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Household Earnings and Income Volatility in the UK, 2009–2017

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Abstract
We study the volatility of sources of individual and household level income in the UK in the years 2009-2017, following the Great Recession and government austerity. We find that the volatility of (pre-tax) earnings and disposable income has fallen for the working-age in this period, largely due to fewer negative and large earnings shocks. For older individuals, we also find a fall in the volatility of private income, mainly due to fewer positive and large income shocks. Taxes and transfers help stabilise incomes, with social security cash benefits and income-dependent refundable tax credits reducing household private income volatility by around a quarter for the working age, and 40 percent for those aged 60 or over. However, over the sample period, taxes and benefits became less well correlated with earnings, reducing their ability to counteract swings in labour income. The findings illustrate the consequences of fiscal retrenchment and the cut-backs to welfare benefits on the stability of incomes.

Keywords Income volatility · Income risk · Taxes · Transfers · Insurance · Recession · Austerity · Longitudinal data

1 Introduction

The amount of risk and uncertainty faced by individuals and households is an important economic question both for understanding individual economic behaviours and for the welfare consequences. Given that most individuals are risk-averse and that self-insurance is unlikely or infeasible for many, an increase in risk and uncertainty has negative consequences for individual welfare. Income instability, defined as the extent to which individuals and

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households experience sizable income swings, has usually been interpreted as a proxy for risk and insecurity (Dynan et al. 2012; Jensen and Shore 2015). Previous studies have documented an association between income instability and clinical depression (Prause et al. 2009), poor health (Halliday 2007), food insecurity (DAHL et al. 2014; Leete and Bania 2010), mortgage delinquency (Diaz-Serrano 2005), reduced educational achievement of children (Hardy 2014), poorer child health outcomes (Wolf and Morrissey 2017), and problem behaviour in adolescents and children (Gennetian et al. 2015; Hill et al. 2013).

Using data from the first 8 waves of the UK Household Longitudinal Study (UKHLS) known as "Understanding Society" (University of Essex et al. 2018), this paper examines trends in instability of various sources of individual and household income in the UK. To measure income instability, we use "volatility", defined as the standard deviation of the arcpercentage annual change in income. We study the period from 2009 to 2017, and so our results reveal how volatility changed in the aftermath of the financial crisis, during a period characterised by relatively high levels of employment, weak growth in earnings, and austerity in government programmes as a result of the chosen path of fiscal retrenchment (and we set this out more clearly in Section 2.1).

We make four main contributions to the literature on income instability. First, we contribute by examining the levels and trends of volatility in the UK between 2009 and 2017. A large part of the existing literature focuses on the USA (e. g. Gottschalk and Moffitt 2009, Bania and Leete 2009, Dahl et al. 2011, Dynan et al. 2012, Ziliak et al. 2011, Gosselin and Zimmerman 2008, Shin and Solon 2011) but with a growing literature from other countries (e. g. Baker and Solon 2003 for Canada, Jappelli and Pistaferri 2010 for Italy, Bartels and Bönke 2013, Bartels and Bönke 2010 for Germany, Sologon and Van Kerm 2018 for Luxembourg, Li et al. 2021 for Australia, Cervini-Plá and Ramos 2011 for Spain). The literature on the UK focuses on years prior to 2009 (Dickens 2000; Blundell and Etheridge 2010; Jenkins and Cappellari 2014; Jenkins 2011; Ramos 2003; Blundell and Preston 1998), and so this is the first paper to examine the income volatility in the UK for the years following the Great Recession.

Second, we examine the extent to which the tax-benefit system can stabilize incomes. Our paper adds to existing work in this area using other methods (Hoynes and Luttmer 2011; Bartels and Bönke 2013; Brewer et al. 2012; Blundell et al. 2015; Angelopoulos et al. 2019).[1] Our work also speaks to the related literature on automatic stabilisers showing the importance of income taxes and social security benefits on stabilising household incomes and consumption in various settings using cross-sectional microdata (Paulus and Tasseva 2020; Dolls et al. 2012; Auerbach and Feenberg 2000; Knieser and Ziliak 2002b; Bargain et al. 2013). Again, none of the existing studies looks at how the tax-benefit system affected income volatility in the UK in the years we consider. We believe it is important to fill this gap, as, in the UK, the years following the great Recession have often been described as a period of 'austerity' and benefit cuts (Deagostini et al. 2017; Cribb et al. 2018).

Our third contribution is expanding the categories of workers included in our analysis of volatility. While most of the existing literature looks at instability or volatility in earnings amongst continuously-employed workers (see, for example, Moffitt and Zhang (2018) and references therein), we include in our analysis also individuals with no earnings (see Jenkins

[1] Angelopoulos et al. (2019) is probably the paper that is closest to ours as it uses the British Household Panel Survey (BHPS): the predecessor of the survey we use (see Fumagalli et al. 2017). The last wave of BHPS was collected in 2008, and thus our paper and Angelopoulos et al. (2019) cover different time periods. Moreover, Angelopoulos et al. (2019) uses a different method to capture income volatility, focuses on households with a spouse/partner relationship, and where the head is between 23 and 62 years and reports non-zero labour income.

and Cappellari 2014 for a similar approach). Perhaps more importantly, we include in our analysis self-employed workers, as self-employment has grown substantially in the period under study. This focus on self-employed is novel in the literature.

Finally, we contribute to the literature on income volatility by showing how instability changes when we move from individual- to household-level concepts of earnings or income, something which is informative about the extent to which households can pool risk and self-insure (see, for example, Blundell et al. 2015). This is possible because in our survey data all individuals within a household are interviewed. To make sure our estimates of volatility are not driven by changes in household composition, we use the re-weighing method proposed by DiNardo et al. (1996) to keep the demographic composition of our sample fixed to 2010 values.

Our findings are as follows. First, across the period, there is a decline in volatility in both earnings and (post-tax, post-transfer) disposable income. For the working-age, this is driven by a falling volatility of individuals' own earnings; for those aged 60 or over, by a falling volatility of private unearned income. Similar to previous studies, we find that volatility of household labour income is always significantly below that of individual labour income for those of working age, suggesting that other household members provide some insurance against swings in own earnings. Taxes and transfers reduce volatility significantly, with most of the impact due to social security cash benefits or income-dependent refundable tax credits: these reduce around a quarter of the volatility of household private income for the working age, and 40% for those aged 60 or over. However, over the 2009–2017 period, taxes and benefits became less well correlated with earnings and became a less important component of disposable income, both of which limit their ability to counteract swings in labour income; this is likely due to the cut backs in welfare benefits as a result of fiscal retrenchment (see (Deagostini et al. 2017, Cribb et al. 2018)). Our results are valid to choices of alternative samples.

The paper proceeds as follows. Section 2 discusses what we might expect to find given what the UK economic and policy context during the period we study, and given the previous literature on earnings and income instability. Section 3 reviews the data and our measure of volatility. We present volatility estimates for earnings and household labour and private income in Section 4. Section 5 examines the role of the tax-benefit system in reducing volatility over the period. In sections 6, we decompose the variance of disposable income changes into the variances and co-variances of its income components. We present sensitivity checks on our main estimates in Section 7. Section 8 concludes.

2 What Might we Expect to Find?

2.1 The UK Economic and Policy Context after the Great Recession

The period we study in this paper, 2009–2017, includes most of the strongest economic downturn in the post-war era -the Great Recession of 2008–2012-, as well as the subsequent economic recovery (2012–2017). The Great Recession was atypical in that the fall in output has been passed through to earnings rather than employment. In 2011–12, employment was just 2 percentage points (pp) lower than its pre-recession peak. In contrast, median weekly earnings were 8% lower than before the recession (Cribb et al. 2017). Since 2012, earnings have recovered but in 2016 they remained around 3% lower compared to 2007/8 whereas the

employment rate was 2 pp. s higher (Cribb et al. 2018). Employment and earnings growth since 2012 has been strongest for low income households (Cribb et al. 2018).

The period between 2009 and 2017 was also a period of important demographic changes. Various studies have pointed out that the 2009 crisis has led to a decrease in fertility rates in several developed countries, including the UK (see, for example, Goldstein et al. 2013, Matysiak et al. 2021, Comolli 2017). The household structure changed substantially also due to young people staying longer with their family, instead of moving out and forming other households (see, for example, Cox et al. 2015, Mazzotta and Parisi 2021). These trends can also be observed in our data (see Fig. A2 of the supplementary materials).

Finally, the period we study also saw changes in the tax-benefit system. Taxes and benefits significantly cushioned the fall in earnings during the recession. At the 10th percentile, the fall in weekly earnings was around 12%, but the fall in earnings plus transfers (benefits and tax-credits) was only around 4% (Cribb et al. 2017). Some of the reforms introduced by the Coalition Government starting from 2011 helped sustain incomes: state pensions were protected by a 'triple lock' and the income tax personal allowance increased significantly for the working age (for a detailed list of all the policy reforms see Deagostini et al. 2017). However, the reforms also contained measures that aimed to contain the fiscal deficit. These reduced the real value of both in-work and out-of-work benefits and made access to some disability related benefits more difficult.

Estimates of the overnight policy effects, that is estimates that abstract from any behavioural adjustment, suggest that changes introduced did not affect all types of families in the same way. The average estimated policy effect between 2011 and 2015 was a 1.2% loss in income due to benefit cuts and a 1.7% gain in income as a result of lower income taxes (Deagostini et al. 2017; Cribb et al. 2018). However, low-income families were disproportionately disadvantaged. For example, the overnight policy effect for families with no earners was a 6% fall in income, corresponding to £620 per year (Cribb et al. 2018). Lone parents, who are more likely to have low incomes, were estimated to have lost on average 2% of their disposable income due to benefit cuts (Deagostini et al. 2017).

Given the economic and policy context, what should we expect regarding income instability, and income volatility in particular? Some authors have suggested that instability rises during recession and falls during periods of economic growth (Gottschalk and Moffitt 2009; Jenkins 2011). However, the evidence that economic downturns increase instability is weak (for a study that finds the opposite result, see Carey and Shore 2013). Since the Great Recession affected earnings more than employment, it might be expected that any negative effects would be spread more widely, thus limiting the extent of the shock to any one household. Since low income household generally experience higher volatility, strong growth of employment and earnings in this group might be expected to reduce average volatility. However, during this period, the UK also experienced an increase in temporary forms of employment (including zero-hours contracts) and especially in self-employment (Hudson-Sharp and Runge 2017). In addition to increasing labour market income volatility, unstable and insecure work may also make it harder to claim the correct benefits, which is likely to increases net income volatility (Ben-Ishai 2015).

It is not entirely clear to what extent recent policy reforms affected income volatility in the UK. The expansion of the tax credits that occurred during the late 1990s and 2000s produced a system that is well positioned to respond to falls in earnings, albeit not to falls in employment (Cribb et al. 2017). The benefits cuts introduced after the Great Recession might, in principle, have led to an increase in income volatility, particularly among low-income family. However, the benefits cuts introduced in the period we analyse mainly regard out of work benefits and

affected entitlements rather than benefit levels. As a result, the changes are likely to have affected income levels more than income volatility.[2]

2.2 Previous Work on Earnings and Income Instability

A substantive part of the existing literature on income instability focuses on the US. Whereas the exact estimates differ somewhat depending on data and methodology, most indicate a substantial rise in the instability of (male) earnings between the 1970s and the 1990s, as well as increased instability of household incomes (e. g. Gottschalk and Moffitt 2009, Bania and Leete 2009, Dahl et al. 2011, Dynan et al. 2012, Ziliak et al. 2011, Gosselin and Zimmerman 2008, Shin and Solon 2011). This literature generally finds that low paid or low skilled workers experience higher levels of income instability and have been affected by increases in instability to a greater extent (Deagostini et al. 2017; Hannagan and Morduch 2015).

An increasing number of studies look at income instability in counties other than the US (e.g. Baker and Solon 2003 for Canada, Jappelli and Pistaferri 2010 for Italy, Bartels and Bönke 2013, Bartels and Bönke 2010 for Germany, Sologon and Van Kerm 2018 for Luxembourg, Li et al. 2021 for Australia, Cervini-Plá and Ramos 2011 for Spain) or compare income volatility patterns across countries (Chauvel and Hartung 2014; Van Kerm 2004; OECD 2011; Daly and Valletta 2008; Menta et al. 2021)). The findings of these studies depend on the measure of volatility and the definition of income adopted, the time period considered and the country analised, possibly due to socio-demographic differences and differences in the labour market, the welfare system, and the dynamic of household formation (see Van Kerm 2004 for an analysis of how these differences may affect the income volatility estimates).

The evidence on trends in earnings and income instability in the UK is mixed. Early work using pseudo-panels and administrative data suggests that earnings have become more unstable in the later part of the 1980s (Blundell and Preston 1998; Dickens 2000). More recent work using longitudinal data and looking at later years is less conclusive. Using the transitory variance of (log) earnings as a measure of instability, Ramos (2003) finds that earnings instability increased between 1991 and 1999. Blundell and Etheridge (2010) study the transitory variance of earnings and disposable income and conclude that while the former is flat, the latter is u-shaped falling in the early 1990s and rising subsequently. Jenkins (2011) uses different measures of income and earnings volatility between 1991 and 2003. He concludes that there is no trend in the instability of earnings, especially among prime-aged male earners. Finally, Jenkins and Cappellari (2014) use similar methods to the ones we use to compute the volatility of male and female earnings between 1991 and 2008 and conclude it has been constant during this period, whereas labour market volatility (i.e. including individuals with zero earnings) has fallen primarily due to stronger employment attachment.[3] The literature has also examined the extent to which the tax-benefit system is able to stabilize incomes.[4] Many transfer programs are designed to cushion incomes in

[2] Cuts to in-work benefits embedded in Universal Credit were likely to have affected income volatility. However, the majority of these are not captured by our data which ends in 2017.

[3] The term volatility has usually been used by studies looking at raw (or age-adjusted) income changes while the transitory variance has been used to denote 'random' shocks following a decomposition based on an income dynamics process.

[4] For the role of transfers in stabilizing consumption, see Bronchetti 2012. Workers' Compensation and Consumption Smoothing. *Journal of Public Economics,* 96**,** 495–508, Gruber 2000. Cash Welfare As a Consumption Smoothing Mechanism for Divorced Mothers. Ibid.75**,** 157–182, Browning and Crossley 2001. Unemployment Insurance Benefit Levels and Consumption Changes. Ibid.80**,** 1–23, Gundersen and Ziliak 2003. The Role of Food Stamps in Consumption Stabilization. *Journal of Human Resources,* 38**,** 1051–1079..

case of adverse shocks to earnings generated by unemployment, ill-health or childbirth. Progressive taxation also plays an important role in the intertemporal smoothing of incomes (Knieser and Ziliak 2002a; Varian 1980). Several studies have suggested that part of the increase in income instability in the US can be explained by welfare reforms that reduced the coverage and the generosity of US income support programs (Hardy and Ziliak 2014; Hardy 2016; Bania and Leete 2009). Similarly, Jenkins (2011) suggests that different levels and trends in income instability in the US and UK can be partly explained by the much stronger British safety net. A growing literature compares the ability of tax and benefits of delivering such protection. Busch et al. (2018) find that, for US, Germany and Sweden, taxes more than transfers contribute to reduce income volatility) For the UK, Angelopoulos et al. (2019) get to the opposite conclusion, namely that, in the UK and for the period between 1991 and 2008, income volatility was mitigated predominantly by the benefit system, rather than the tax system.

3 Data and Methodology

We use data from Understanding Society, the UK Household Longitudinal Study, or UKHLS (University of Essex et al. 2018). UKHLS began in 2009 with a sample of approximately 40,000 households, and collects information in an annual interview, including demographic, labour market and detailed income data. Individuals aged 16 and above are eligible for an adult interview and the study aims to interview every adult member of the household. We use data from the first 8 waves.

Understanding Society includes a detailed set of questions on individual incomes that follow the best practise recommendations for income data collection of the Canberra group (United Nations, 2011) including for the self-employed.[5] The income data has been considered to be of high quality and is, for example, the data source for official statistics on income dynamics (DWP).[6] Fisher et al. 2019 has considerable information about the income data and its collection and also shows that household net income estimates from *Understanding Society* closely match and follow external estimates from a cross-sectional gold standard income survey. Moreover, the share of household income estimated to be from earnings and self-employment income is shown to also mirror the external gold-standard data source over time (Fisher et al. (2019)).

There is no established consensus on how to measure income instability. Some studies have directly examined raw income changes (including the present paper) whereas others have used error component models that distinguish between permanent and transitory shocks.

An important disadvantage of error component models is that they are data demanding and heavily rely on the parametric specification for identification. Results are often sensitive to the chosen parametric assumptions complicating interpretation (Shin and Solon 2011; Moffitt and Zhang 2018; Guvenen 2009). Moreover, error component models usually do not fit well the income profiles of individuals with high income variability such as the self-employed or those with intermittent labour market histories.

[5] Self-employment income is collected in a distinct module that asks self-employees for their share of the net profit or loss on their most recent accounts or, where not available, an estimate of their net usual monthly or weekly self-employment income.

[6] The methodology used to derive the net income estimates has been designed to replicate as close as possible the methodology developed by the Department for Work and Pensions (DWP) for computing Households Below Average Income (HBAI) estimates (see Fisher et al. 2019).

Other studies use volatility measures based on raw income changes. These measures are non-parametric, simple to compute, require only two consecutive years to estimate and are defined at the individual level. They can also easily incorporate zero incomes, an important feature in our case. For these reasons, we use a measure of income volatility, the standard deviation of the arcpercentage change in income:

$$V_t = \sqrt{Var\left[100 * \frac{Y_{it} - Y_{it-1}}{(Y_{it} + Y_{it-1})/2}\right]}$$

where Y_{it} is income at time t for individual i . We divide the change in income by the mean of the two years rather than by income in the first year (Y_{t-1}) because this has been shown to minimize the influence of outliers and allows for the inclusion of observations where income is zero in either year(Ziliak et al. 2011; Jenkins and Cappellari 2014). It also ensures the measure is symmetric: the size of any change does not depend on the ordering of incomes in year *t-1* and *t*. While not originating in an income dynamics model, our measure of volatility has been shown to be closely related to the variance of transitory shocks in more complex models[7] (Ziliak et al. 2011; Moffitt and Zhang 2018).

When income is zero in both years, we set the arcpercentage change equal to zero as well (as this implies no change). The arcpercentage change can take values between −200% and + 200%. Individuals with no income in year *t-1* but positive income in year *t* will have an arcpercentage change of +200%. Similarly, individuals with positive income in year *t-1* and no income in year *t* will have an arcpercentage change of −200%.

We calculate volatility measures for five income concepts that build on and extend each other by progressively including more income sources. The five income concepts are: individual labour earnings (including self-employment), household labour earnings, household private income (defined as the sum of household labour earnings and all other non-labour private sources of income such as private pensions, property and investment income, alimony and other smaller sources of income such as education maintenance grants or inter-household transfers), household total gross income (defined as the sum of household private income and all state benefits received by members of the household, including tax credits), and household disposable income (defined as total gross income minus income taxes and national insurance contributions). For those of working-age, the sources of household private income other than labour income are typically marginal and, as such, volatility trends and levels in household labour and private income will be very similar. But non-labour private sources of income are important for older individuals, and they will play an important role in determining volatility for those aged 60 or more. An overview of our income concepts can be found in Table 1.

The income concepts we use have been constructed using the UKLHS derived income variables. The derived income variables summarize and aggregate the detailed income information collected by the survey, including earnings, pensions, benefits and other income. UKHLS imputes missing values due to item and unit non-response in these derived variables, but not in their components. We use these imputed values throughout our main analysis, but we present some robustness checks in Section 7.[8]

[7] More specifically, Ziliak et al. (2011) show that "volatility" includes changes in income stemming from changes to the time loadings of the permanent variance component (i.e. the 'prices' of unobserved skill) and changes to the time factor loadings and shocks of the transitory variance component.

[8] We also estimated results for after housing costs incomes. The main volatility trends were very similar to the before housing cost results and can be found in the supplementary materials figure A7.

Table 1 Definition of income concepts

Income	Definition
Individual labour earnings	Gross monthly labour income: sum of usual gross earnings, self-employment income and earnings from second jobs;
Household labour earnings	Sum of total personal monthly income from labour income received by all household members; equivalised (modified OECD scale)
Household private income	Sum of household labour earnings, private benefit income received by all household members, pension income received by all household members, investment income received by all household members and miscellaneous income received by all household members; equivalised (modified OECD scale)
Household total gross income	Sum of household private income and social benefit income received by all household members; equivalised (modified OECD scale)
Household disposable income	Net household income; taxes deducted only on earnings; equivalised (modified OECD scale)

Information on income taxes and national social insurance contributions is not collected directly by the survey. However, UKHLS provides net income estimates derived from a mixture of direct reporting by respondents and imputations based on gross incomes and household and individual characteristics. The imputation methods and extent of missing data in UKHLS are typical of other household surveys and described in detail in Fisher et al. (2019).

All five of our income concepts refer to current monthly values. We use monthly Before Housing Costs HBAI CPI values to deflate all incomes to average 2017 levels. We set all negative incomes to zero; this affects only between 0.18% and 0.07% of observations (depending on the income concept). Volatility estimates are presented by year in which the interview was issued to field. In most cases, this is the year the interview actually took place. However, due to field work constraints, a small number of households are interviewed in the subsequent year.

All incomes (individual and household) are equivalised using the 'modified OECD' scale.[9] This essentially means that demographic changes (for example the birth of a child) will appear as income shocks (including in the labour market income estimates) even though income may have remained unchanged. Our approach is motivated by income shocks often having a demographic origin, and several transfer policies being expressly designed to mitigate such shocks. For example, the UK child benefit and child tax credits are specifically designed to reduce the economic shock of having children.

We would ideally like to separate changes in volatility due to changes in the demographic characteristics from changes due to labour market activity and policy reforms. Previous research (see Section 2.1) has shown that during the period we study, fertility declined somewhat and the share of young adults living in the parental home increased. We use the re-weighing method proposed by DiNardo et al. (1996) to keep the demographic composition of our sample fixed to 2010 values. Note that this assumes that demographic changes do not impact on the income volatility process. Input variables to the weighting models are detailed household composition (18 categories constructed based on the ages and number of household members) and the age of children (4 categories, differentiating between infants and toddlers, pre-school, primary and secondary school children). We then multiply these weights with our original longitudinal weights provided by UKHLS, and we use these new weights to weight

[9] Volatility estimates when not equivalising turn out to be very similar to the equivalised ones. See figure A1 of the supplementary materials.

our volatility estimates. Note though that estimates obtained without re-weighing for demographic change are virtually unchanged, (Supplementary Appendix, Figs. A3-A7) suggesting that demographic trends did not drive volatility during the period we study.

Our sample consists of all individuals aged 25 and over who have valid information on all our five income concepts in at least two consecutive years.[10] Given the divergent evolution of median incomes for the working age and pensioner households, we carry out our analysis separately for individuals aged 25–59 and individuals aged 60+. We do not include individuals younger than 25 in our analyses as many of them are students or apprentices and their larger than average volatility of earnings or income does not necessarily translate into economic instability or insecurity. We are left with 23,942 working age individuals (and approx. 103,000 observations) and 13,164 individuals aged 60 or over (and approx. 60,000 observations) with a non-zero longitudinal weight. Note that individuals who are working age in one year may move into the 60+ group in subsequent years. We use longitudinal weights throughout to account for selective attrition. Unweighted results are very similar (available from the authors). For all our estimates, we calculate bootstrapped standard errors based on 1000 replications.

4 Volatility of UK Private Incomes after the Great Recession

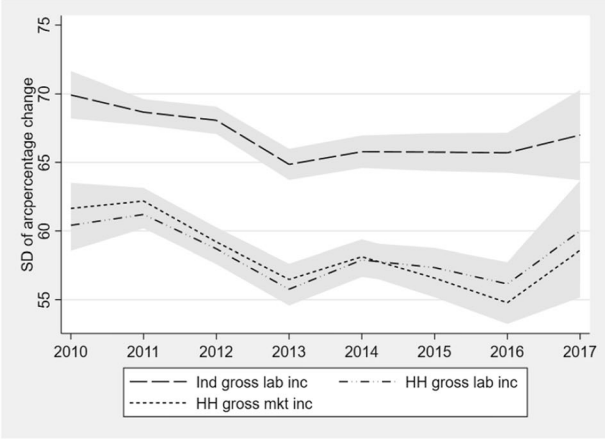
We start by examining trends in the volatility of earnings and other private sources of incomes. Figure 1 maps the yearly volatility in individual labour income, household labour income and household private income between 2010 and 2017 separately for the working age and 60 + .

Among the working age, the volatility of individual labour income fell from 2010 to 2017 by almost 6%; household labour and private income volatility fell by similar magnitudes by 2016, but then ticked up in 2017. Household labour income volatility is always significantly below that of individual earnings suggesting labour and wage shocks are not positively correlated within the household (formal correlations are shown in section 6). The labour income of other household members provides some insurance against swings in own earnings. Non-labour private income sources have a negligible effect on volatility for those of working age.

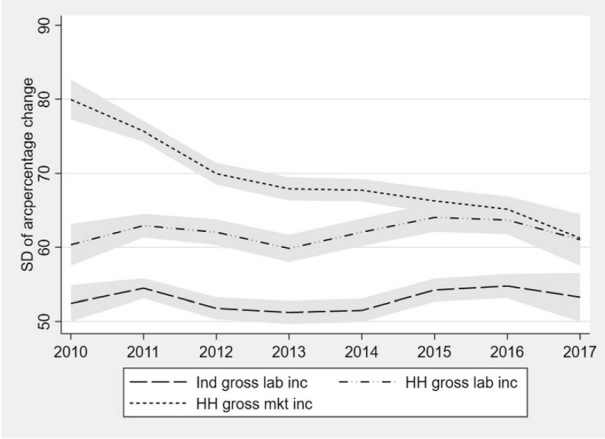
Figure 2 plots the 10th and the 90th percentile of the distribution of arcpercentage changes for the working age. There is a clear reduction in the (absolute) size of income changes at the 10th percentile from 2010 to 2015, particularly for the household level measures. In contrast, changes to positive shocks are much more limited.

Among individuals aged 60+, there is no apparent trend in the volatility of labour income (individual or household), while there was a large decrease in private income volatility (Fig. 1b). Figure 3 shows the decline in the volatility of household private income is attributable mainly to a fall in large positive income shocks. The 90th percentile of the distribution of arcpercentage changes is almost halved from 2010 to 2017. This drop is almost completely concentrated in private pension income (not shown in the figure) and while we do not have direct evidence, we suspect the large positive shocks observed in 2010 and 2011 reflect, at least in part, delays in drawing down defined contributions (DC) assets after the stock market crash of late 2008/early 2009. The FTSE100 increased by almost 50% between April 2009 and April 2011, having fallen by nearly 30% between April 2008 and April 2009

[10] Note, our unit of analysis is the individual not the household. We attach household incomes to all individuals who reside in the same household.



(a)

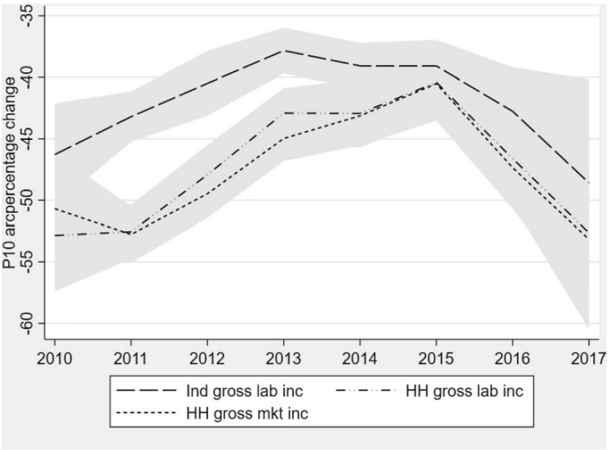


(b)

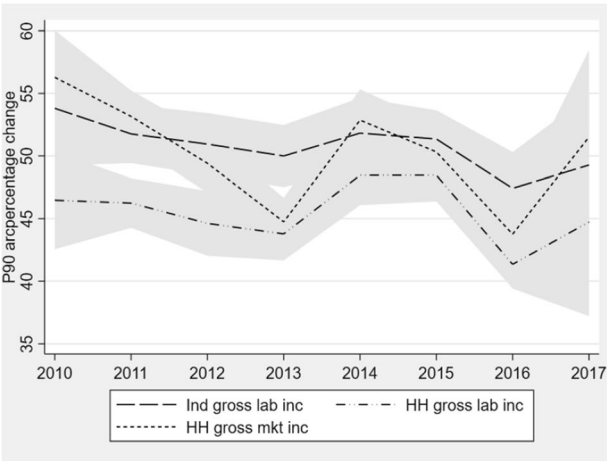
Fig. 1 Volatility of individual and household labour and private incomes, 2009–2017 (**a**) Working age (25–59) (**b**) Older age (60+). Note: 'Ind gross lab inc'=individual gross labour earnings;' HH gross lab inc' = household gross labour earnings; 'HH gross mkt inc'=Household gross private income; All incomes are equivalised using the modified OECD scale

(fig. A8). The fall in stock market prices will have incentivised some individuals to postpone annuitizing their DC pension, whereas the subsequent recovery will have given them an opportunity to do so.

For individuals aged 60+, household labour income volatility is consistently higher than individual labour income volatility, the opposite pattern to that found among the working age (compare dashed and dash-dotted lines in Fig. 1b). The difference arises from individuals who are



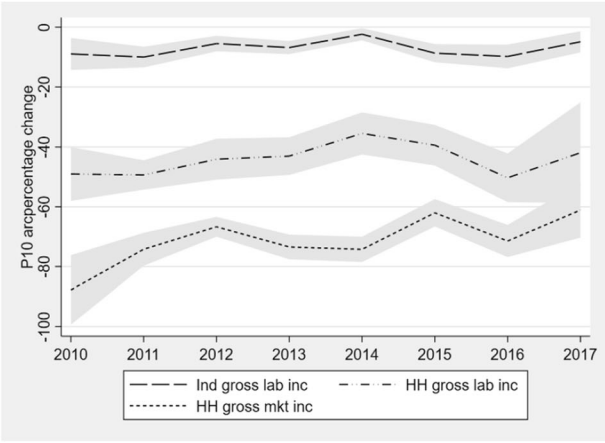
(a)



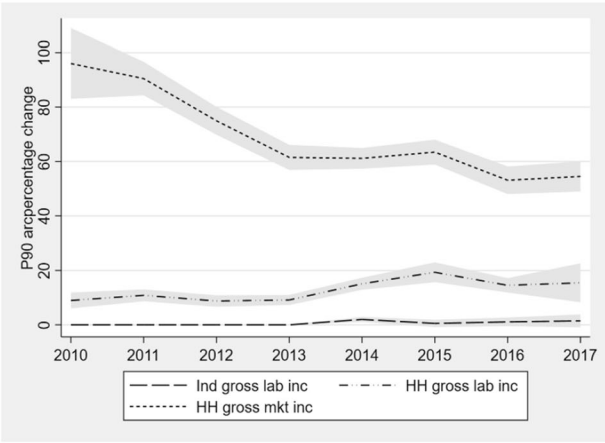
(b)

Fig. 2 Selected quantiles of the arcpercentage change of individual and household labour and private incomes, 2010 to 2017. Working age (25–59). (**a**) P10 (**b**) P90. Note: 'Ind gross lab inc'=individual gross labour earnings;' HH gross lab inc' = household gross labour earnings; 'HH gross mkt inc'=Householeold gross private income; All incomes are equivalised using the modified OECD scale

themselves retired but have a partner that is of working age and in work: for these individuals, individual labour income volatility will be zero, but household labour income volatility will be positive. The volatility estimates presented in Fig. 1 include all individuals with valid income information satisfying the age condition. In contrast, many of the previous studies of earnings volatility have focused on continuously employed individuals. To facilitate comparisons with previous results, Fig. 4a plots volatility estimates for working age individuals who are



(a)



(b)

Fig. 3 Selected quantiles of the arcpercentage change of individual and household labour and private incomes, 2010 to 2017. Older age (60+). (**a**) P10 (**b**) P90. Note: 'Ind gross lab inc'=individual gross labour earnings;' HH gross lab inc' = household gross labour earnings; 'HH gross mkt inc'=Householeold gross private income; All incomes are equivalised using the modified OECD scale

continuously employed, i.e. they report being in paid employment and positive earnings in both years.[11] Our estimates are very similar to Jenkins and Cappellari (2014) for the period 1990–2008. They find that the earnings volatility of men and women continuously employed is around 30, the same as we do. As a further check on robustness, we restricted the sample to individuals

[11] These individuals may still have experienced a non-employment spell in-between interviews.

who report full-time employment for all months in-between interviews and the volatility estimates are around five points lower, but trends are identical (see fig. A9).

A comparison between Fig. 1 and 4a shows that the fall in income volatility for respondents continuously employed is smaller than the fall in income volatility estimated for the whole population, and in some cases statistically indistinguishable from zero. This suggests that changes in income volatility over this period are not driven by the earnings of employees, but by changes in employment and labour market attachment. Among the working age, the share of labour market exits fell from around 4% to around 3% and the share of those continuously in work increased from 73.5 to 76.5%. The fall in labour market exits is likely to be the main driver of the fall in income volatility estimated for the whole population.

Figure 4b shows volatility estimates for working-age individuals who declare self-employment in both waves. Volatility estimates are much higher, about twice as high as for employees. Over the period we study, volatility for the self-employed remained relatively constant, with a small uptick towards the end, especially for household incomes.

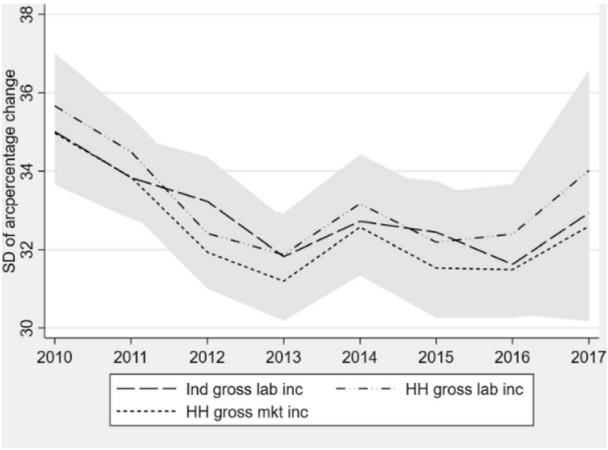
An important question is to what extent workers with different skills experience different levels of volatility and whether they experienced different trends during the decade we study. To answer this question, Fig. 5 plots volatility estimates for working age individuals with a higher degree and for those who left school at 16 (GCSE or less). Interestingly, both groups experience similar levels of individual labour income volatility. In contrast, there is a large difference in household income volatility. Whereas for educated workers of working age household income is much less variable than individual income, this is not the case for low educated working age individuals. This result, similar to the findings by Blundell et al. 2015 for Norway, suggests that households of educated workers are more able to provide partial insurance against income volatility.

5 The Role of Taxes and Benefits in Reducing Income Volatility

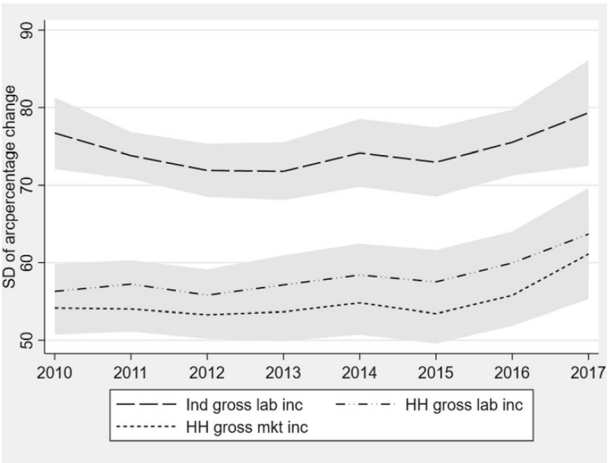
In this section, we assess the role the tax benefit system played in reducing income volatility during 2010–2017 by comparing the volatility of gross household private incomes with that of household gross total incomes which include all public transfers and that of household disposable incomes which additionally incorporate national insurance contributions and income taxes.

Figure 6 plots these measures separately for the working age and 60+. Taxes and transfers reduce volatility significantly: in both graphs the dotted line (gross household private income) lies well above the dashed and solid lines (gross household total income and household disposable income). Most of the effect is attributable to transfers: just under a third of the volatility of household private income for the working age is reduced by transfers, as opposed to just 1–2% being due to taxes. The relative reduction in volatility from taxes and benefits remained constant throughout the period at around 33–34%. Transfers play an even larger role in reducing volatility for the 60+ group: the volatility of household private income is reduced by almost 40% by transfers, reflecting the importance of state pensions for those who retire. As in the case of the working age, the absolute change in income volatility brought about by taxes and benefits did not change throughout the period.

Next, we assess the ability of the tax-benefit system to mitigate volatility stemming from labour market exits. We do this by looking at the distribution of shocks to household private and disposable incomes (i.e. excluding and then including transfers and taxes) for those households where at least one member was affected by a labour market exit. An exit is



(a)

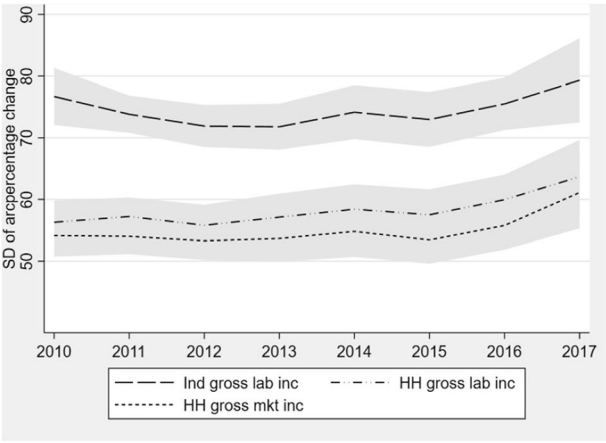


(b)

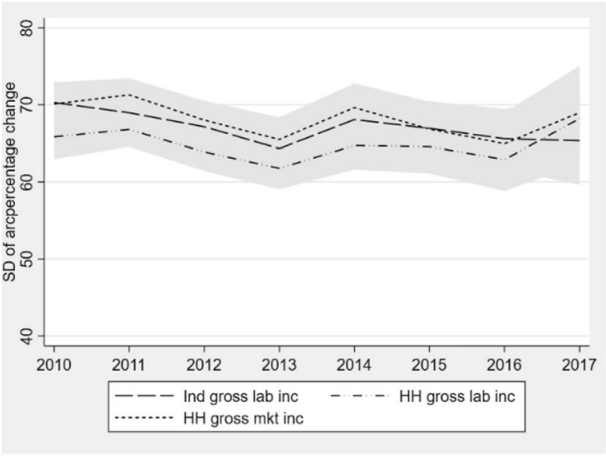
Fig. 4 Volatility of individual and household private incomes, 2010–2017; Working age (25–59) who are continuously employed (**a**) or continuously self-employed (**b**). Note: 'Ind gross lab inc'=individual gross labour earnings;' HH gross lab inc' = household gross labour earnings; 'HH gross mkt inc'=Householeold gross private income; All incomes are equivalised using the modified OECD scale

defined based on earnings reported at the time of the interview, i.e. positive earnings are reported at t-1 and zero earnings at t. By construction, individuals who exit employment entirely have an arcpercentage change of individual labour earnings of −200%. Because their labour market exits are likely of a different nature, we examine working-age and 60+ individuals separately.

Figure 7 shows selected quantiles of the arcpercentage change in household gross private and disposable incomes for working age individuals experiencing a labour market exit. Taxes



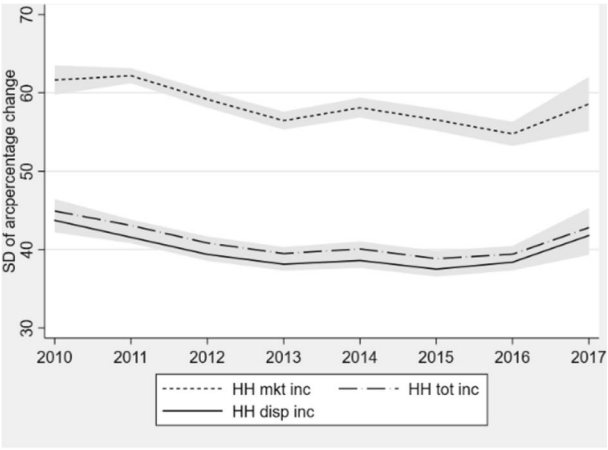
a)



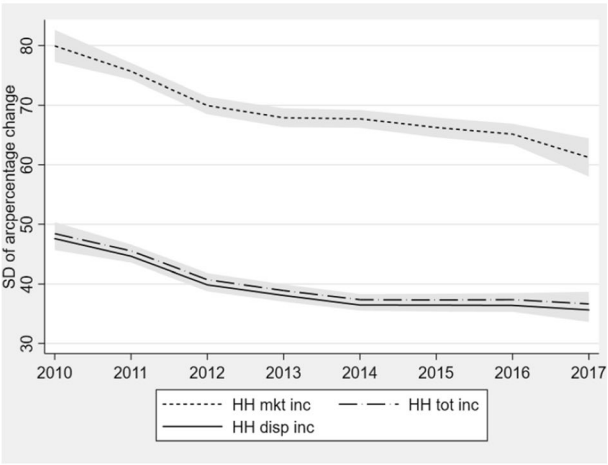
b)

Fig. 5 Volatility of individual and household private incomes by education, 2010–2017; Working age individuals (25–59) with a higher education degree (**a**) and working age individuals (25–59) with GCSEs or less (**b**). Note: 'Ind gross lab inc'=individual gross labour earnings;' HH gross lab inc' = household gross labour earnings; 'HH gross mkt inc'=Householeold gross private income; All incomes are equivalised using the modified OECD scale

and benefits greatly reduce the size of large negative shocks. The 10th percentile of the distribution of changes is approximately halved when taxes and benefits are added (from −200% to −120%) and the 25th percentile falls from −150% to −75%. The extent to which taxes and benefits reduce large negative shocks in household private income reduced in 2016 and 2017. This is mostly due to increased selection: as employment levels and labour market attachment increased, individuals who experienced labour market exits became more selected. Our data shows they are more likely to be older, less likely to live with other earners and less likely to have dependent children. To a lesser extent, the fall is also due to a fall in the real



a)



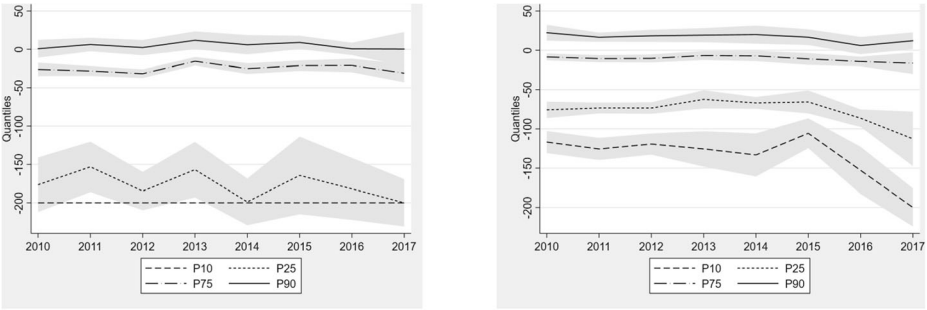
(b)

Fig. 6 Volatility of household incomes before and after taxes and benefits, 2010–2017. (**a**) Working age (25–59) (**b**) Older age (60+). Note: 'HH mkt inc'=household private income; 'HH tot inc'=household total gross incomes; HH disp inc = household disposable income. All incomes are equivalised using the 'modified' OECD scale

value of benefits generated by lack of inflation indexing.[12] In contrast, the higher percentiles of the distribution of changes are little changed when taxes and benefits are added. This pattern is consistent with a tax-benefit system which is targeted on the left tail of the distribution of income changes.

Figure 8 shows the same for respondents aged 60+: as expected, labour market exits are associated with smaller shocks to household incomes than amongst the working-age

[12] This is especially true for 2017 when inflation reached 2.56%.



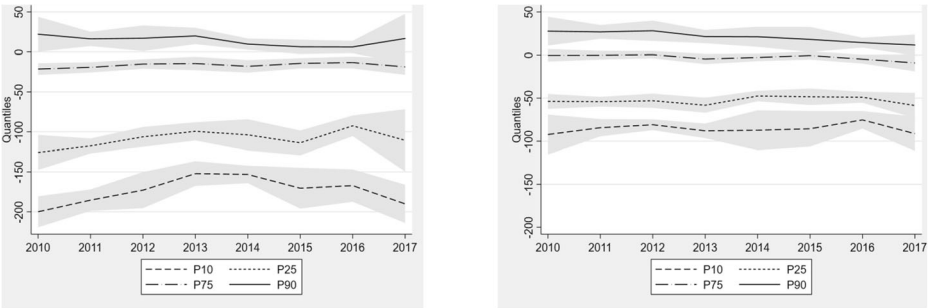
(a) (b)

Fig. 7 Selected quantiles of household private income and household disposable income changes of labour market leavers of working age. (**a**) Household gross market income (**b**) Household disposable income. Note: 'HH mkt inc'=household private income; 'HH tot inc'=household total gross incomes; HH disp inc = household disposable income. All incomes are equivalised using the 'modified' OECD scale

population. The size of the shocks in the left tail of the distribution of income changes is reduced considerably by the tax-benefit system. At the 10th percentile, disposable income shocks are at least a third smaller compared to gross market incomes (−100% vs. -150 to −200%). At the 25th percentile, the size of the shocks is halved, from around −100% for household gross market income to −50% in the case of disposable income. Taxes and benefits therefore play an important role in mitigating income shocks associated with labour market exit among individuals aged 60 + .

6 Decomposing Trends in the Volatility of Household Disposable Income

An important issue for understanding changes in the volatility of disposable income is the extent to which shocks to various income sources are correlated or not and how correlations changed over time. To gain insight, we decompose the variance of disposable income into the



(a) (b)

Fig. 8 Quantiles of household private income and household disposable income changes of labour market leavers aged 60+. (**a**) Household gross market income (**b**) Household disposable income. Note: 'HH mkt inc'=household private income; 'HH tot inc'=household total gross incomes; HH disp inc = household disposable income. All incomes are equivalised using the 'modified' OECD scale

sum of the component variances and its co-variances. We decompose disposable income as the sum of own earnings (I1), earnings of other household members (I2), non-labour private income (I3), transfers (I4) and taxes (I5). The variance of changes in disposable income can be written as the sum of the variances of five weighted income components and the corresponding covariances, where the weights are the shares of the income components in disposable income. Formally, we have

$$Var(Y_{it}) = \sum_{j=1}^{J} Var\left(s_{ijt}I_{ijt}\right) + 2\sum_{j=1}^{J-1}\sum_{k=1}^{j-1} Cov\left(s_{ijt}I_{ijt,}\, s_{ikt}I_{ikt}\right)$$

where $Var(Y_{it})$ is the variance of the arcpercentage change in disposable income in year t, $Var(s_{ijt}I_{ijt})$ is the variance of the arcpercentage change in the income component j in year t weighted by its share in total disposable income, $Cov(s_{ijt}I_{ijt}, s_{ikt}I_{ikt})$is the covariance of the weighted changes in income j and k in year t and J is the number of income components which in our case is five (see Hardy and Ziliak 2014 for the full decomposition formula). Tables 2 and 3 show the evolution of i) variances of the constituent income sources, ii) their co-variances and iii) their shares between 2010 and 2017 for the working age and 60 + .

Table 2 shows the decomposition of the volatility of household disposable income for working age respondents. Between 2010 and 2017, the variances of arcpercentage changes fell for all private income components. By contrast, the variance of benefit income changes hardly changed, and the variance of tax changes increased slightly.

The covariance between earnings of members of the same household provides information about the extent households can self-insure against income volatility by pooling risks. The covariance between individual earnings and the earnings of other household members is very close to zero throughout the period (the correlation coefficient ranges between 0.0003 and

Table 2 Decomposition of the volatility of household disposable income for the working age

	2010	2011	2012	2013	2014	2015	2016	2017
V (I_1)	4889.35	4709.85	4622.77	4216.56	4257.15	4238.91	4234.55	4368.11
V(I_2)	5424.88	5473.71	5287.38	4946.63	5114.54	5142.45	5114.27	5129.31
V(I_3)	11,338.5	11,197.66	10,751.65	10,522.59	10,517.1	10,540.32	10,665.66	9966.82
V(I_4)	6237.27	5985.19	5942.38	6344.98	6096.99	6520.29	6229.5	6075.75
V(I_5)	6063.03	6316.79	6189.62	5880.28	6385.86	6416.04	6566.09	7043.88
C(I_1, I_2)	−13.09	−116.7	−114.97	−150.61	−90.21	−117.89	4.71	42.75
C(I_1, I_3)	−457.39	−305.71	−343.97	−379.02	−266.98	−233.07	−202.88	−312.85
C(I_1, I_4)	−958.79	−715	−735.23	−607.75	−647.68	−599.39	−462.02	−475.25
C(I_1, I_5)	2349.8	2268.08	2176.35	1895	2040.12	1945.15	1925.23	2306.8
C(I_2,I_3)	−275.58	−119.94	−138.85	−29.34	−115.6	−62.33	−163.07	143.61
C(I_2, I_4)	−698.6	−573.81	−549.83	−476.95	−537.24	−752.74	−635.82	−476.53
C(I_2, I_5)	2256.49	2415.4	2124.8	1987.98	2108.06	2055.59	2123.31	2045.88
C(I_3, I_4)	979.1	685.96	827.81	1171.51	1026.28	1045.53	1178.99	922.91
C(I_3, I_5)	−139.28	−199.91	−262.82	−300.76	−122.49	−36.95	61.83	0.28
C(I_4, I_5)	−881.16	−766.48	−682.05	−569.4	−614.81	−600.4	−648.96	−484.55
S(I_1)	46.24	46.79	48.08	49.7	50.96	51.2	50.29	51.72
S(I_2)	45.97	45.13	45.1	44.87	44.63	44.94	45.18	45.57
S(I_3)	5.75	6.07	6.56	6.59	6.57	6.63	6.58	6.55
S(I_4)	19.26	20.05	19.73	19.33	18.67	18.26	17.72	16.9
S(I_5)	23.33	22.64	22.39	21.99	21.61	21.48	21.4	21.57

Note: I1 = own earnings; I2 = earnings of other household members; I3 = non-labour, private income; I4 = transfers; I5 = direct taxes and insurance contribution. Source: Authors' calculations based on UKHLS

Table 3 Decomposition of the volatility of household disposable income for those aged 60+

	2010	2011	2012	2013	2014	2015	2016	2017
V (I_1)	2750.19	2962.45	2670.52	2621.2	2639	2924.81	2948.91	2785.47
V(I_2)	2890.5	3099.89	2960.03	2930.84	3023.42	3210.92	3099.28	2949.06
V(I_3)	8473.99	7375.72	6236.46	6011.02	5818.32	5562.44	5396.11	4957.13
V(I_4)	3890.01	3557.95	2767.7	2561.88	2707.44	2700.16	2764.27	2910.18
V(I_5)	4431.4	4528.57	4411.72	4354.84	4375.47	4619.21	4605.69	4432.53
C(I_1, I_2)	64.64	156.77	147.48	95.75	169.69	162.6	44.78	246.03
C(I_1, I_3)	−398.72	−193.45	−212.75	−235.33	−220.92	−257.93	−289.32	−116.17
C(I_1, I_4)	−317.79	−272.63	−252.56	−182.32	−202.55	−243.45	−270.95	−208.69
C(I_1, I_5)	1412.2	1500.46	1351.26	1231.49	1300.53	1397.36	1325.57	1291.39
C(I_2,I_3)	−213.51	−175.3	−96.49	−174.07	−243.18	−328.8	−252.61	−204.35
C(I_2, I_4)	−295.32	−196.65	−213.7	−273.72	−307.79	−245.12	−202.8	−260.23
C(I_2, I_5)	1809.82	1879.58	1827.52	1737.71	1907.81	1861.92	1789.64	1777.08
C(I_3, I_4)	731.56	554.76	250.59	274.54	297.18	242.23	221.75	234.88
C(I_3, I_5)	−193.28	−263.67	−245.27	−260.01	−302.62	−339.76	−300.49	−216.32
C(I_4, I_5)	−311.57	−258.91	−295.09	−281.87	−265.11	−278.38	−205.12	−275.72
S(I_1)	8.54	8.7	8.48	8.91	9.29	9.91	9.54	9.8
S(I_2)	13.09	12.72	11.97	12.01	12.07	12.21	12.89	14.12
S(I_3)	30.73	31.51	32.73	33.21	33.41	33.67	33.88	33.59
S(I_4)	51.5	50.66	50.36	49.54	49.11	48.34	47.7	46.73
S(I_5)	4.53	4.4	4.03	3.95	4	4.18	4.28	4.4

Note: I1 = own earnings; I2 = earnings of other household members; I3 = non-labour, private income; I4 = transfers; I5 = direct taxes and insurance contribution. Source: Authors' calculations based on UKHLS

0.02), confirming that households with multiple earners do not experience correlated earnings shocks.

The covariance between individual earnings and benefit income gives information about the extent the benefit system can reduce income volatility. Table 2 (rows 8 and 11) shows that, for working age respondents, benefit income changes are negatively correlated with changes in earnings, which reduces the volatility of disposable income. The ability of the benefit system to insure against income volatility decreased in the period under study for working age respondents. From 2010 and 2017, the covariance between changes in own earnings and changes in benefit income (C (I1, I4)) was halved, whereas the covariance between changes to the earnings of other household members and changes to benefit income (C(I2, I4)) fell by more than a quarter.

The covariance between taxes and earnings changes also fell throughout the period, albeit the magnitude of the fall was smaller (between 9 and 23% depending on the earnings concept).[13]

Together, these results suggest that the ability of the British tax-benefit system to automatically stabilize incomes of the working age has diminished. Taxes and benefits represented a smaller share of disposable income in 2017 compared to 2010 and changes in taxes and benefits are much less well correlated with changes in earnings. These results are consistent with the policy changes taking place in this period: cuts to working age benefits and increases in the maximum amount exempted from income tax.

Table 3 shows variance decomposition results for individuals aged over 60. The volatility of earnings increased slightly from 2010 to 2017, mostly due to increased employment rates. On

[13] Income tax in the UK is levied at the individual level, but the variable measuring tax payments that we use is calculated at the household level.

the other hand, the variance of non-labour private income fell by 42%. Similarly, the variance of benefit income changes fell by a quarter while that of taxes remained relatively stable.

The share of benefit income fell among the 60+ by almost 5 percentage points, and the share of earnings and other private income sources has increased. As expected, benefit income changes are negatively correlated with changes in earnings but *positively* correlated with changes in non-labour private incomes; this may reflect individuals starting to receive both state pension and private pensions at the same age. Over the period we study, the covariance of benefit income changes with own earnings changes has remained relatively stable whereas that with non-labour private income changes fell significantly but continues to remain positive. Finally, the covariances between taxes and market incomes changes have changed by little.

Summing up, the capacity of the tax-benefit system to smooth the short-run volatility of incomes of individuals aged 60+ was largely unchanged: the share of benefit income fell for this group as well, but changes in taxes and benefit have become slightly better correlated with changes in private incomes. This pattern is consistent with individuals in the 60+ group being much less affected by benefit cuts, and also benefiting less from the increase in the personal allowance.

Overall, the changes in the volatility of household disposable income were the result of two conflicting trends. On the one hand, declining earnings and non-labour income volatility reduced the volatility of household disposable incomes. On the other hand, taxes and benefits became less well correlated with earnings, and became a less important component of disposable income, both of which limit their ability to counteract swings in labour income for the working age. This is not enough, though, to outweigh the first impact, and so overall the volatility of disposable incomes fell.

7 Robustness and Sensitivity Checks

In this section, we present results from alternative specifications as a sensitivity check on our main findings. Figure 9 presents volatility trends by income source when the sample is restricted to the balanced panel. This provides a check that differential attrition is not affecting our results.[14] Comparing panel a and b of Fig. 8 shows that using a balanced panel makes virtually no difference for the estimation of income volatility. The level of volatility is slightly lower when estimated on the balance panel, but the difference with the level of volatility estimated on the unbalance panel is negligible (between 0.5 and 4.5 depending on income and year). The trends are virtually identical.

We next review the sensitivity of our results to income imputations. Our income concepts are aggregations of individual income sources and have an imputation flag indicator recording the proportion of income that has been imputed.[15] We construct four alternative samples restricted to include only observations where the share of imputed income in total gross

[14] Because most of the income concepts we use are household level but households themselves are not a longitudinal unit of observation, it is not immediately clear how 'balanced' should be defined. We therefore include all individuals for whom an individual interview exists in all 8 waves regardless of any components of household income being imputed (which would be due to non-response from the individual herself or other household members. We have also experimented with including all individuals for whom income data (collected or imputed) exists in all 8 waves. Results (available from the authors upon request) are unchanged.

[15] Table A1 of the supplementary materials reports the share of missing data by wave and decile for the main income components.

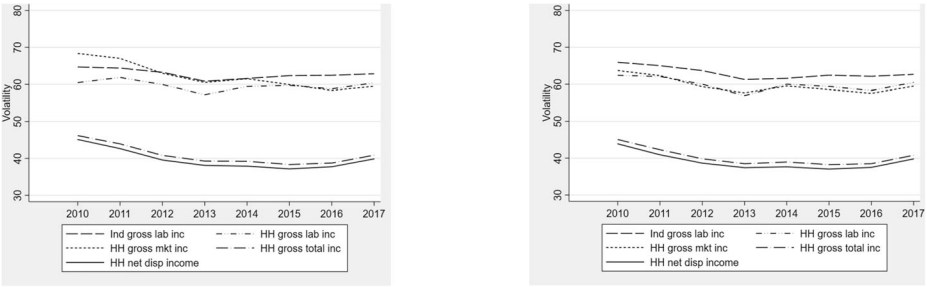


Fig. 9 Volatility of individual and household incomes, 2009–2017, full and balanced panels. (**a**) Full sample (**b**) Balanced sample

household incomeis: i) less than 50% ii) less than 20%, iii) 0% (i.e. there is no imputed income) and iv) 0% in all waves. Note that the fourth specification is very restrictive as it requires valid income information in all waves not only of the individual but also of all the other members of her household: only 1358 individuals out of 40,672 satisfy this condition (See Table 4).

Figure 10 shows volatility estimates (using both working age and old-age individuals) computed using these restricted samples. Volatility levels drop slightly when we impose restrictions on the amount of imputed income. Trends, however, are remarkably similar for all income concepts. The only exception is the fourth specification where we restrict our sample to individuals in households where all members supplied valid income data in all waves. The level of volatility is much lower for this subsample and the volatility of individual labour income is increasing rather than falling. However, this is a very small and selected sample compared to the rest.

8 Discussion and Conclusions

Using individual and household longitudinal data, we examine the volatility of earnings, household disposable income (as well as intermediate income concepts) between 2009 and 2017. We find that the volatility of individual earnings declined by around 6% among people of working age. Similar declines occurred in the volatility of household gross labour and private incomes. The fall in volatility is driven primarily by a reduction in the size of negative shocks to earnings stemming from increased labour market attachment and fewer labour market exits. These findings are consistent with strong employment and earnings growth

Table 4 Number of individuals and observations, various alternative specifications

Sample	# individuals	# observations
Balanced sample	16,594	111,368
Imputed income <20%	32,679	122,051
Imputed income<50%	35,953	144,809
Imputed income=0%	28,123	86,151
Imputed income=0% in all waves	1358	8845

Source: Authors' calculations based on UKHLS

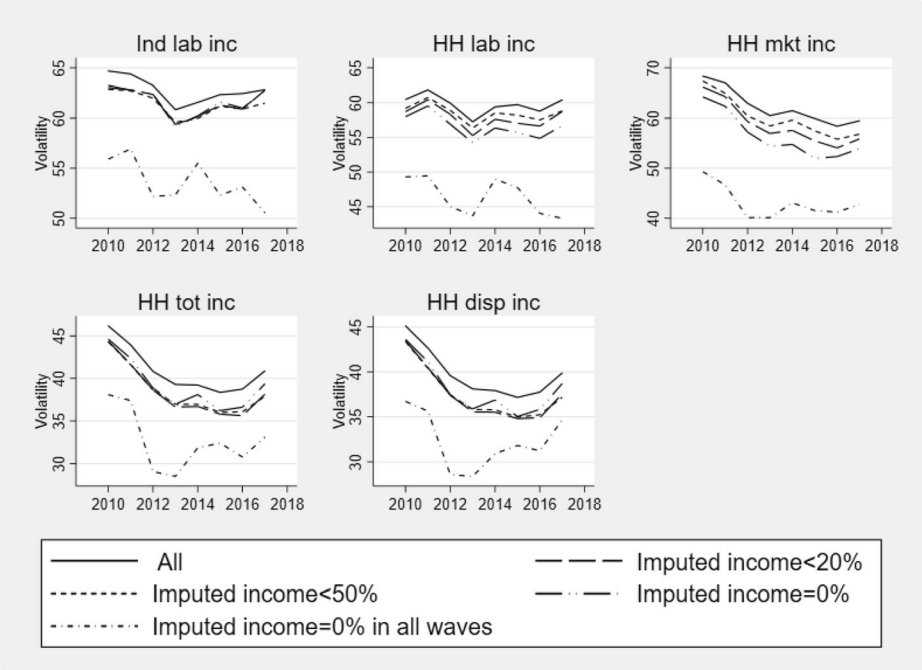


Fig. 10 Impact of income imputations on the volatility of individual and household income 2009–2017

among low-income households during this period. We also present volatility for the self-employed who represent a significant part of the UK labour force. We find that the self-employed have income that are approximately twice as volatile as those of employees. We also find that volatility increased for this group towards the end of the period we study.

The volatility of household gross private income fell dramatically for respondents aged 60+ driven by a fall in the size of positive shocks to private pension income. While we do not have any direct evidence, we believe stock market volatility in the wake of the financial crisis induced some individuals to postpone annuitizing their defined contribution assets and this led to a larger than average number of positive shocks when the stock market recovered in 2010 and 2011.

Consistent with the existing body of evidence, we find that the tax-benefit system plays a significant role in reducing the volatility of labour and other private income. We show that, in our case, this is dominated by the transfer system (that is social security benefits, means-tested safety net benefits, and income-related refundable tax credits), rather than taxes.[16] The reduction in volatility is higher for older individuals (at around 40%) compared to working age individuals (at around 30%). In the specific case of labour market exits, the tax-benefit system greatly reduces the size of negative shocks - the 10th percentile of income changes is approximately halved when we consider net income after taxes and benefits. However, for the latest part of the time span considered (2016–2017) we find worrying signs suggesting that this

[16] In future research it would be interesting to further understand cross-country differences in the degree of income smoothing from taxes and benefits. Differences can arise due to differences in methodology, data (eg. annual vs. current) and also the period considered.

insurance against large negative shocks is declining. Consistent with the fact that policy reforms over this period cut working-age benefits and increased the amount of income that is free from tax, we find that, among the working-age population, changes to tax payments and (especially) payments of cash benefits became less well correlated with changes in earnings.

Our main volatility estimates are very similar to the headline results of Jenkins and Cappellari (2014), who use the BHPS to analyse the period of time immediately before the one we consider. Like Jenkins and Cappellari (2014) did for earlier years, we find no change in the volatility of earnings among the continuously employed (including the self-employed) but a falling volatility of labour income due to an increased share of individuals who are continuously in work. Cuts to working age benefits during the period reduced the ability of the tax-benefit system to cushion negative earnings shocks. Further research is needed to check that our findings are replicated using other measures of income instability such as transitory variances from income dynamics models.

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