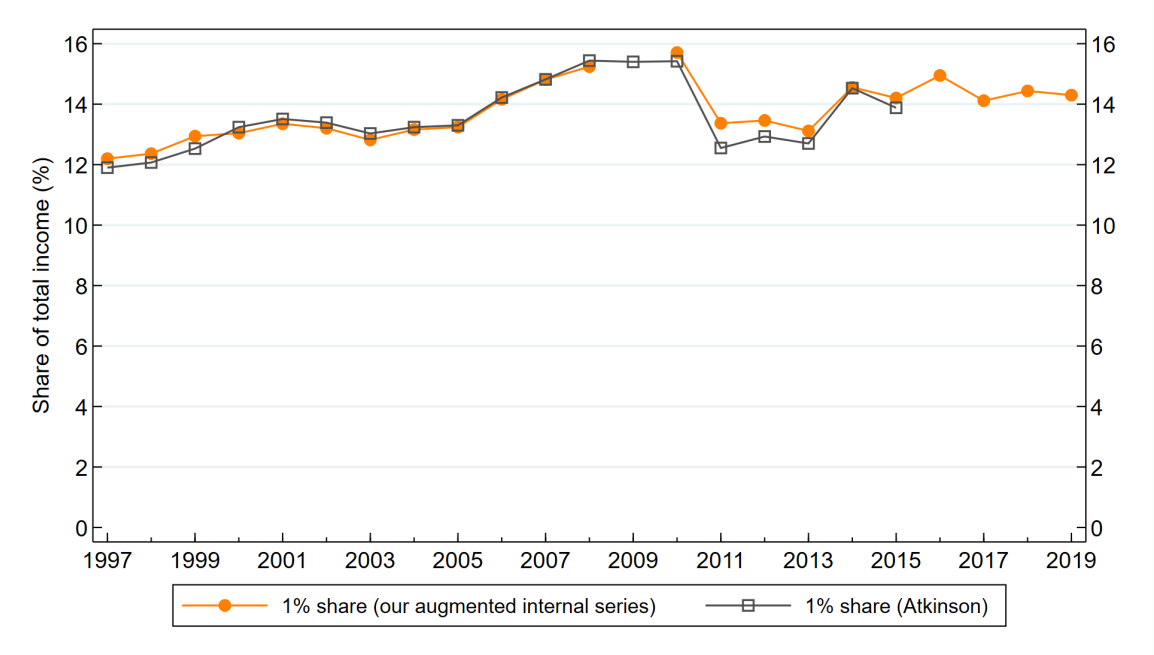
(b) **Top 0.5%, 0.1%, and 0.05% shares**



Notes: We construct augmented internal top shares by dividing aggregate assessable income among the top x% (based on the Survey of Personal Incomes, SPI) by our preferred SPI-based assessable income control total (Section 4.1). We construct external top shares by dividing aggregate assessable income among the top x% (based on the SPI) by our National Accounts (NA) based assessable income control total (Section 4.2). We define all top shares relative to the total number of individuals aged 15 or older in the population living in the UK.

Source: Authors' calculations based on the SPI, Family Resources Survey and Benefit Expenditure and Caseload Tables (augmented internal); and the UK National Accounts (external).

Figure 4: **Top 1% share: our augmented internal series and the Atkinson series**



Notes: We construct our 'augmented internal' by dividing aggregate assessable income among the top x% (based on the Survey of Personal Incomes, SPI) by our preferred augmented internal income control total (Section 4.1). We define all top shares relative to the total number of individuals aged 15 or older in the population living in the UK. 'Atkinson' is the assessable income series developed by Atkinson (2005b) and subsequently extended in Atkinson (2012, 2013, 2014); Atkinson and Ooms (2015); Alvaredo (2017).
Source: Authors' calculations based on the SPI, Family Resources Survey (FRS) and Benefit Expenditure and Caseload Tables (our augmented internal); and WID ('Atkinson').

Top shares have risen in the past two decades, but in relative terms much more so at the very top of the income distribution (Figure A2). While the share of income earned by the top 10% remained stable between 1996-97 and 2018-19, the top 1% (0.1%) share grew by 17% (37%) over the same period.

7 Conclusion

We outline two approaches one could adopt to construct an income control total for measuring top income shares: an augmented internal control total based on tax and survey data; and an external control total based on the National Accounts. We set out our reasons for favouring the augmented internal approach with reference to five desirable properties that a 'good' top share series should possess: (i) comparability between the numerator and denominator (income control total); (ii) comparability over time; (iii) comparability across countries; (iv) statistical performance; and (v)

practical considerations. We argue that while our external income total lacks four of these properties, and cannot be assessed on (iv), the augmented internal income total has favourable attributes when it comes to (i), (ii), and (v). On this basis, we advocate the use of an augmented internal income control total for constructing an assessable income series.

Our top share series for the UK based on this augmented internal control total displays a higher level of inequality and a slightly flatter trend relative to the assessable income series published in the *World Inequality Database* (Alvaredo, 2017). Using an updated external control total, the assessable income share of the top 1% rose from 10.0% to 12.4% between 1996-97 and 2018-19. In contrast, our augmented internal series suggests the top 1% share was around 2 percentage points higher over this period, rising from 12.2% to 14.3% over the same period. This increase in income shares is even more pronounced, in relative terms, further up the income distribution.

Prior to this work, the WID had not updated the UK's assessable income series for years after 2015, as a growing gap between alternative estimates of the income control total made it unclear which methodological approach should be adopted (Atkinson, 2005b; Alvaredo, 2017). We resolve this issue by making a principles-based selection from among the alternatives, and set out a method for constructing the UK's assessable income control total that can be easily replicated in future years. Our augmented internal control total shows that inequality declined less in the aftermath of the Financial Crisis than previous results suggested (Atkinson, 2012, 2013, 2014; Atkinson and Ooms, 2015).

Though we focus on the UK, there are broader lessons to be learned from our findings. Regardless of the income definition one chooses to target, constructing accurate top share estimates almost always requires combining multiple data sources as, in most countries, no single data source covers incomes received by the whole population. We show that using macroeconomic aggregates from the National Accounts is not a neat and tidy solution to this problem: unless one is targeting National Income as defined in the National Accounts (as in the headline estimates on the *World Inequality Database*), it is challenging to reconcile National Accounts components with one's chosen definition. This can have a significant quantitative effect on the results.

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Appendices

A Additional Tables and Figures

Table A1: Alternative methods for constructing top income shares

Series	Income definition	Method: numerator	Method: income control total (denominator)	Series coverage
Augmented internal (this paper)	Assessable income	Total income of the top x% using tax microdata (the SPI)	Sum of: - Total income of individuals above the tax threshold from tax data (the SPI) - Total income of individuals below the tax threshold from household survey data (the FRS) - Adjustment for the under-reporting of benefit income	1997-2019
External (this paper)	Assessable income	Total income of the top x% using tax microdata (the SPI)	Retain components of National Income that are assessable for Income Tax	1997-2019
Atkinson series	Assessable income	Pareto interpolation of income distribution tabulations based on tax data (the SPI)	Until 2009: total income among the taxpaying population (in the SPI) plus an adjustment for unobserved pension income using aggregates from the National Accounts. 2010-2014: retain components of National Income that are assessable for Income Tax (though in practice there was some departure from this definition)	1908-2014 (tax unit is married couple until 1990, individual since)
WID DINA	National Income	Use tax data to correct for under-coverage in household surveys, then allocate components of National Income in proportion to the distribution of income components in the adjusted survey data, before calculating the share held by the top x%	Aggregate National Income	1980-2018

Notes: For further details on the construction of our 'augmented internal' and 'external' series, see Sections 3-4. For further details on the construction of the 'Atkinson series', see Atkinson (2005b, 2007, 2012, 2013, 2014); Atkinson and Ooms (2015); Alvaredo (2017). For further details on the construction of the UK 'WID DINA' series, see Blanchet et al. (2020); Morgan and Neef (2020).

Table A2: **Population control totals**

Tax year	UK 15+ population mid-year estimate
1996-97	46,882,387
1997-98	47,019,534
1998-99	47,183,869
1999-00	47,399,683
2000-01	47,682,430
2001-02	48,006,375
2002-03	48,329,512
2003-04	48,660,278
2004-05	49,011,959
2005-06	49,506,853
2006-07	49,957,988
2007-08	50,434,191
2008-09	50,886,632
2009-10	51,278,250
2010-11	51,706,249
2011-12	52,168,942
2012-13	52,491,310
2013-14	52,798,440
2014-15	53,189,228
2015-16	53,579,245
2016-17	53,971,222
2017-18	54,232,656
2018-19	54,524,104

Notes: UK 15+ population taken from the ONS UK 15+ population mid-year estimate.
Source: Office for National Statistics.

Table A3: **Income control totals (£ millions)**

Tax year	External, pre-tax	Augmented internal, pre-tax	Augmented internal, post-tax	Atkinson series (pre-tax)
1996-97	567,502	465,318	366,498	476,479
1997-98	598,232	503,186	399,103	514,729
1998-99	629,244	535,923	422,460	552,598
1999-00	667,036	572,906	453,927	568,467
2000-01	713,059	629,443	495,777	626,305
2001-02	744,728	648,690	513,057	644,550
2002-03	766,319	659,903	522,384	658,785
2003-04	798,861	662,389	518,985	665,214
2004-05	846,390	725,986	567,560	729,666
2005-06	898,485	791,608	615,523	798,792
2006-07	960,760	843,380	654,217	852,000
2007-08	1,014,536	905,771	701,261	906,262
2008-09	1,034,036			
2009-10	1,032,952	918,473	721,595	953,933
2010-11	1,047,147	905,749	710,685	983,554
2011-12	1,074,383	941,829	741,248	1,002,550
2012-13	1,111,714	967,135	765,447	1,018,712
2013-14	1,159,172	1,025,162	812,748	1,038,730
2014-15	1,201,697	1,041,585	828,749	1,091,202
2015-16	1,257,811	1,116,097	886,900	
2016-17	1,286,061	1,140,885	913,441	
2017-18	1,338,271	1,175,959	942,107	
2018-19	1,401,063	1,215,998	971,961	

Notes: 'External, pre-tax' is constructed by summing income components in the 'Households' sector of the National Accounts (NA) 2021 Blue Book (as outlined in Section 4.2). 'Augmented internal, pre-tax' is constructed by summing individual incomes above the standard personal allowance (based on the Survey of Personal Incomes, SPI); individual incomes below the standard personal allowance (based on the Family Resources Survey, FRS); and an adjustment for under-reported benefit income based on administrative Benefit Expenditure and Caseload Tables (as outline in Section 4.1). 'Augmented internal post-tax' is constructed as 'Augmented internal, pre-tax' after deducting Income Tax and National Insurance Contributions (see Appendix C for details). 'Atkinson total' is the income total developed by Atkinson (2005b) and subsequently extended in Atkinson (2012, 2013, 2014); Atkinson and Ooms (2015); Alvaredo (2017).

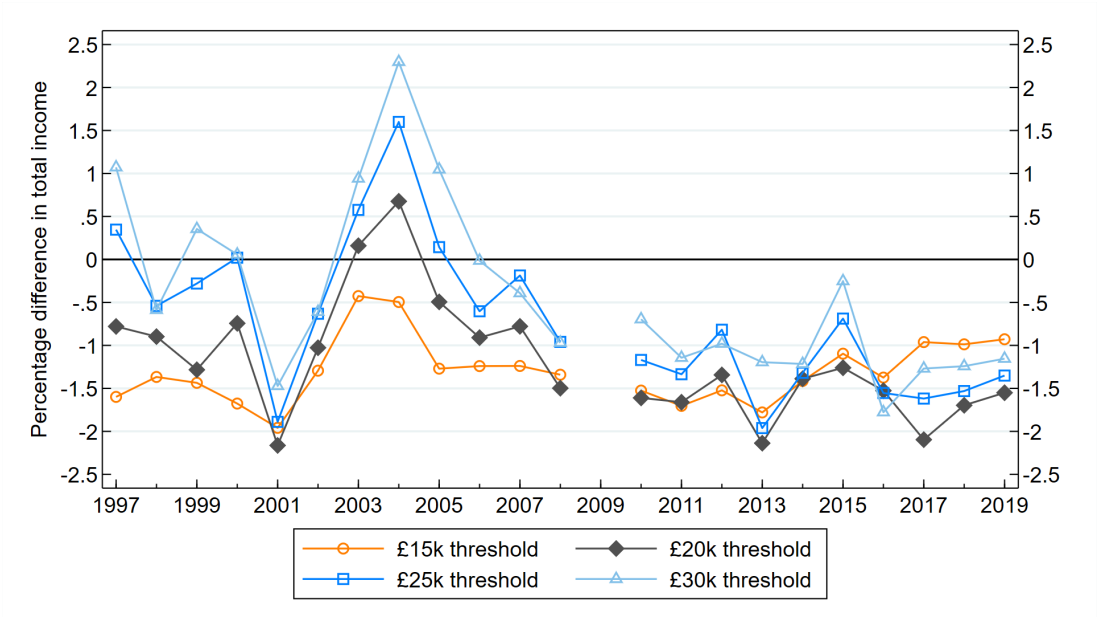
Source: Authors' calculations based on the SPI, FRS, and Benefit Expenditure and Caseload Tables (SPI total); the UK National Accounts (NA total); and WID (Atkinson series).

Table A4: **Top assessable income shares (pre-tax) (%), augmented internal series**

	Top 10%	Top 5%	Top 1%	Top 0.5%	Top 0.1%	Top 0.05%
1996-97	40.3	27.5	12.2	8.8	4.2	3.1
1997-98	39.9	27.4	12.4	8.9	4.2	3.1
1998-99	40.7	28.3	12.9	9.4	4.6	3.4
1999-00	40.8	28.4	13.0	9.5	4.7	3.5
2000-01	40.6	28.5	13.4	9.8	4.9	3.5
2001-02	41.0	28.7	13.2	9.6	4.7	3.4
2002-03	40.6	28.2	12.8	9.3	4.4	3.2
2003-04	41.2	28.8	13.2	9.5	4.6	3.3
2004-05	40.7	28.5	13.2	9.6	4.7	3.4
2005-06	41.5	29.4	14.2	10.4	5.2	3.8
2006-07	41.9	30.0	14.8	11.0	5.6	4.1
2007-08	42.1	30.4	15.2	11.5	6.0	4.5
2008-09						
2009-10	42.6	30.7	15.7	12.0	6.6	5.0
2010-11	40.7	28.5	13.4	9.8	5.0	3.7
2011-12	41.0	28.8	13.5	9.9	5.0	3.7
2012-13	40.5	28.5	13.1	9.5	4.8	3.5
2013-14	41.4	29.7	14.6	11.0	5.8	4.4
2014-15	41.0	29.3	14.2	10.6	5.6	4.2
2015-16	41.3	29.9	14.9	11.4	6.2	4.7
2016-17	40.5	29.0	14.1	10.6	5.6	4.2
2017-18	40.6	29.2	14.4	10.9	5.8	4.4
2018-19	40.4	29.0	14.3	10.8	5.8	4.4

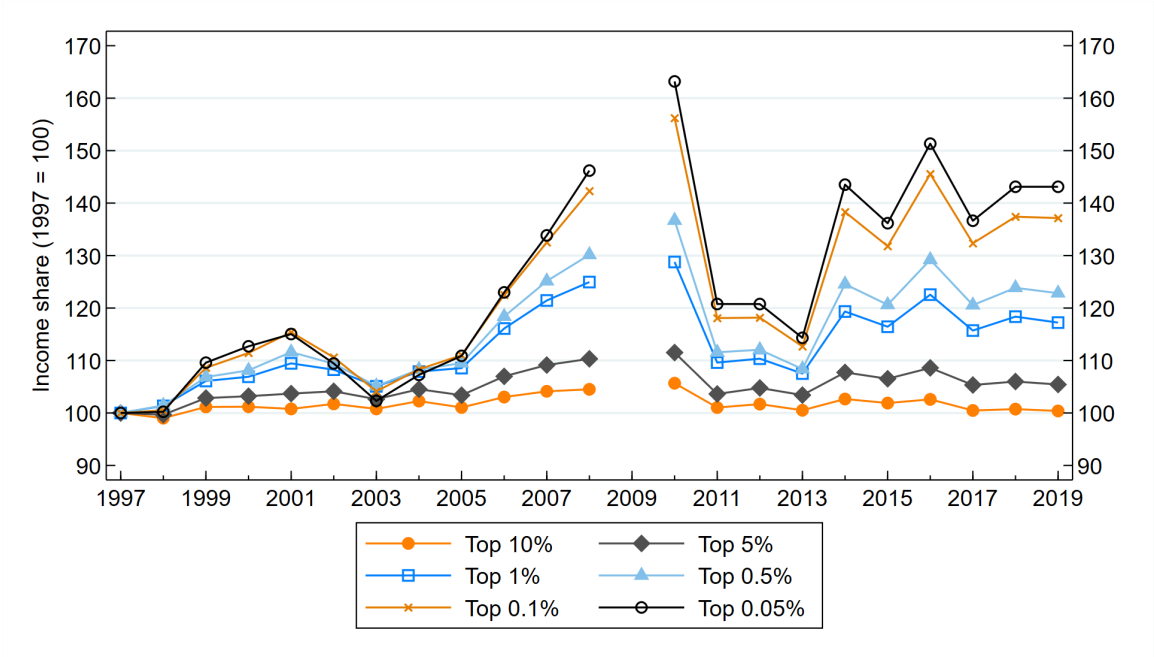
Notes: Constructed by dividing aggregate assessable income among the top $x\%$ (based on the Survey of Personal Incomes, SPI) by our preferred SPI/FRS assessable income total (Section 4.1). We define top shares relative to the total number of individuals aged 15 or older in the population living in the UK. SPI not released in 2008-09.
Source: UK series: authors' calculations based on the SPI, FRS and Benefit Expenditure and Caseload Tables.

Figure A1: **Difference in augmented internal control total from using different nominal thresholds for joining SPI and FRS data, as percentage of augmented internal control total from using personal allowance (%)**



Notes: Each income control total is constructed by summing individual incomes above £Y in the Survey of Personal Incomes (SPI); individual incomes below £Y in the Family Resources Survey (FRS); and an adjustment for under-reported benefit income based on administrative Benefit Expenditure and Caseload Tables (as outlined in Section 4.1).
Source: Authors' calculations based on the SPI, FRS, and Benefit Expenditure and Caseload Tables (SPI total).

Figure A2: **Growth in top shares relative to 1997, augmented internal series**



Notes: We define top shares using the augmented internal control total by dividing aggregate assessable income among the top $x\%$ (based on the Survey of Personal Incomes, SPI) by our preferred SPI/FRS assessable income total (Section 4.1). We normalise the series such that the top share in 1996-97 is equal to 100. We define all top shares relative to the total number of individuals aged 15 or older in the population living in the UK.
Source: Authors' calculations based on the SPI, FRS and Benefit Expenditure and Caseload Tables.

B Additional Details: Data

In this section we provide additional information on the sampling designs used to construct the SPI and FRS, and our methods for harmonising and combining the data sources.

B.1 Survey of Personal Incomes

The sampling frame used to construct the SPI has changed over time, due to operational changes in how tax records are maintained by HMRC. HMRC holds individual tax records in three separate computer systems: the National Insurance and Pay-As-You-Earn system (NPS),[1] which covers all employees and occupational pension recipients; the Computerised Environment for Self-Assessment (CESA), which contains tax returns that are filed by individuals who have income on which tax is not automatically withheld (such as self-employment, rental, and untaxed investment income), as well as individuals with earnings above a given threshold; and the Claims system, which covers a small number of individuals without NPS or CESA records who have had too much tax deducted at source. The SPI samples tax records from each of these databases, using a slightly different sampling strategy for each. The PAYE population from NPS is stratified by gender and pay plus occupational pension income. The sampling probabilities vary across the income distribution and over time, with high income individuals being over-sampled. In 2018-19, PAYE cases accounted for 52% of the sample. Self-assessment tax returns (CESA) are stratified by main income source and range of income and tax due. Again, those with high income or tax due are sampled at a higher rate, and SA cases accounted for 44% of the sample in 2019. Less than 5% of the sample is derived from Claims cases, which were sampled with varying probabilities over our sample period.

The key SPI variable used to compute the total income of those earning above the personal allowance is *total income* (TI). We make two harmonisation adjustments to this variable: First, we deduct PSAV_XS 'Amount saved towards your pension in excess of the Annual Allowance' from TI in 2011-12, as this component is not included in TI in other years.

Second, we adjust TI to account for the way in which dividends are recorded in the SPI. Specifically, an adjustment is applied to the dividends component of total income to account for the notional tax credit which was available on dividends from shares in UK (and some foreign) companies until 2016-17. Until 1999, a 20% tax credit represented the tax already paid on profits made by UK companies under Advanced Corporation Tax (ACT). In 1999, ACT was abolished, but the (now notional) tax credit remained in place at a 10% rate, before being abolished altogether in 2016-17.

[1] NPS replaced the Computerisation of Pay-As-You-Earn (COP) database which was operational until 2007, and which was used to construct the SPI sampling frame pre-2007.

Until 2016-17, dividends in the SPI have been grossed up by the dividend tax credit amount, though this tax credit amount does not represent any dividends actually received by individuals. To avoid creating an arbitrary discontinuity in 2016-17, we retrospectively remove the notional dividend credit as far back as 1999-00 by reducing the SPI dividend variable by 10%.

B.2 Family Resources Survey

The Family Resources Survey samples UK private dwellings, excluding individuals living in institutional settings (e.g. prisons, care homes, and student accommodation). The survey uses a stratified clustered probability sample design. The primary sample unit is postcode sectors, which are selected with probability proportional to size. Each postcode sector is then stratified by region, the socio-economic classification of resident households, the proportion of economically active adults within the region, and the proportion of economically active men who are unemployed. Households are randomly sampled within each stratification group. Further details on the sampling strategy and grossing methodology can be found in Department for Work and Pensions (2018).

Respondents in the FRS provide information on income they receive at a granular level, and are free to choose the period over which they report each income flow. The ONS then convert these values to a weekly value prior to the release of the Public Use Files. We then annualise these by multiplying weekly values by a scaling factor of 365/7 (366/7 in leap years). For individuals who originally reported income on an annual basis, our annualised measure reflects the income they actually receive over the period of a year. However, for individuals who report their income on a weekly or monthly basis, there may be some discrepancy between our annualised measure and actual annual earnings, especially if their earnings are volatile.

B.3 National Accounts

The National Accounts provide estimates of aggregate income that cover all UK resident households. This includes private households as well as those living in institutional settings such as care homes, student accommodation, and prisons. The National Accounts capture a broader set of income components than just those assessable for Income Tax in the UK. In Table B1 we illustrate which components of income in the Households sector account are included in our external income control total, and in each of the formulae used to construct the income control total for the Atkinson series.

Table B1: **Income components included in our external income control total and Atkinson's NA-based formulae**

Income component	Atkinson 1 (ESA95)	Atkinson 2 (ESA10)	Our NA-based total
Wages and salaries (excluding employers' contributions)	✓	✓	✓
Gross operating surplus (imputed rent of owner-occupiers)	✓	✓	
Gross mixed income (self-employment income)	✓	✓	✓
Social security pension benefits in cash	✓	✓	✓
Widows' and guardians' allowances	✓	✓	✓
Unemployment benefit	✓	✓	✓
Jobseeker's allowance (contributory)	✓	✓	✓
Incapacity benefit (includes Employment Support Allowance)	✓	✓	✓
Maternity benefit	✓	✓	
Statutory sick/maternity pay	✓	✓	✓
Other social insurance pension benefits (including occupational pensions)	✓	✓	✓
Other social insurance non-pension benefits not provided by General Government (including employer-provided non-pension insurance)	✓	✓	
War pensions and allowances	✓	✓	
Income support	✓	✓	
Income tax credits and reliefs	✓	✓	
Child benefit	✓	✓	
Non-contributory Jobseeker's Allowance	✓	✓	
Care allowances	✓	✓	✓
Disability benefits	✓	✓	
Universal credit	✓	✓	
Personal Independence Payments	✓	✓	
Other benefits	✓	✓	
Interest received before FISIM (actual interest paid by banks)	✓	✓	✓
FISIM allocation received (National Accounts concept: implicit 'service charge' paid by households to financial intermediaries)	✓	✓	
Distributed income of corporations (dividends, withdrawals from the income of quasi-corporations, earnings on property investment)	✓	✓	✓
Income attributable to insurance policy holders			
Income payable on pension entitlements		✓	
Investment income attributable to collective investment fund shareholders (dividends, retained earnings)			
Rent (on natural resources)	✓	✓	✓
Deductions			
Housing benefits (component of "social benefits other than transfers in kind")	✓	✓	
Imputed rent (of Household, NPISH, and General Government sectors)	✓	✓	
Interest (inc. FISIM) paid by households	✓	✓	
Rent paid by households (on natural resources)	✓	✓	
Fixed capital consumption	✓	✓	
Final 10% deduction		✓	

Notes: 'NPISH' refers to Non-Profit Institutions Serving Households; 'FISIM' refers to Financial Intermediation Services Indirectly Measured'. The formula for 'Atkinson 1 (ESA95)' was used to produce the income control total for the Atkinson series between 2009-10 and 2012-13 (Atkinson (2012); see also Box E1). The formula for 'Atkinson 2 (ESA10)' was used to produce the income control total for the Atkinson series between 2013-14 and 2014-15 (Atkinson and Ooms (2015); see also Box E2). Social fund benefits are added rather than subtracted in both Atkinson formulae as Atkinson and Ooms (2015) suggest. The formula for 'Our NA-based total' is our own derived measure of assessable income using the Blue Book (see also Box 1). The 'Final 10% deduction' reduces the income total by 10% to account for an upward revision in total income (Atkinson and Ooms (2015); see also Appendix E).
Source: Atkinson (2012); Atkinson and Ooms (2015); Office for National Statistics (2021).

B.4 Benefit Expenditure and Caseload Tables

The UK government's Benefit Expenditure and Caseload Tables contain administrative information on aggregate government spending on state benefits (welfare payments). These statistics are released with each budget (we use Spring 2020).

We use these statistics to adjust for under-reported benefit income in the FRS (see Section 4.1). We only adjust benefit types which can be directly compared across data sources. Statutory Sick Pay (SSP) and Statutory Maternity Pay (SMP), which are observable in the FRS, are not disaggregated from other income components in the SPI, meaning we cannot compare our total with the expenditure tables. Since entitlement to these benefits is concentrated among individuals with incomes above the tax threshold, under-coverage is not a major source of concern. Corlett et al. (2018) do not list SMP/SSP among the benefit types suffering from significant under-reporting across the FRS as a whole. Meanwhile, Bereavement allowance/Widowed parent's allowance/Widow's pension cannot be directly compared with 'Bereavement related benefits' in the expenditure tables, which includes a combination of taxable and non-taxable benefits. Our final benefits adjustment is therefore only applied to Carer's Allowance, Employment Support Allowance (of which contributory), Incapacity Benefit, Jobseeker's Allowance, and State Pension (excluding State Pension sent overseas).

C Post-tax shares

To construct a measure of post-tax income, we deduct Income Tax liabilities and National Insurance Contributions (NICs) from assessable income (pre-tax). In doing so we depart from the methodology used by Atkinson (2005b, 2007), who did not deduct NICs when constructing post-tax income. We argue that the post-NICs measure of income is the relevant one, as NICs are functionally equivalent to a tax on earned income, and deducting them gives a more realistic measure of individual post-tax income. However, a lack of data on NICs has limited the extent to which NICs can be treated as equivalent to taxes on income in statistics on post-tax incomes. Neither the SPI microdata, nor the SPI-derived tabulations that were used by Atkinson, include information on the NICs paid by individuals. To construct a measure of post-tax, post-NICs income, we first model the NICs paid by individuals in our tax and survey data by applying the NICs schedule to the relevant income sources.[2] Information on tax paid is taken directly from the SPI. As we only include individuals from the FRS who are below the personal allowance, there is no tax liability to be estimated for these individuals.

Our post-tax income control total is constructed by adding the post-tax (and post-NICs) income accruing to individuals with assessable (pre-tax) income in excess of the standard personal allowance from the SPI, to the post-NICs income of individuals with assessable income below the standard personal allowance from the FRS.[3] We adjust this sum to account for under-reported benefit income, using the same approach as discussed in Section 4.1. That is, we add the difference between total government expenditure on taxable benefits (including the state pension), and gross benefit income reported in our SPI and FRS subsamples, for comparable benefit types (see Section B.4). We do not attempt to deduct tax paid on these benefit receipts in our adjustment. However, as these benefit payments are concentrated at the bottom of the income distribution, we expect the amount of tax due on this income to be insignificant relative to our income control total.

Our post-tax series shows the share of income going to the top after Income Tax and NICs are deducted from individual income. Top shares are, unsurprisingly, lower post-tax than prior to

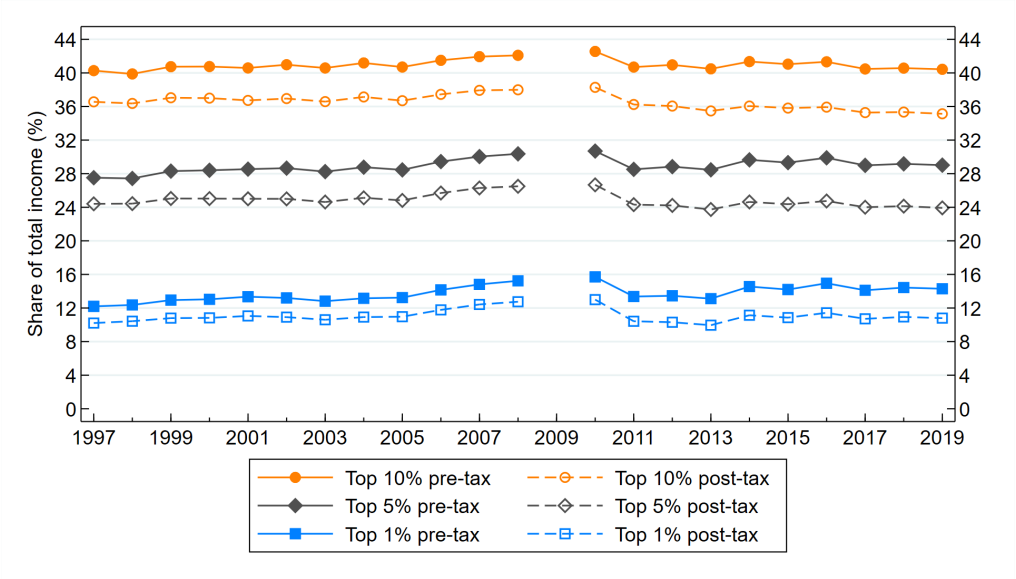
[2] NICs are paid on employment and self-employment income. We only include NICs paid by the employee (and not by the employer) in our deduction. Thus, we only consider the deductions for which statutory incidence is on the individual.

[3] As we are using the standard personal allowance as the joining threshold for the two datasets, we expect that the majority of the taxpaying population will be captured in the SPI sample. Individuals with incomes below the standard personal allowance, but who nevertheless pay tax (e.g. because the standard personal allowance does not apply to them) should be represented in the FRS sample of individuals with earnings below the personal allowance. We do not attempt to calculate the tax liability of these individuals when constructing our post-tax series. We do, however, deduct NICs, estimating these in the same way as for individuals in the SPI. The threshold for NICs has been lower than the Income Tax threshold in recent years and this gap is growing, meaning that a growing proportion of our FRS sample are required to make NICs.

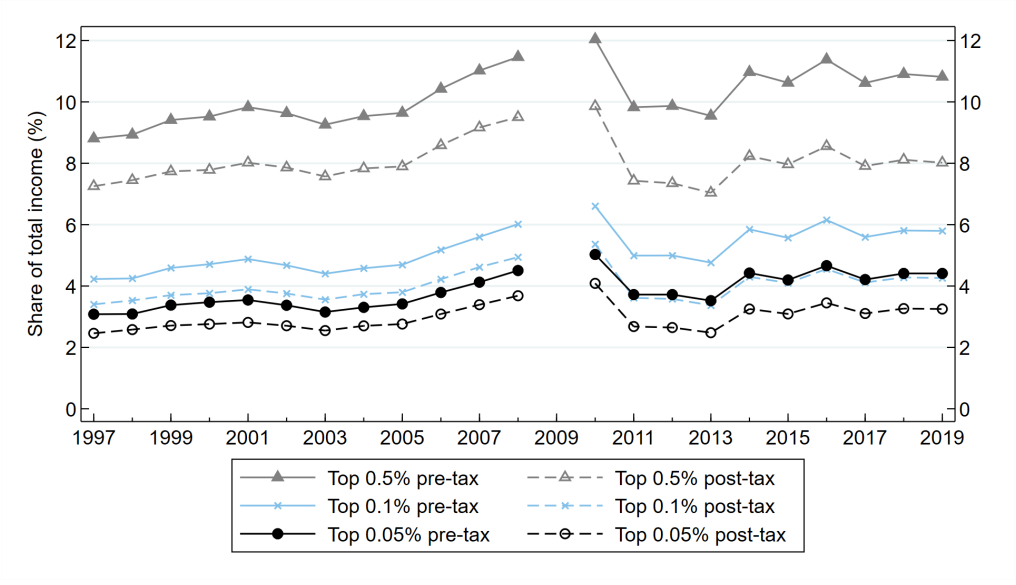
redistribution. Figure C1 shows that the top 1% (0.1%) share fell from 14.3% to 10.8% (5.8% to 4.3%) following the deduction of individual income taxes in 2018-19.

Figure C1: **Top pre- and post-tax income shares**

(a) **Top 10%, 5%, and 1% shares**

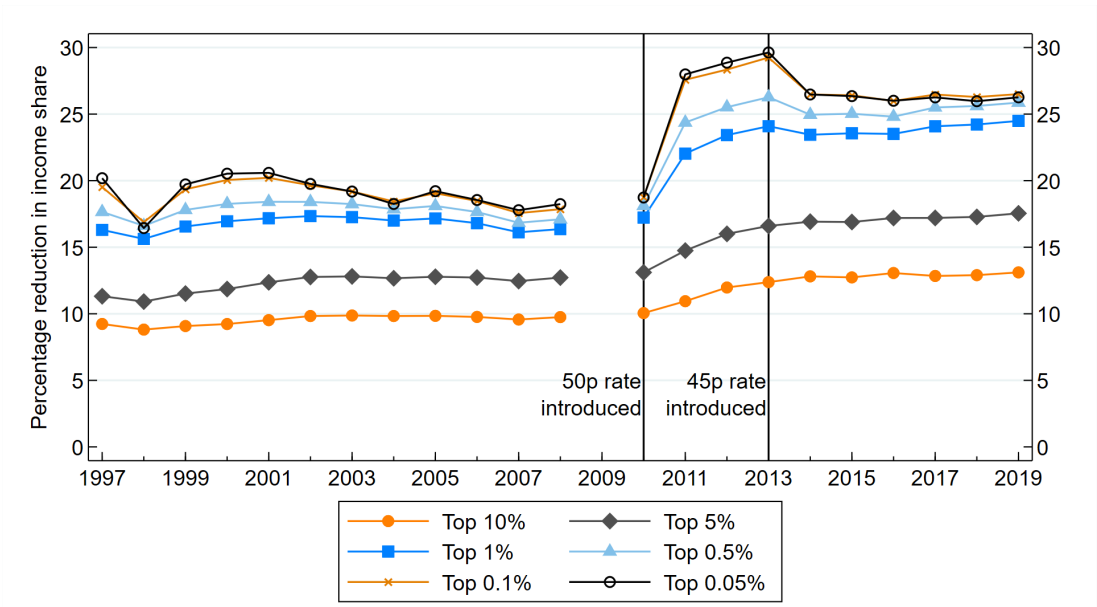


(b) **Top 0.5%, 0.1%, and 0.05% shares**



Notes: We construct pre-tax shares by dividing the aggregate (pre-tax) assessable income of the top x% (based on the Survey of Personal Incomes, SPI) by our preferred augmented internal income control total. We construct post-tax shares by deducting individual Income Tax liabilities and National Insurance Contributions from pre-tax assessable individual income. We re-rank individuals on post-tax income to construct the post-tax numerator. For Income Tax liabilities, we deduct the actual tax liability as recorded in the SPI. For National Insurance Contributions, we calculate individual estimates by applying the relevant NICs schedule in a given year to the relevant income-source variables in the SPI and FRS. We provide the data underlying these figures in Table C1.
Source: Authors' calculations based on the SPI, FRS, and Benefit Expenditure and Caseload Tables.

Figure C2: **Percentage reduction in top shares following the deduction of Income Tax and National Insurance Contributions (%)**



Notes: Constructed by calculating the percentage difference between the post-tax share of the top x% and the pre-tax share of the top x%. We base top shares on our SPI-based numerator and augmented internal control total. We define all top shares relative to the total number of individuals aged 15 or older in the population living in the UK.
Source: Authors' calculations based on the SPI, FRS, and Benefit Expenditure and Caseload Tables.

Since the 1990s, the extent of redistribution appears to have increased. Figure C2 shows the percentage reduction in top shares following the deduction of income taxes. This illustration highlights the role of tax rates in affecting redistribution: the income share of the top 1% was reduced by 17% as a result of progressive individual income taxation in 2009-10. This rose to 22% in 2010-11, coinciding with the increase in the top marginal tax rate from 40% to 50%. The reduction in top shares following the deduction of individual income taxes fell again slightly in 2013-14 when the 45% top marginal rate was introduced, from 24% to 23% for the top 1%.

Table C1: **Top shares post-tax (%), augmented internal series**

	Top 10%	Top 5%	Top 1%	Top 0.5%	Top 0.1%	Top 0.05%
1996-97	36.6	24.4	10.2	7.3	3.4	2.5
1997-98	36.4	24.4	10.4	7.4	3.5	2.6
1998-99	37.0	25.0	10.8	7.7	3.7	2.7
1999-00	37.0	25.0	10.8	7.8	3.8	2.8
2000-01	36.7	25.0	11.1	8.0	3.9	2.8
2001-02	36.9	25.0	10.9	7.9	3.8	2.7
2002-03	36.6	24.6	10.6	7.6	3.6	2.5
2003-04	37.1	25.1	10.9	7.8	3.7	2.7
2004-05	36.7	24.8	11.0	7.9	3.8	2.8
2005-06	37.4	25.7	11.8	8.6	4.2	3.1
2006-07	37.9	26.3	12.4	9.2	4.6	3.4
2007-08	38.0	26.5	12.7	9.5	4.9	3.7
2008-09						
2009-10	38.3	26.7	13.0	9.9	5.4	4.1
2010-11	36.2	24.3	10.4	7.4	3.6	2.7
2011-12	36.1	24.2	10.3	7.4	3.6	2.6
2012-13	35.5	23.7	10.0	7.0	3.4	2.5
2013-14	36.1	24.6	11.1	8.2	4.3	3.3
2014-15	35.8	24.4	10.9	8.0	4.1	3.1
2015-16	35.9	24.7	11.4	8.6	4.6	3.5
2016-17	35.3	24.0	10.7	7.9	4.1	3.1
2017-18	35.3	24.1	10.9	8.1	4.3	3.3
2018-19	35.1	23.9	10.8	8.0	4.3	3.3

Notes: Constructed by dividing aggregate post-tax income among the top x% (based on the Survey of Personal Incomes, SPI) by our preferred SPI/FRS post-tax income total (Section 4.1). We define top shares relative to the total number of individuals aged 15 or older in the population living in the UK. SPI not released in 2008-09.
Source: UK series: authors' calculations based on the SPI, FRS and Benefit Expenditure and Caseload Tables (augmented internal shares).

D Population control

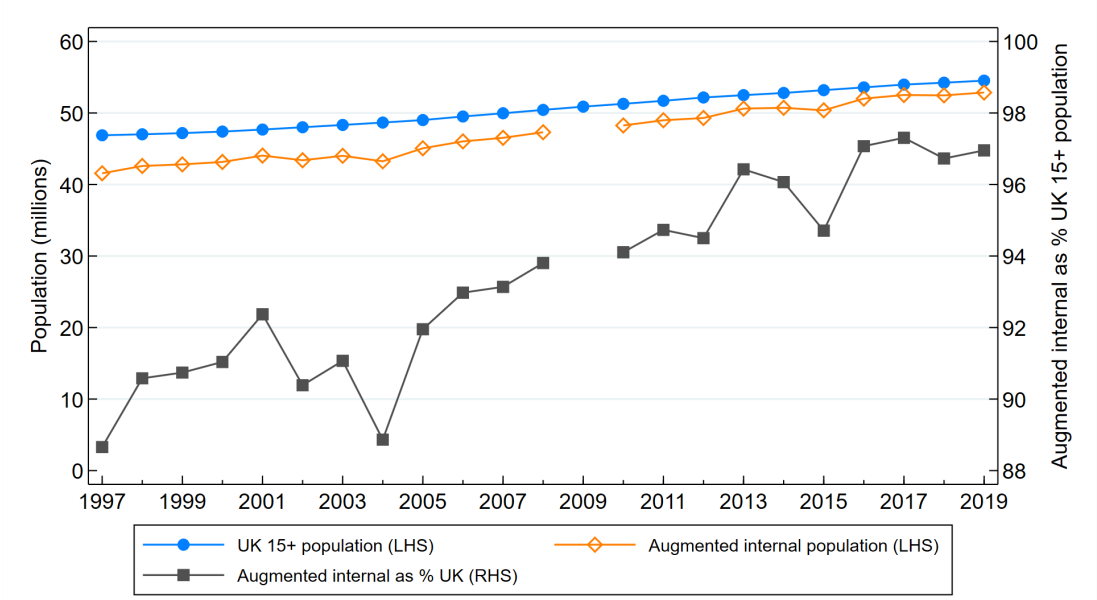
In recent years, population coverage in our combined SPI/FRS sample has improved, and the population total now corresponds to 97% of the ONS mid-year estimate. In the 1990s and early 2000s, population coverage fell far short of the ONS total, at 89-93%. With incomplete population coverage, the choice of which population control to use matters for top share estimates. In this section we illustrate how and why population coverage varies over the time period, discuss the cases under which different population controls may provide more accurate top share estimates, and show how top shares vary when an internal population control is used.

Which population control yields the most accurate estimate of top income shares depends on how population under-coverage is distributed across the income distribution. The ONS population control will provide an accurate estimate of top income shares in the extreme case that all population under-coverage is concentrated among individuals with zero assessable income. In this case, the income control is correct despite the population under-coverage (we only miss people who have no income), and we accurately measure the income of the top x%.

By contrast, the internal population control will provide an accurate estimate of top income shares if under-coverage is uniformly distributed across the income distribution. In other cases, it is often impossible to say which population control provides the most accurate estimate. If we have full coverage of the top x% of the population, and under-coverage is concentrated further down the income distribution, then the numerator will be measured accurately while the income control total will be too low, leading to the over-estimation of top income shares. Using an internal population control does not guarantee greater accuracy in this case: reducing the numerator population will lead to a lower estimate for the numerator, but this could lead to an under-estimation of top shares, depending on the distributions of income and under-coverage. If we have incomplete coverage of the top x% of the population, then both population controls will yield biased estimates and the direction of bias is ambiguous.

Since 2007, population coverage in our combined sample has been at least 95% (Figure D1). Prior to this, population coverage was lower, at only 89% in 1997. There are a number of potential explanations for this under-coverage. One is under-coverage of individuals below the personal allowance stemming from some individuals being outside the scope of the FRS. Those living in institutional settings (care homes, students in halls of residence, prisoners) are estimated to total 1.2m (Corlett et al., 2018), and are not represented in the FRS. The adult population in the FRS also excludes 15-year-olds (of whom there were 714,000 in 2019-20). However, where individuals outside of the

Figure D1: **SPI/FRS combined population and ONS UK 15+ total**

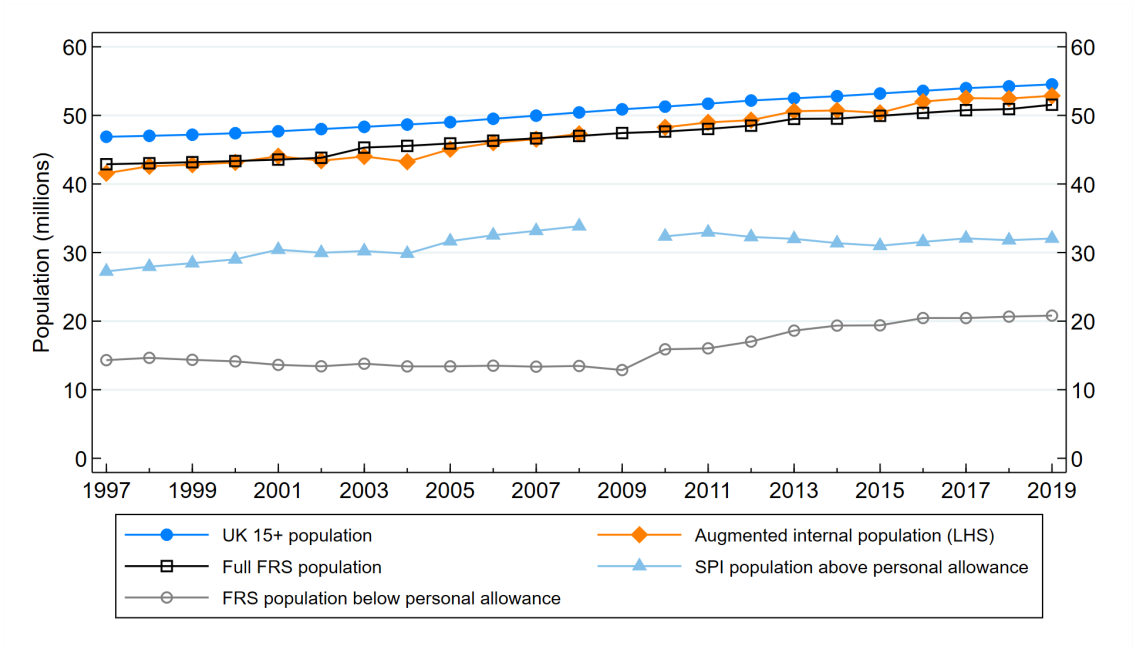


Notes: 'Augmented internal population' sums the total population of individuals with assessable income above the standard personal allowance in the Survey of Personal Incomes (SPI), and the total population of individuals with assessable income below the standard personal allowance in the Family Resources Survey (FRS).
Source: Authors' calculations based on the SPI and FRS. The 'UK 15+ population mid-year estimate' is obtained from the ONS.

scope of the FRS are liable to pay Income Tax (e.g. on pensions for those in care homes), they will be captured by the SPI. This means that under-coverage of these groups should only be an issue at the bottom of the income distribution. This will not affect the accuracy of the ONS population control in capturing the top $x\%$ of the income distribution, and will have only a minor effect on the income control total.

However, it appears that population under-coverage in the earlier years can be at least partly attributed to the coverage of taxpayers within the SPI. Figure D2 shows that the population coverage of the FRS has remained stable over time, with the exception of a small increase in 2003 when Northern Ireland joined the sample population (the number of individuals in Northern Ireland with incomes below the personal allowance was just 494,000 in 2003). The total number of individuals with earnings above the personal allowance in the SPI was flat in the mid 2000s, despite a growing UK population. Moreover, within most £5k income ranges between £10,000 and £65,000, the SPI identifies fewer people than the FRS does between 2002-03 and 2004-05, with population coverage increasing thereafter. Most of this rise can be attributed to a rise in the coverage of taxpayers, rather than a rise in the coverage of individuals included in the SPI who ultimately pay no Income

Figure D2: **Population totals by source**

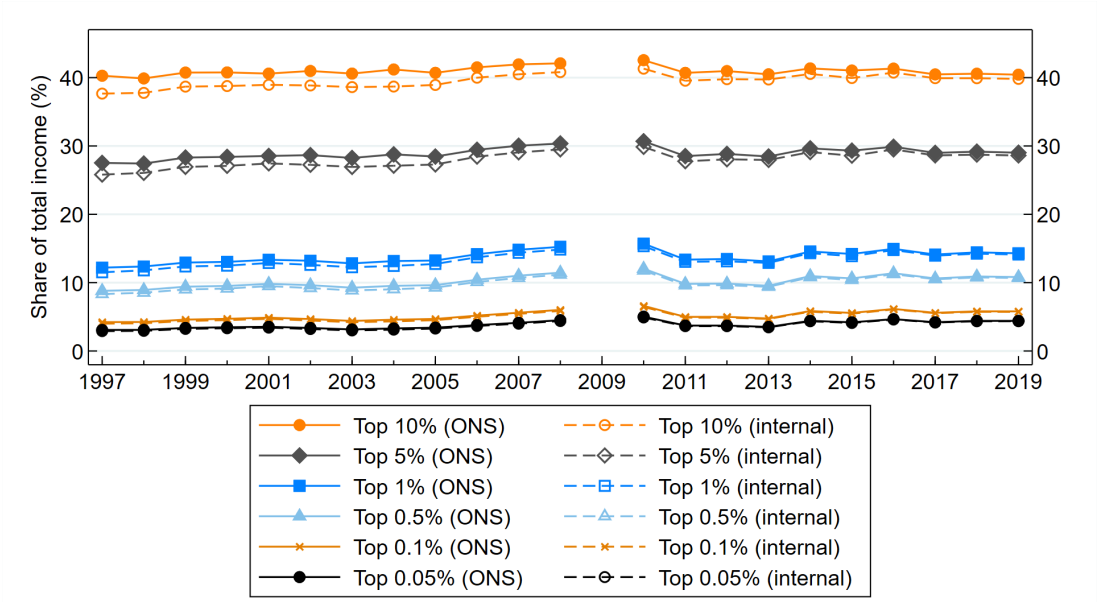


Notes: 'Augmented internal population' sums the total population of individuals with assessable income above the standard personal allowance in the Survey of Personal Incomes (SPI), and the total population of individuals with assessable income below the standard personal allowance in the Family Resources Survey (FRS). 'Full FRS population' is the total (weighted) population of all individuals covered in the FRS. 'FRS population below personal allowance' is the total (weighted) population of all individuals in the FRS with assessable income below the personal allowance. 'SPI population above personal allowance' is the total (weighted) population of all individuals in the SPI with assessable income above the personal allowance. The latter two series sum to obtain the 'Augmented internal population'.
Source: Authors' calculations based on the SPI and FRS. The 'UK 15+ population mid-year estimate' is obtained from the ONS.

Tax. Why the coverage of taxpayers in the SPI increases in the early 2000s remains something of a mystery.

It is not clear what the implications of these findings are for our top share estimates. If the under-coverage issue mainly concerns those on lower or middle incomes, our top shares will be over-estimated. On the other hand, if the rise in population coverage mainly reflects an increase in the coverage of top earners, it is not possible to sign the bias of our estimates. In either of these cases, it is not clear that using an internal population control can provide a more accurate estimate—and this problem is not changed by an alternative choice of income control total, which is an independent issue. However, we present our top share series using an internal population control (taking $x\%$ of the SPI/FRS combined population total) in Figure D3 for comparison. Using the internal population control, top shares rose during the 1990s and 2000s relative to top shares using the ONS population control. As population coverage rose, so too did the number of people included in the top $x\%$,

Figure D3: **Augmented internal top shares using alternative population control totals**



Notes: We construct the top shares labeled 'ONS' using the ONS UK 15+ mid-year population estimate as the population control total. We construct the top shares labeled 'internal' using the augmented internal total as the population control.
Source: Authors' calculations based on the SPI, FRS and Benefit Expenditure and Caseload Tables.

generating a mechanical increase in the aggregate income of the top $x\%$ which offsets the increase in the control total. Since 2008, the choice of population control makes little difference to top income shares as coverage is high.

E Comparison with the Atkinson series

In this appendix we provide additional detail on the differences between our approach to estimating the income control total, and the Atkinson series. We first compare our augmented internal control total with Atkinson's internal control total, used prior to 2009 (Section E.1). We then compare our external control total with Atkinson's external control total, used from 2010 (Section E.2). Finally, in Section E.3, we provide a step-by-step cross-walk between Atkinson's National Accounts-based control total (which was used from 2010 onwards) and our external control total, as presented in Section 4.2.

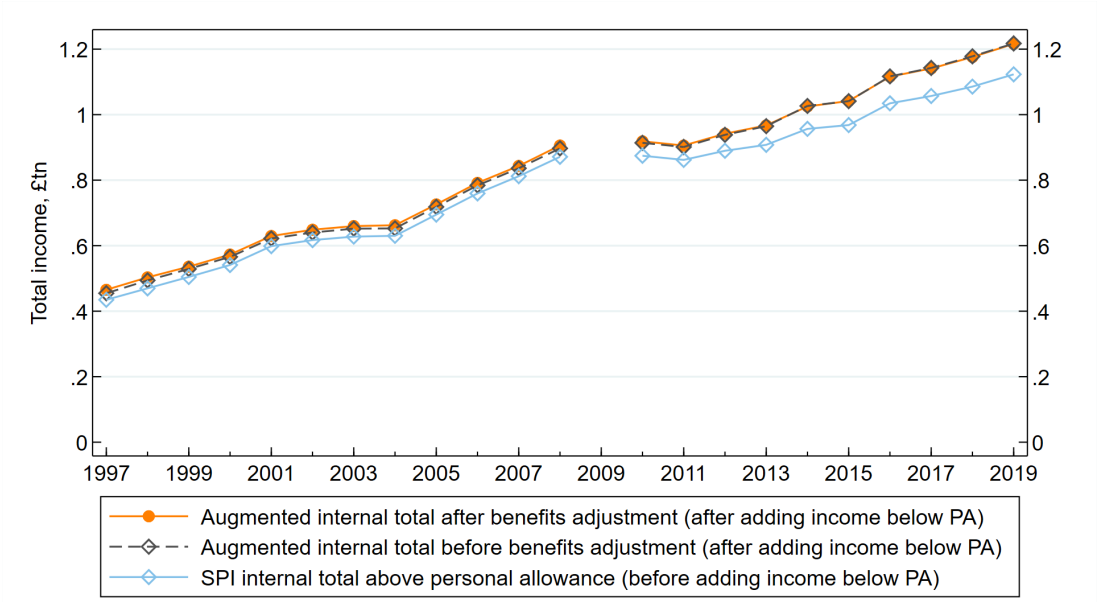
E.1 Comparing SPI-based income control totals

Prior to 2009, the income control total used in the Atkinson series was based on the 'augmented internal' approach. The total income of the taxpaying population was taken from the Personal Income Statistics tabulations, which are derived from the SPI, rather than the underlying microdata (Atkinson, 2012). These tabulations omit non-taxpayers above the standard personal allowance, whose tax liabilities are reduced to zero after deductions and reliefs. Including these individuals in our income control total adds 1 million individuals, and increases total income by 1% (£11 billion) in 2018-19.

The SPI total in the Atkinson series was supplemented with pension income captured in the National Accounts which was over and above the pension income total obtained from the SPI, to account for non-filers (Atkinson, 2007). No explicit adjustment was made to account for (non-pension) income below the personal allowance. As Figure E1 suggests, this omission made little difference to the income total in the earlier years of our sample period because the personal allowance was so low. In recent years, however, omitting incomes below the personal allowance results in a growing amount of missing income from the control total, strengthening the case for our survey-based adjustment.

Supplementing the internal SPI income total with data from the FRS has the disadvantage of making the production of top income share statistics slightly more tedious. However, we argue that Figure E1 provides a compelling reason for making this effort. In 2018-19, excluding the FRS adjustment would lead us to underestimate total income by 7.7%, up from 4% in 1997. Fortunately, total income below the personal allowance can be estimated straightforwardly, using FRS variables which have already been cleaned and expressed in a weeklyised format. FRS data are released ahead of the SPI Public Use Tape, so supplementing the SPI total in this way does not come at the expense of timeliness.

Figure E1: **SPI-based income control totals before and after adjustments**



Notes: 'SPI internal total above personal allowance (before adding incomes below the PA)' is constructed by summing the total income (TI) of all individuals with incomes in excess of the standard personal allowance in the Survey of Personal Incomes (SPI). 'Augmented internal total before benefits adjustment (after adding income below PA)' is constructed by adding the total income of individuals with incomes below the standard personal allowance from the Family Resources Survey (FRS) to the SPI internal total. 'Augmented internal total after benefits adjustment (and after adding income below PA)' is constructed by adding an adjustment for under-reported benefit income equal to the difference between total income in the SPI/FRS combined total and the amount reported in the UK government's Benefit Expenditure and Caseload Tables.
Source: Authors' calculations based on the SPI, FRS, and Benefit Expenditure and Caseload Tables.

E.2 Comparing National Accounts-based income control totals

Atkinson (2012) subsequently adopted a National Accounts-based approach to constructing the income control total, used for years 2009-10 and later. This methodological change was made on the basis that it would offer improved comparability across countries (Atkinson, 2012). At the time, the two methods yielded almost identical income control totals for 2007-08 (the SPI was not released in 2008-09) and so it seemed "a good year in which to make the change" (Atkinson, 2012). Figure E2 illustrates the point at which the two series appear to cross. Originally, the Atkinson total was based on the pre-2014 system of accounts (ESA95) and was constructed as follows:[4]

[4]This formula is expressed as in the WID technical reports. In Table B1 the Atkinson formulae are expressed "constructively" to illustrate the sub-components which are retained in the final income control total using this method.

Box E1: Formula used to produce the Atkinson total for 2010-11 to 2012-13 using the National Accounts

Sum of:
Balance of primary income, gross (Table 6.1.4)
Social benefits, other than transfers in kind (Table 6.1.4)

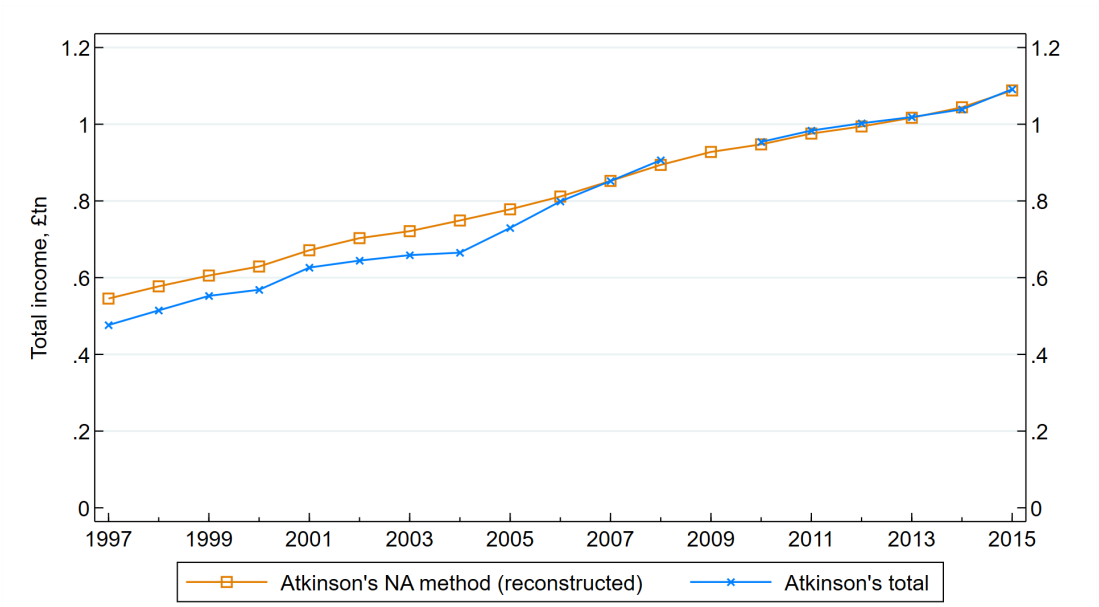
Less:
Social fund benefits[a] (Table 5.2.4S)
Employee benefits from employers' liability insurance (Table 6.1.4S)
Redundancy fund benefits (Table 5.2.4S)
Employers' actual social contributions (Table 6.1.4)
Imputed rent of owner-occupiers (Table 6.4)
Attributed property income of insurance policy holders (Table 6.1.3)
Imputed social contributions (net) (Table 6.1.4)
Housing benefits (Table 5.3.4S)
Fixed capital consumption (Table 6.1.4)

This includes income received by Non-Profit Institutions Serving Households, as well as income received by the Households sector.

[a] This is actually subtracted, rather than added as the recent WID technical notes suggest (Atkinson and Ooms, 2015)

Notes: The table numbers refer to the Blue Book table in which the income component is recorded (Office for National Statistics, 2021).

Figure E2: **Atkinson's total income series, and our reconstruction of Atkinson's NA based-method**



Notes: 'Atkinson's NA method (reconstructed)' is constructed using the most recent version of the Atkinson National Accounts-based formula (Alvaredo, 2017), which differs slightly from the original formula presented in Box E1 (see Section E for details). In this series we use data from the 'Households and NPISH' sector of the 2016 Blue Book. This differs from the actual Atkinson series, which took data for 2010-14 from the earliest Blue Book publications for those years, rather than using the latest edition of the National Accounts to revise previous years' estimates. 'Atkinson's total' is the income control as it was published in the *World Inequality Database* (WID), which is constructed using SPI-based methods up to 2008.
Source: 'Atkinson's NA method (reconstructed)': authors' calculations based on the UK National Accounts. 'Atkinson's total': WID.

In 2014, a new National Accounts framework (ESA10) came into force, leading Atkinson and Ooms (2015) to revise the formula used to compute the income control total. A key change was the addition of "Investment income payable on pension entitlements", which is payable to pension funds rather than directly to households. This was added to the income total on the grounds that this investment income is ultimately received by households (Atkinson and Ooms, 2015). Overall, the revised formula used by Atkinson and Ooms (2015) resulted in an income total which was 10.1% higher in 2009-10, 9.9% higher in 2010-11, and 9.0% higher in 2011-12.[5] Around 70-80% of this increase was accounted for by the inclusion of "investment income payable on pension entitlements". However, ONS publications which accompanied the revised 2014 Blue Book also suggested that there were revisions to the estimated income of the NPISH sector, which at the time was combined with the Households sector in the National Accounts (Office for National Statistics, 2014a,b). Referencing

[5]Estimates for 2009-10 to 2011-12 were not updated in line with the revised formula. The revised formula was only used to construct the estimates for 2013-14 onwards, which were added on as an extension to the existing series.

these revisions, and noting that the upward revision would "call into question the previous choice of 2009 as a link year with the previous method", Atkinson and Ooms (2015) chose to reduce the ESA2010-based totals by 9.6% on a provisional basis. The percentage by which the total has been reduced has subsequently increased as more recent Blue Book figures have implied a larger difference between the revised totals and the earlier totals in the years following Atkinson's change in methodology (Alvaredo, 2017).

Since 2014, the formula used by Atkinson to construct the National Accounts-based income total is as follows:

Box E2: Revised formula used to produce the Atkinson series for 2013-14 onwards

Sum of:
Balance of primary incomes, gross (Table 6.1.4)
Social benefits, other than transfers in kind (Table 6.1.4)
Less:
Social fund benefits[a] (Table 5.2.4S)
Employee benefits from employers' liability insurance (Table 6.1.4S)
Redundancy fund benefits (Table 5.2.4S)
Employers' actual social contributions (Table 6.1.4)
Imputed rent of owner-occupiers (Table 6.4)
Attributed property income of insurance policy holders (Table 6.1.3)
Attributed property income to collective investment fund shareholders (Table 6.1.3)
Imputed social contributions (net) (Table 6.1.4)
Housing benefits (Table 5.3.4S)
Fixed capital consumption (Table 6.1.4)

Final total is reduced by approximately 10%

This includes income received by Non-Profit Institutions Serving Households, as well as income received by the Households sector.

[a] This is actually subtracted, rather than added as the recent WID technical notes suggest (Atkinson and Ooms, 2015)

Notes: The table numbers refer to the Blue Book table in which the income component is recorded (Office for National Statistics, 2021).

Our external approach differs from the Atkinson formula set out in Box E2 in two key ways. First, we exclude the NPISH sector from the outset. The income of this sector is not part of households' assessable income, and thanks to back-dated disaggregated National Accounts which have been produced by the ONS since 2017, there is no longer a need to make ex-post adjustments

to account for the income of the NPISH sector. In particular, there is no longer a justification for maintaining the 10% ex-post reduction to total income. In Subsection E.3.1, we illustrate that this 10% reduction mostly removed income that should have been attributed to the Household sector, not to the NPISH sector.

Second, we address – as far as is possible – remaining definitional differences between the definition of income arrived at in the implementation of Atkinson's formula (Box E2), and assessable income. Key departures from assessable income that are built into Atkinson's formula include:

- the inclusion of non-taxable benefits;
- the inclusion of investment income payable on pension entitlements;
- the deduction of interest paid by households (on mortgages etc.);
- conceptual differences in the measure of interest;
- the deduction of depreciation (fixed capital consumption);
- the inclusion of gross operating surplus less the imputed rent of Households, NPISH and General Government.

Table B1 illustrates the income components which are retained in (i) the original Atkinson formula (based on ESA95); (ii) the most recent Atkinson formula (based on ESA10); and (iii) our formula as outlined in Section 4.2. It is clear that the Atkinson formulae are much more comprehensive in terms of the sources of income included, but that these formulae also involve a number of deductions which have no counterpart in the tax code. The most significant in magnitude are the deductions for interest paid by households (which includes mortgage payments), fixed capital consumption, and imputed rent.

The net effect of these differences is that our NA-based income control total is considerably higher than the Atkinson total (Figure 2). Subsections E.3.3 to E.3.7 illustrate the quantitative impact of addressing these departures from assessable income step-by-step.

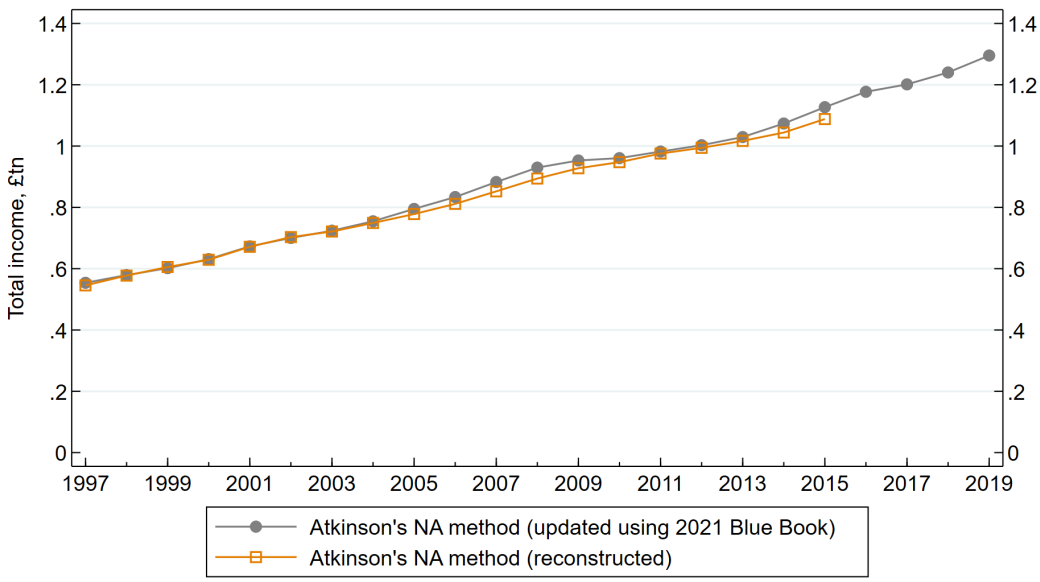
E.3 A precise crosswalk between National Accounts-based income control totals

E.3.1 Step 1: Update the Atkinson NA series using up-to-date Blue Book estimates

First, we update Atkinson's income control total series using the latest version of the Blue Book estimates (2021), maintaining the same formula as in Box E2. The revised income total is higher

in each tax year since 2010-2014, ranging from 0.7% higher in 2010-11, to 3.6% higher in 2014-15 (Figure E3). Revisions to the National Accounts are common, and the ONS note that "expectations of accuracy and reliability in early estimates are often too high" (Office for National Statistics, 2021). The Atkinson methodology does not update previous years' figures based on revisions to the Blue Book, resulting in an over-reliance on early estimates. To the extent that the revised Blue Book estimates are of higher quality than earlier estimates, we ought to update the income control total to reflect these revisions.

Figure E3: **Atkinson's NA income control total, first reconstructed, then updated using the 2021 Blue Book**



Notes: 'Atkinson's NA method (reconstructed)' is constructed using the latest Atkinson formula (Box E2) (Alvaredo, 2017) with data from the 'Households and NPISH' sector of the 2016 Blue Book. Note that the income totals differ from the published Atkinson series for 2010-2014 as we use the 2016 Blue Book to obtain figures for all previous years, rather than using the earliest Blue Book available for a given year. 'Atkinson's NA method (updated using 2021 Blue Book)' is constructed using the most recent Atkinson formula with data from the 'Household and NPISH' sector of the latest release of the Blue Book (2021).
Source: Authors' calculations based on the UK National Accounts.

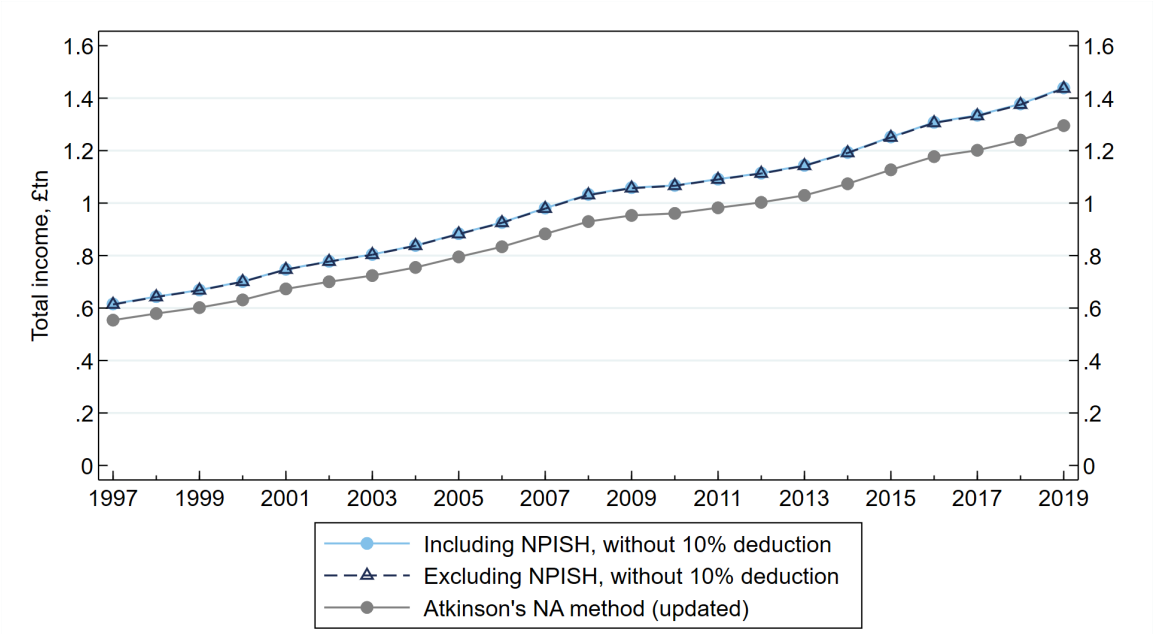
E.3.2 Step 2: Exclude the NPISH sector

Second, using disaggregated National Accounts released since 2017 and back-dated for earlier years, we update the Atkinson series by excluding the NPISH sector. In doing so, we argue there is no longer a justification for maintaining the ex-post 10% deduction first implemented by Atkinson and Ooms (2015). The initial motivation for doing this was to offset the increase in the income total resulting from the adoption of ESA2010, on the basis that this upward revision was partly a reflection of an increase in income attributed to the NPISH sector (Atkinson and Ooms, 2015). If the NPISH

sector can be excluded from the outset, then there is no argument for reducing the income total in this way.

Figure E4 illustrates the income total including the NPISH sector with and without the 10% deduction (otherwise following the formula in Box E2). The two series are scarely distinguishable. Income received by the NPISH sector accounts for less than 1% of Household sector income, suggesting that the majority of income removed by the 10% deduction was actually attributable to households. Excluding the NPISH sector, and reversing the 10% deduction, therefore raises total income relative to the updated Atkinson series by just under 11% on average. A substantial proportion of the increase in total income observed by Atkinson and Ooms (2015) following their modifications to the original formula (prior to the ex-post reduction) can be attributed to inclusion of 'investment income payable on pension entitlements', which increased the total by approximately 7%.

Figure E4: **Total income using Atkinson's NA method, with and without the 10% deduction, compared to excluding the NPISH sector and not deducting by 10%**

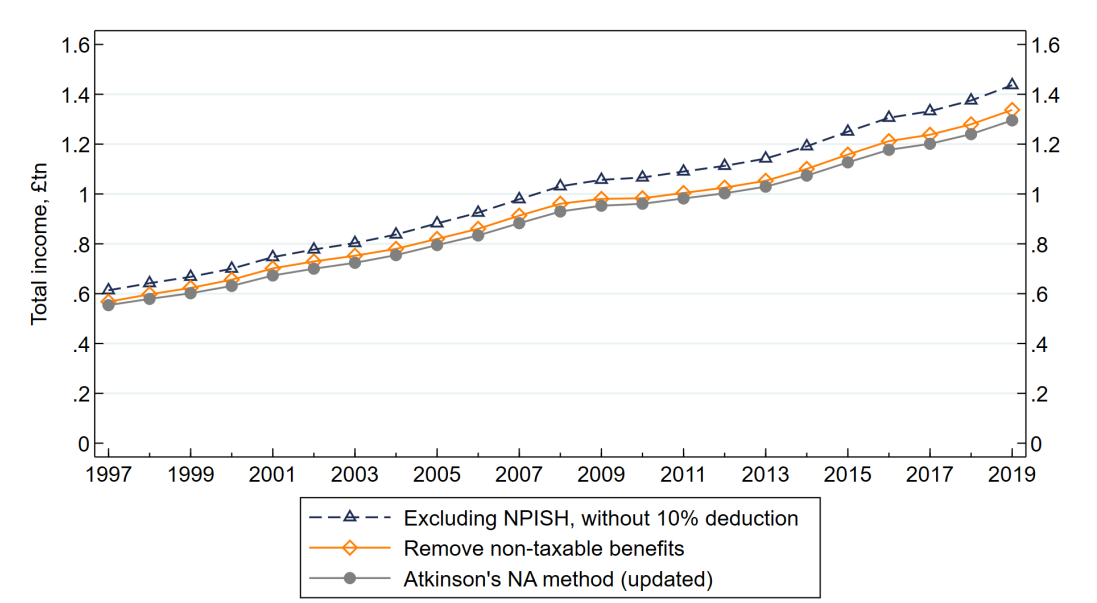


Notes: 'Atkinson's NA method (updated) is constructed using the most recent Atkinson formula (Box E2) (Alvaredo, 2017) with data from the 'Household and NPISH' sector of the latest release of the Blue Book (2021). 'Including NPISH, without 10% deduction starts from 'Atkinson's NA method (updated)' and simply reverses the 10% deduction that is implemented in that series. 'Excluding NPISH, without 10% deduction' is constructed using the Atkinson formula outlined in Box E2, but excluding the NPISH sector from the outset, and ignoring the final 10% deduction.
Source: Authors' calculations based on the UK National Accounts.

E.3.3 Step 3: Remove non-taxable benefits

Third, we remove non-taxable benefits from the income total (Figure E5). This reduces total income by 7% on average relative to the previous step (excluding the NPISH sector and removing the 10% deduction).

Figure E5: **Total income before and after the removal of non-taxable benefits**

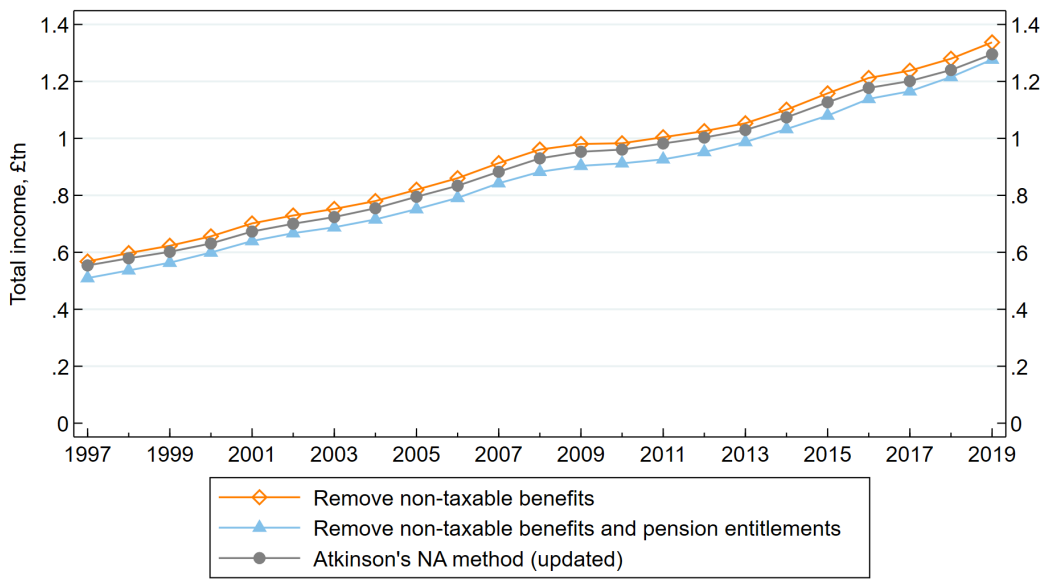


Notes: 'Atkinson's NA method (updated)' is constructed using the most recent Atkinson formula (Box E2) (Alvaredo, 2017) with data from the 'Household and NPISH' sector of the latest release of the Blue Book (2021). 'Excluding NPISH, without 10% deduction' is constructed using the Atkinson formula outlined in Box E2, but excluding the NPISH sector from the outset, and ignoring the final 10% deduction. 'Remove non-taxable benefits' starts from 'Excluding NPISH, without 10% deduction' and removes non-taxable benefits (see Table B1 for full list of benefits excluded).
Source: Authors' calculations based on the UK National Accounts.

E.3.4 Step 4: Deduct pension fund income

Fourth, we exclude 'investment income payable on pension entitlements' from total income. These payments are made to pension funds, rather than directly to households, and they are not assessable for Income Tax. Deducting this component reduces total income relative to the previous step (removing non-taxable benefit). The rate at which total income reduces is decreasing over time, however, and ranges from 10% in 1996-97 to 5% in 2018-19 (Figure E6).

Figure E6: **Total income before and after the removal of pension entitlements**



Notes: 'Atkinson's NA method (updated)' is constructed using the most recent Atkinson formula (Box E2) (Alvaredo, 2017) with data from the 'Household and NPISH' sector of the latest release of the Blue Book (2021). 'Remove non-taxable benefits' is constructed by removing non-taxable benefits from the Atkinson formula, after excluding the NPISH sector and removing the 10% deduction (see Section E.3.3). 'Remove non-taxable benefits and pension entitlements' starts from 'Remove non-taxable benefits' and removes income attributable to pension funds.
Source: Authors' calculations based on the UK National Accounts.

E.3.5 Step 5: Modify the interest concept, and reverse the deduction of interest payments

Next, we make two changes to the way interest is accounted for in the measurement of total income.

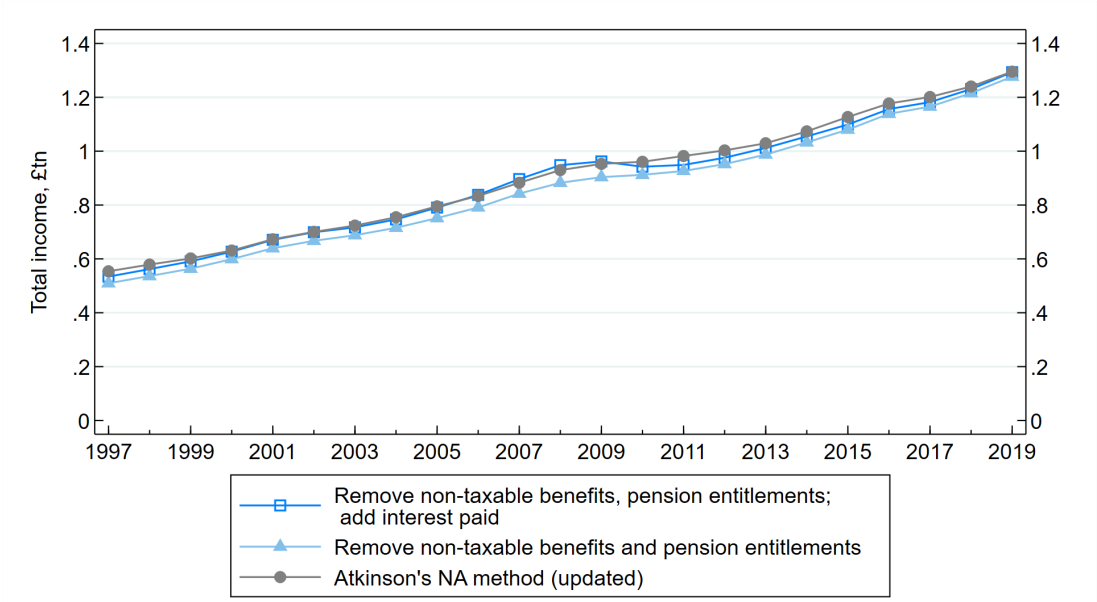
First, we address the conceptual difference between interest paid by financial institutions (that is assessable for Income Tax), and interest recorded in the National Accounts. In the National Accounts, interest is decomposed into the actual interest paid by financial institutions, and an implicit 'service charge', known as FISIM, paid by depositors and borrowers to financial institutions for their services as an intermediary. What is termed 'interest' in the National Accounts is the sum of bank interest ('interest before FISIM allocation') and FISIM, which is not actually part of the interest flow received by households. Only the first component is assessable for Income Tax, but FISIM is included implicitly in Atkinson's formula as part of the balance of gross primary income.

The balance of gross primary income, one of the main components in Atkinson's formula, is net of interest paid by households (e.g. on mortgages). As no tax deduction is made for interest

payments, we reverse the deduction of this outgoing from total income as our second step.[6]

Amending the concept of interest included in the NA-based income total by removing FISIM and reversing the deduction of interest paid results in the first significant change in the trend of the National Accounts-based total (Figure E7). This is driven by the switch from net to gross interest. Interest receipts (and payments) rose significantly in the lead up to the financial crisis, and fell afterwards. The result is a National Accounts-based income total whose trend corresponds more closely to the augmented internal income total series. This is a reassuring sign that we are approaching an income measure more closely aligned with the definition of assessable income.

Figure E7: **Total income before and after the addition of interest payments and changes to the definition of interest**



Notes: 'Atkinson's NA method (updated)' is constructed using the most recent Atkinson formula (Box E2) (Alvaredo, 2017) with data from the 'Household and NPISH' sector of the latest release of the Blue Book (2021). 'Remove non-taxable benefits and pension entitlements' is constructed by deducting income attributable to pension entitlements from the series 'Remove non-taxable benefits', which is in turn computed using the Atkinson formula excluding the NPISH sector and removing the 10% deduction. 'Remove non-taxable benefits, pension entitlements; add interest paid' starts from 'Remove non-taxable benefits and pension entitlements' and reverses the deduction of interest and rent on natural resources paid by households (i.e. adding these payments back in), as well as aligning the interest concept used with 'bank interest'.
Source: Authors' calculations based on the UK National Accounts.

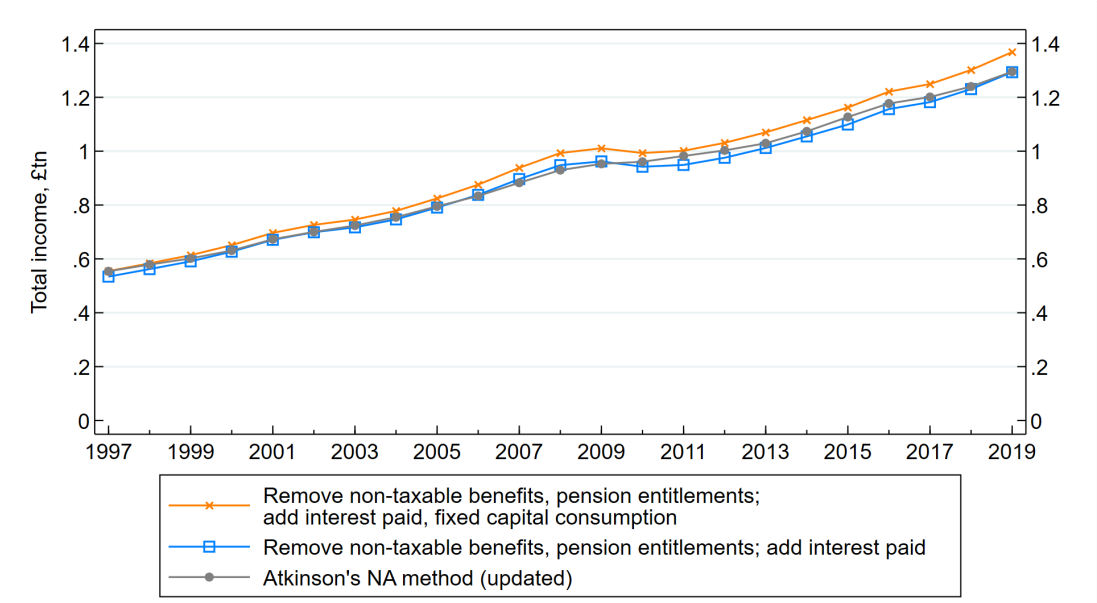
E.3.6 Step 6: Adding depreciation (fixed capital consumption)

National income as defined in the National Accounts represents the total income received after the deduction of fixed capital consumption. The Atkinson formula adopts this convention, deducting

[6]Rent paid on natural resources is also deducted in the Atkinson formula in a similar way, though this component is very small in magnitude. We add this back in just as we add interest paid by households, but do not separately show its effect here.

the fixed capital consumption of the Household sector from the income total. No such deduction is made in the calculation of assessable income, so we reverse the deduction of this component from the National Accounts total. Fixed capital consumption trends upwards over time, so reversing its deduction increases the slope of the National Accounts-based income total (Figure E8).

Figure E8: **Total income before and after reversing the deduction of fixed capital consumption**



Notes: 'Atkinson's NA method (updated)' is constructed using the most recent Atkinson formula (Box E2) (Alvaredo, 2017) with data from the 'Household and NPISH' sector of the latest release of the Blue Book (2021). 'Remove non-taxable benefits, pension entitlements; add interest paid' is constructed by reversing the deduction of interest and rent on natural resources paid by households (i.e. adding these payments back in) to the series 'Remove non-taxable benefits and pension entitlements', and aligning the interest concept with 'bank interest' (see Section E.3.4). 'Remove non-taxable benefits, pension entitlements; add all property income changes, fixed capital consumption' is constructed by reversing the deduction of fixed capital consumption from the series 'Remove non-taxable benefits, pension entitlements; add interest paid'.
Source: Authors' calculations based on the UK National Accounts.

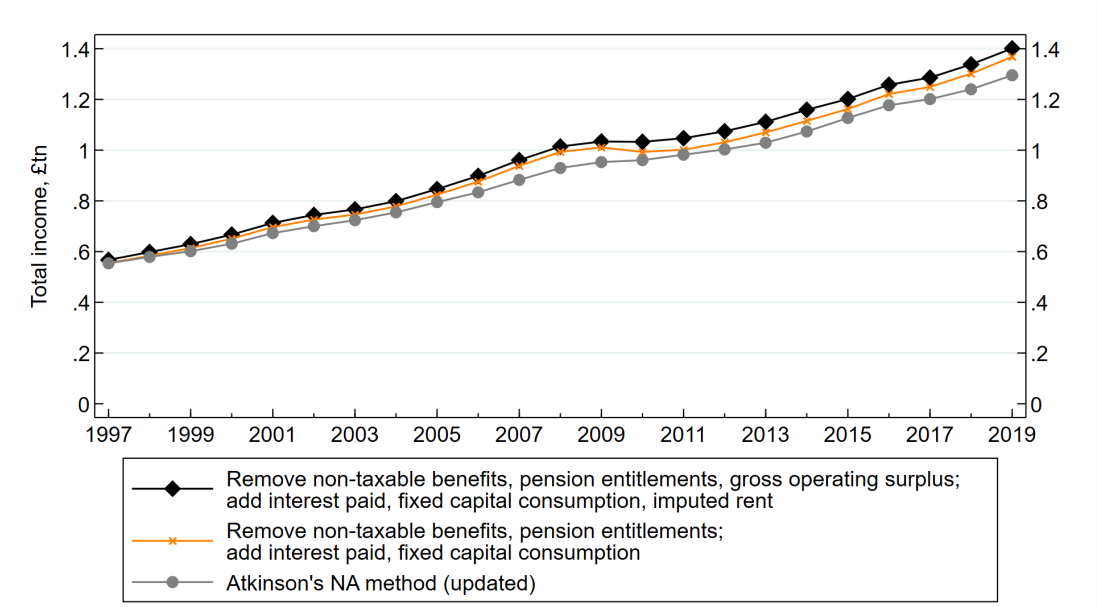
E.3.7 Step 7: Excluding Gross Operating Surplus (less imputed rent)

Finally, the Atkinson income total includes the gross operating surplus of the household (and NPISH) sector, which is a subcomponent of the balance of gross primary income and includes the imputed rent of owner-occupiers. A deduction is subsequently made to account for the fact that imputed rents are not assessable for Income Tax (see Box E2). The issue with this approach is that while gross operating surplus includes the imputed rent of owner-occupiers, the imputed rent total which is then deducted is obtained from the final consumption expenditure table of the Household, NPISH and General Government sectors combined. This expenditure total exceeds the value of gross operating

surplus accruing to households, meaning that the addition of (gross operating surplus - imputed rent) results in an economically meaningless net *deduction* from total income. In fact, gross operating surplus contains little other than the imputed rent of owner-occupiers, and so there is no clear case for including it in the first place (Office for National Statistics, 2016, 2018). We exclude gross operating surplus from the outset (and remove the deduction for imputed rent). This increases the income total by 2.9% on average (Figure E9).

Figure E9 illustrates how our NA-based total – which is now as close to assessable income as it can be – compares to an income total constructed using the latest Atkinson formula (Box E2) with the current Blue Book data ('Atkinson's NA method'). The trend in total income is flatter using Atkinson's method, implying a steeper rise in income inequality than we observe using our alternative National Accounts income total.

Figure E9: **Total income, before and after reversing the adjustment for imputed rent**



Notes: 'Atkinson's NA method (updated)' is constructed using the most recent Atkinson formula (Box E2) (Alvaredo, 2017) with data from the 'Household and NPISH' sector of the latest release of the Blue Book (2021). 'Remove non-taxable benefits, pension entitlements; add interest paid, fixed capital consumption' is constructed by reversing the deduction of fixed capital consumption from the series 'Remove non-taxable benefits, pension entitlements; add interest paid' (see Section E.3.4). 'Remove non-taxable benefits, pension entitlements, gross operating surplus; add interest paid, fixed capital consumption, imputed rent' starts from 'Remove non-taxable benefits, pension entitlements; add interest paid, fixed capital consumption' and removes gross operating surplus, simultaneously reversing the deduction for imputed rent. This results in our final NA-based income control series which is equivalent to 'NA-based pre-tax total' in Figure 2.
Source: Authors' calculations based on the UK National Accounts.