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Earnings and labour market volatility in Britain, with a transatlantic comparison

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HIGHLIGHTS

- New evidence about earnings instability for Britain
- Findings for men and women, employed workers and all workers
- Between 1992 and 2008, earnings volatility was constant for both sexes
- Between 192 and 2008, labour market volatility declined for both sexes
- This decline is related to changes in employment attachment
- British trends differ from their US counterparts

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ABSTRACT

We contribute new evidence about earnings and labour market volatility in Britain over the period 1992–2008, for women as well as men, and provide transatlantic comparisons (Most research about volatility refers to earnings volatility for US men.). Earnings volatility declined slightly for both men and women over the period but the changes are not statistically significant. When we look at labour market volatility, i.e. also including individuals with zero earnings in the calculations, there is a statistically significant decline in volatility for both women and men, with the fall greater for men. Using variance decompositions, we demonstrate that the fall in labour market volatility is largely accounted for by changes in employment attachment rates. We show that volatility trends in Britain, and what contributes to them, differ from their US counterparts in several respects.

1. Introduction

There is a substantial literature for the USA analysing trends in earnings instability using a range of measures and data sets, with a critical issue being whether instability has been increasing in parallel with the well-known rise in cross-sectional earnings inequality. The balance of evidence suggests that, at least for men, earnings instability grew over the 1970s through to the 1990s but levelled off thereafter — which is in contrast to the emphasis on ever-growing instability (and consequential greater income risk) that is emphasized in popular accounts such as those by Gosselin (2008) and Hacker (2008). Earnings inequality in Britain has also increased over the last three decades, for both men and women. For example, the ratio of the 90th percentile to the 10th percentile increased during the 1980s (by 2.4 and 1.9 percentage points per year for full-time men and women respectively) and the 1990s (1.1 and 1.0 percentage points per year), and continued to increase during the 2000s albeit at a decreasing rate (0.7 and 0.3 percentage points per year): see Machin (2011: Table 11.1). However, there is little evidence about what happened to earnings instability in Britain, especially in the 1990s and 2000s. This paper provides a transatlantic perspective on

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earnings and labour market instability and its trends, with new evidence for Britain for the period 1992–2008.

There are several reasons for interest in longitudinal earnings instability (See the reviews by inter alia Gottschalk and Moffitt 2009 and Moffitt and Gottschalk, 2012.). First, information about the longitudinal earnings processes contributes to understanding of the causes of the rise in inequality in the cross-section (more on this in Section 2). Second, the information helps understanding of other aspects of household behaviour. Consumption smoothing is greater in the face of transitory income shocks compared to permanent shocks (Friedman, 1957; Attanasio and Weber, 2010). Third, there is much interest in earnings and income stability from a normative perspective. An increase in instability increases longitudinal mobility (re-ranking in the earnings distribution) and also equalizes lifetime incomes, aspects that are often viewed as welfare-improving (Shorrocks, 1978; Gottschalk and Spolaore, 2002). Fourth, much of the research interest in earnings instability is undoubtedly because of its connection with income risk. This is emphasized in the books by Hacker (2008) and Gosselin (2008) though, as many economists have emphasised, assessments of the welfare consequences of greater instability also need to take into account the extent to which earnings changes reflect voluntary decisions by workers and their families and the extent to which they are insurable in principle and anticipated and insured against in practice. See the caveats expressed by, for example, Celik et al. (2012), Dahl et al. (2011), Dynan et al. (2012), Moffitt and Gottschalk (2012), and Shin and Solon (2011). For structural models aiming to identify income risk, see Blundell et al. (2008) and Cunha et al. (2005).

The substantial body of research about earnings instability about the USA does not exist in the same form for most other countries, and yet cross-national comparisons help benchmark estimates of levels and trends for each country, and raise questions about similarities and differences in labour markets and other institutions. Most of the US research on earnings volatility has been based on the Panel Study of Income Dynamics and matched data from the Current Population Survey (with recent research also drawing on administrative record data). We argue below that the survey data we use, from the British Household Panel Survey, are of high quality and compare well with US survey data. They are therefore a good source for examining volatility for the first time for Britain and also for undertaking transatlantic comparisons.

Earnings instability has been characterized in three ways in the literature — using transitory variances estimated from parametric models of earnings dynamics or their non-parametric counterparts, or using measures of 'volatility' that summarize the dispersion across individuals of short-run earnings changes (see below for more discussion). In this paper, our evidence for Britain about levels and trends in earnings instability is based on measures of volatility. There are no previous estimates that we are aware of; so our first contribution is this new evidence.

We use multiple measures in order to check the robustness of our estimates of trends. Our headline results are based on the standard deviation (or variance) of two-year earnings changes. In addition to the methodological advantages of this measure (discussed in the next Section), use of this volatility measure leads to the further contributions of our paper.

Second, we examine not only earnings volatility among workers with positive earnings in two consecutive years (as in most previous studies), but also the volatility among all workers, including those gaining or losing a job or remaining without a job. This simply cannot be done if one follows the 'transitory variances' approach to measuring instability literature (see below) because it uses log(earnings) measures which are undefined if earnings are zero. Our research follows Ziliak et al. (2011) who in turn used the volatility measure proposed by Dynan et al. (2012) that allows one to 'include the zeros'. For brevity, we use the term 'earnings volatility' to refer to volatility among workers with positive earnings at the two time points, and we use the term 'labour market volatility' to refer to volatility among all potential workers, i.e. including individuals with zero earnings as well as those with positive earnings.

Third, and related, we provide estimates about volatility trends for women as well as men. This is appropriate given the secular increase in women's employment rates over the last few decades and the growing importance of women's earnings to total household income. Like most US studies of earnings instability of all three types, those using volatility measures have either focused on men only (e.g. Cameron and Tracy, 1988; Celik et al., 2012; Juhn and McCue, 2012; Shin and Solon, 2011; Shin, 2012) or examined household heads (mostly men) and their spouses (Dahl et al., 2011; Dynan et al., 2012). Indeed, Dynan et al. (2012) restrict their attention to household heads belonging to households that do not experience a change in head or residential mobility (they were primarily interested in the volatility of family income rather than of earnings). Only Ziliak et al. (2011) study volatility for US men and women regardless of headship status in a systematic manner. Some comparisons of volatility in the USA and EU countries are presented in an OECD report (2011) and its background working paper (Venn, 2011), but the focus is on a single volatility measure and estimates for men and women are not provided separately.

We show that earnings volatility in Britain declined slightly for both men and women between 1992 and 2008 but the changes are not statistically significant. When we widen the scope to look at labour market volatility, we find that there is a statistically significant decline over the period for both women and men, with the fall greater for men. Using variance decompositions, we demonstrate that the main factor accounting for the downward trend in labour market volatility is a secular decline in the proportions of workers moving into and out of employment combined with greater employment attachment, and suggest a business cycle explanation for this. The flat trend in earnings volatility is not attributable to factors related to job-changing that offset each other, or to changes in part- and full-time working, or secular improvements in educational qualifications. We show that these findings about British trends differ from those for the USA in several respects. In particular there has been no fall in labour market volatility in the USA as there has been in Britain and trends in employment attachment rates are quite different.

2. Methods for measurement of earnings instability

Earnings instability has long been associated with the transitory variance of earnings, and estimated using both parametric model-based and non-model-based methods. There is a long tradition of fitting parametric models of earnings dynamics, from the pioneering research by Lillard and Willis (1978) onwards. Applications of this variance component approach include Abowd and Card (1989), Baker (1997), Baker and Solon (2003), Haider (2001), Guvenen (2009), Hause (1980), Lillard and Willis (1978), Lillard and Weiss (1979), MaCurdy (1982), and Moffitt and Gottschalk (2011, 2012). All this research uses US or Canadian data. Applications to British men's earnings data are Daly and Valletta (2008), Dickens (2000), Kalwij and Alessie (2007), and Ramos (2003). An excellent review of variance component modelling and recent extensions is provided by Meghir and Pistaferri (2011).

To fix ideas, suppose that the dynamics of earnings can be described using the canonical random effects model:

$$y_{it} = u_i + v_{it}. \quad (1)$$

The logarithm of earnings for person i in year t, y_{it}, is equal to a fixed 'permanent' random individual-specific component, u_i, with mean zero and constant variance σ_u^2 (common to all individuals), plus a year-specific idiosyncratic random component with mean zero and variance σ_{vt}^2 (common to all individuals) that is uncorrelated with u_i. Thus, total inequality as measured by variance of log income, σ_t^2, is equal to the sum of the variance of 'permanent' individual differences plus the variance of 'transitory' shocks:

$$\sigma_t^2 = \sigma_u^2 + \sigma_{vt}^2. \tag{2}$$

Assuming that permanent differences are relatively fixed over time, changes over time in cross-sectional income inequality arise mostly through changes in the variance of the transitory component. The interpretation of this latter component as idiosyncratic unpredictable income change leads to the association of changes in the transitory variance with changes in income risk.

Of course, the parametric models cited above use much more sophisticated specifications than Eq. (1), for instance, allowing the permanent component to follow a random walk or have individual-specific rates of growth; allowing for persistence in transitory shocks described by a low-order autoregressive moving average process; and also allowing for calendar-time variation in the transitory and permanent components' shares of total earnings inequality by including year-specific 'factor loading' on each component.

At the same time, the parametric variance components modelling approach has potential weaknesses. Guvenen (2009) and Doris et al. (2013) draw attention to the difficulties of differentiating between model specifications when using the panel data sets on earnings that are typically available. Also, robust identification is difficult without relatively long panels. Similarly, Shin and Solon make the case that model-based 'estimates of trends can be sensitive to arbitrary variations in model specification' (2011: 975), making reference to the finding of Baker and Solon (2003) that specifications used in previous work were rejected by their more general specification fitted to rich administrative data. To illustrate this point further, we note that the estimated time paths of the transitory earnings variance are quite different in the Ramos (2003) and Daly and Valletta (2008) studies for Britain despite only relatively minor differences in model specification.

All of the studies cited so far in this Section consider men's earnings and so women's earnings are not analysed. Also, all refer to workers with positive earnings and any additional labour market instability associated with movements into or out of employment is not captured.

Model-based estimates of the transitory variance have been supplemented by non-parametric estimation approaches, notably by what Moffitt and Gottschalk (2012) refer to as a 'window averaging' method (otherwise known as the Gottschalk and Moffitt (1994) 'BPEA' method). See also their more recently proposed 'approximate non-parametric' method (Moffitt and Gottschalk, 2012).

Shin and Solon (2011) argue that the window averaging method provides biased estimates of the transitory variance on the grounds that it also reflects (unobserved) changes over time in the contribution of the permanent component of the total earnings variance. In short, any descriptive measure is likely to capture permanent as well as transitory shocks. But Shin and Solon do not see this as a problem: '[b]ecause permanent shocks … are even more consequential than transitory ones, it makes sense to include them in a measure of earnings volatility' (2011: 976), and they argue for 'transparent methods that focus on simple measures of dispersion in year-to-year earnings changes' (2011: 973).

There is now a growing number of papers about the USA using these measures of earnings volatility in addition to Shin and Solon's own research: see Cameron and Tracy (1988), Celik et al. (2012), Congressional Budget Office (2008), Dahl et al. (2011), DeBacker et al. (2013), Dynan et al. (2012), Juhn and McCue (2012), Shin and Solon (2011), Shin (2012), and Ziliak et al. (2011). In the spirit of this literature, our research also employs 'simple measures' but studies Britain, for which there are no previous estimates. We consider both men and women, and both earnings and labour market volatility.

In a companion paper (Cappellari and Jenkins, 2013a), we derive estimates of trends in transitory earnings variances for British men and for women using parametric variance component models and find broadly similar trends to those reported below for earnings volatility. Window-averaging estimates of transitory variances for men also show the same trends as those we report later in this paper for earnings volatility (Jenkins, 2011a,b).

3. Data and measures of volatility

3.1. Data

We use data from waves 1–18 (survey years 1991–2008) of the British Household Panel Survey (BHPS). The BHPS is a household panel with design features similar to those of the US Panel Study of Income Dynamics (PSID). Some relevant BHPS–PSID differences are discussed below. The original BHPS respondents were a nationally-representative sample of the private household population of Great Britain (England, Wales, and Scotland) in 1991. The survey re-interviewed respondents annually thereafter in the autumn of each year, through to 2008 which was the final year of the survey and hence also the last year covered by our analysis. Although a large fraction of the BHPS sample was included in the panel survey that replaced the BHPS (Understanding Society), the first interviews in the new survey were in 2010, and households were interviewed throughout the year rather than in the autumn (so their first interview in the new survey was 18 months or more after the final BHPS interview, rather than around one year later). In any case, suitable earnings data from Understanding Society had not been released when we began our research.

Our analysis of earnings instability is based on individual-level earnings changes between two consecutive years $t - 1$ and t, for $t = 1992$, …, 2008. We focus on working-age individuals in employment or non-employment. More specifically, we work with samples that exclude individuals who were (i) aged either less than 16 years or aged 60 years or more at t or $t - 1$; (ii) non-respondents (did not provide a full, telephone or proxy interviews at t or $t - 1$); (iii) self-employed at either t or $t - 1$; or (iv) a full-time student at either t or $t - 1$.

The age selection is similar to that of Ziliak et al. (2011). Although the age range is wider than those used by, for example, Shin and Solon (2011) and others who use a bottom age limit of 25 years, our choice is effectively the same because we also drop individuals in education (We repeated the main analyses dropping all individuals aged less than 25 years and the findings were the same.). Regarding the top age limit, note that the State Retirement Pension (SRP) age in the UK was 60 years for women and 65 years for men over this period, and that a significant proportion of men and women leave the labour market before the SRP age (Office for National Statistics, 2013). We drop self-employed individuals, as do all studies of earnings instability that we are aware of (whether model- or non-model-based), because of concerns that self-employment earnings data are less accurate than employment earnings data due to a combination of higher rates of response error and higher rates of item non-response. For discussion of self-employment earnings and non-response in the BHPS, see Jenkins (2011a: Chapter 4).

The total base sample size for the period as a whole was an unbalanced panel of around 6357 men (43,880 person-years) and 6697 women (54,130 person-years). This corresponds to subsamples for each $(t - 1, t)$ year pair of between 2000 and 2600 men, and between 2600 and 3300 women. The BHPS sample sizes for men are larger than those used in Shin and Solon's (2011) study of US men's earnings volatility using PSID data (ranging between about 1000 and 2000 individuals per year-pair). The sample sizes are substantially smaller than those derived from matched-CPS data (Ziliak et al., 2011 report sample sizes of men and women combined of between 10,000 and 30,000 for each year pair) or from longitudinally-linked administrative record data (Congressional Budget Office, 2008; Dahl et al., 2011 use Continuous Work History Sample data comprising more than 700,000 individuals for each year pair). Given BHPS sample sizes, we report standard errors for our headline estimates (as did Shin and Solon, 2011), and use only relatively coarse subgroup breakdowns in our volatility decomposition analysis (Section 5).

Sample attrition is a negligible issue for the analysis. This is because wave-on-wave retention rates are very high in the BHPS (95% or greater), and we are considering two-year changes only. Weights that adjust for non-response and post-stratification grossing-up to match population totals are supplied with the BHPS, but their use makes little difference to earnings volatility estimates and so for brevity we report only results based on unweighted data (sensitivity analyses are reported in Appendix A).

The quality of our earnings measures benefits from the BHPS design: interviews are sought with all individuals aged 16 or more years within a household. Hence information about earnings is gathered from the earner himself or herself, by contrast with the practice of the US PSID or CPS, each of which uses a single household informant to report on each household member's earnings. The BHPS practice is likely to improve reporting accuracy especially for women's earnings since household headship in couple households is typically attributed to men. In addition, earnings data are not top-coded in the BHPS, also by contrast with the PSID and CPS.

Our principal measure of earnings is earnings from employment in the pay period most recent to the annual BHPS interview, converted to a monthly amount pro rata (BHPS variable *pay g*). The measure refers to a main job, whether part-time or full-time, and does not include earnings from any second or other jobs (which are less well measured). Nominal amounts are converted to 2011 prices using the consumer price index (UK Office for National Statistics series D7BT). Earnings values are positive for workers and zero for non-workers.

Our earnings measure differs from the 'annual earnings' measures used in US studies of earnings volatility. Although a measure of 'annual labour income' is released in the BHPS files, arguably this measure is inherently less accurate than the current earnings measure because it is estimated by the survey producers from responses to a series of questions about last earnings received (as above) and retrospective recall questions about circumstances during the reference period: numbers of weeks worked, dates of job changes (if any) and the earnings received when beginning a new job or jobs. The BHPS emphasis on current earnings is in line with virtually all UK household surveys.

Although the BHPS current earnings variable is of better quality than the BHPS annual labour income variable, its use is potentially problematic if used for comparisons with the USA. Because some people do not work all year round, there is a greater chance of finding zero earnings values with a current earnings measure than an annual measure. Put another way, some of what may be counted as labour market volatility when a current measure is used would contribute to earnings volatility were an annual measure to be used. To minimize the chances of the problem contaminating our transatlantic comparisons, we use annual earnings measures for these after first demonstrating that our principal findings about British volatility trends are the same regardless of whether a current or annual measure is used.

Respondents with missing values on the BHPS monthly (and annual) earnings variables have values imputed by the survey producers using a regression-based cross-wave predictive mean matching procedure. In line with the concern expressed by US researchers about measurement error and hence spurious earnings instability being introduced by item-response imputation ('allocated earnings' in US jargon), the results that we report in the main text are based on samples from which imputed observations are dropped. We show in Appendix A that including observations with imputed earnings in the calculations changes results very little.

To ensure that longitudinal earnings changes reflect genuine instability rather than systematic lifecycle variation, many US studies age-adjust earnings or earnings changes: observed earnings (or earnings changes) are regressed on a polynomial in age, and subsequent analysis is of earnings residuals. We show in Appendix A that volatility estimates based on age-adjusted and raw earnings changes are very similar in our data set and so we focus on unadjusted estimates in the main text. Observe in addition that the BHPS following rule ensures that the average age within each of our two-year sub-samples changes little over the 18-year period, reducing the likelihood that estimates of volatility trends are driven by sample ageing. For men, the average age increases from 36 in the 1992 subsample to 40 in the 2008 subsample; for women the corresponding averages are 37 and 40 years.

Many US studies of earnings instability use samples from which the top and bottom one per cent of positive earnings observations are dropped (e.g. Shin and Solon, 2011; Celik et al., 2012; Moffitt and Gottschalk, 2012). The motivation is to reduce the influence of top-coding (not relevant in the BHPS case) and of outlier observations. Like Dahl et al. (2011: 753), our preliminary analysis suggested that trimming made little difference to estimated trends in earnings volatility and so for brevity the results reported below refer to estimates based on untrimmed distributions. An additional reason for not trimming the data is that we are interested in labour market volatility as well as earnings volatility and, for the commonly-used arc standard deviation measure of volatility (see below), observations moving from employment to non-employment or vice versa are attributed with earnings change values that would be at risk of being dropped were trimming to be employed although they are genuine. Hence, rather than trimming the data to reduce the influence of outliers, we employ a number of earnings instability measures that are more robust to the influence of outliers than the standard deviation in order to check the sensitivity of our results.

3.2. Measures of volatility

The principal measure of volatility used in this paper is the standard deviation of the arc percentage change in individual earnings between two years $t-1$ and t, I, a measure also used by Dahl et al. (2011), Dynan et al. (2012), and Ziliak et al. (2011):

$$I = \sqrt{\text{Variance}[100(E_{it} - E_{it-1})/E_{i\tau}]}, \tag{3}$$

where $E_{i\tau} = (E_{it-1} + E_{it})/2$ for each individual i with earnings E_{it} in year t. $E_{i\tau}$ is the two-year longitudinal average of person i's earnings. If an individual is not working at both $t-1$ and t, his or her arc percentage change value is set equal to zero. Individual earnings changes are therefore bounded above by 200% and below by −200%. The aggregate measure of volatility, I, is bounded below by zero, which corresponds to the (unlikely) case in which the arc percentage change in earnings is the same for every individual; otherwise, the greater is the dispersion (variance) of individual earnings changes, the greater is volatility measured by I. In most of our analysis, the standard deviation is used to summarize dispersion rather than the variance because the former leads to a volatility measure that is in the same metric as earnings levels and earnings changes (Dynan et al., 2012). However, we do use the variance when decomposing total volatility into within- and between-group components because the standard deviation is not additively decomposable (see below).

Measure I has the advantage that it can be used to summarize both earnings volatility and labour market volatility, precisely because zero-earnings values can be included in the measure. Shin and Solon (2011) and subsequent research (e.g. Celik et al., 2012; Shin, 2012; Ziliak et al., 2011) also summarize earnings volatility using the standard deviation of the distribution of changes in log(earnings), S:

$$S = \sqrt{\text{Variance}[\log(E_{it}) - \log(E_{it-1})]}. \tag{4}$$

S is defined only for workers with positive earnings at both $t-1$ and t. If the distribution of earnings changes primarily consists of relatively

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small values, then $S \approx I$. We confirm below that S and I provide very similar estimates of earnings volatility trends in Britain.

As summary measures of dispersion in a distribution, the standard deviation and variance are known to be potentially sensitive to outliers. We check the robustness of our estimates of trends by presenting more information about the complete distribution of earnings changes at each t – we track quantiles of the earnings change distribution over time (as did Shin and Solon, 2011 and Dahl et al., 2011) – and we also present estimates for two other summary indices. The absolute Gini coefficient (one-half of Gini's mean difference) of the earnings change distribution, A, is a monotonic transformation of the 'L2 moment', a measure of dispersion based on order statistics with desirable properties such as greater robustness to outliers compared to the variance: see Hosking (1990) for details. We also provide estimates of the proportion of persons experiencing a year-on-year earnings change greater than 20% in magnitude, P. A volatility measure of this form was used by Dahl et al. (2011), Monti and Gathright (2013), OECD (2011), and Venn (2011). P is analogous to a headcount measure of poverty (because it only depends on the prevalence of earnings changes larger than some threshold value) rather than a measure of inequality of earnings changes per se. However, it can also be interpreted as being another measure which downweights very large earnings changes (since all arc percentage changes greater than 20% are treated the same).

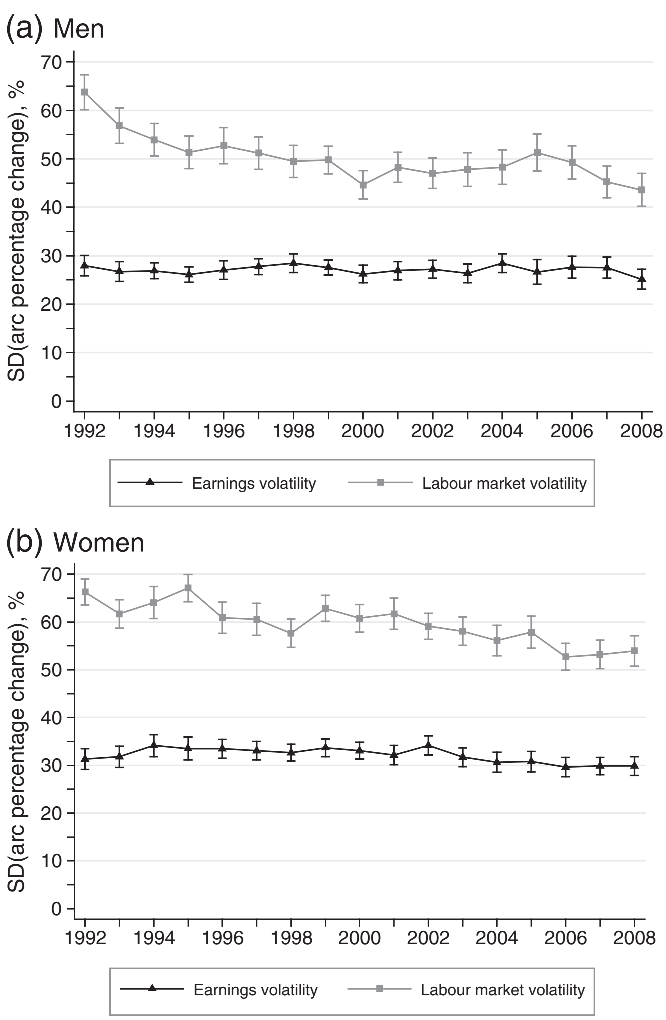

Fig. 1. Earnings and labour market volatility for British men and women, 1992–2008. Notes: authors' estimates are from BHPS data (unweighted, not age-adjusted, excluding imputed earnings values). The measure of volatility is I (see main text). Error bars show point-wise 95% confidence intervals, calculated using bootstrap standard errors (1000 replications) accounting for survey clustering and stratification. Year labels refer to year t for earnings changes between $t - 1$ and t.

4. Volatility trends: Britain, 1992–2008

Our headline estimates of trends in earnings and labour market volatility are shown in Fig. 1 for men and women (These are based on the BHPS current earnings measure; estimates based on annual earnings are presented later.). Volatility is summarized using the standard deviation of the arc percentage changes in earnings (I). In each chart, the lower line summarizes earnings volatility (calculated for annual subsamples with positive earnings in both years) and the upper line summarizes labour market volatility (calculated for samples also including individuals with zero earnings). The vertical bars show 95% confidence intervals around each year's volatility estimate, derived using bootstrap estimates of standard errors that take account of the BHPS survey design (clustering and stratification).

For both men and women, there is no significant change in earnings volatility over the period 1992–2008. For men, the estimate of I for 1992 is 27.9% (standard error: 1.83) and for 2008, 25.1% (s.e.: 1.33), representing a decline of 2.8 percentage points or around 3% but which does not differ significantly from zero (t-statistic for test of non-zero difference assuming independence = 1.3). Earnings volatility is slightly greater for women than for men, but the trend is also flat. I is estimated to be 31.3% (s.e.: 1.11) for 1992 and 29.9% (s.e.: 1.00) for 2008, a decline of 1.4 percentage points or about 4.6% which does not differ significantly from zero (t-statistic = 0.96).

By contrast with earnings volatility, labour market volatility declined significantly over the period as a whole for both men and women. For men, we estimate that I fell from 63.8% (s.e.: 1.08) in 1992 to 43.6% (s.e.: 1.73) in 2008, which is a decline of 20 percentage points, or some 32%. The change in I is significantly different from zero (t-statistic = 9.9). For women, there is also a statistically significant decline (t-statistic = 5.7) but the size of the change is smaller: from 66.3% (s.e.: 1.40) in 1992 to 54.0% (s.e.: 1.62) in 2008, which is a fall of 12.3 percentage points or 18%. For men, the rate of decline is fastest in the early-1990s, and slowed thereafter but, for women, there is no similar pattern in the trend. For both sexes, there are year-to-year fluctuations in I, and most of these are within the bounds of sampling variability.

The estimates of volatility levels and trends shown in Fig. 1 are robust to whether individuals with imputed earnings are included in the estimation samples, whether there is age-adjustment of raw earnings changes, or whether sample weights are used: see Appendix Figs. A1 and A2. For example, the inclusion of imputed earnings observations increases volatility estimates (as expected), but the impact is very small.

The estimates of downward trends are also unaffected by the choice of index used to summarize volatility. Appendix Figs. A3 and A4 display estimates of labour market volatility for men and women respectively calculated using the standard deviation of the arc percentage earnings changes (I), the absolute Gini coefficient (A), and the percentage of individuals with an earnings change greater than 20% in magnitude (P). The main impact of using A and P rather than I is that the magnitude of the fall in volatility is smaller, reflecting the fact that the former two indices give a lower weight to large earnings changes including the change imputed when there is a change in labour force attachment. See Cappellari and Jenkins (2013b) for more discussion.

Fig. 2 shows trends in the quantiles of earnings change distributions for earners and all individuals, and by sex. Six quantiles are plotted; three below the median (the 5th, 10th, and 25th percentiles) and three above the median (the 75th, 90th, and 95th percentiles). The median change is not plotted in order not to obscure the plot lines (it is slightly above zero in each case; mean changes are shown later). It is clear that the flat trend in aggregate earnings volatility for men and

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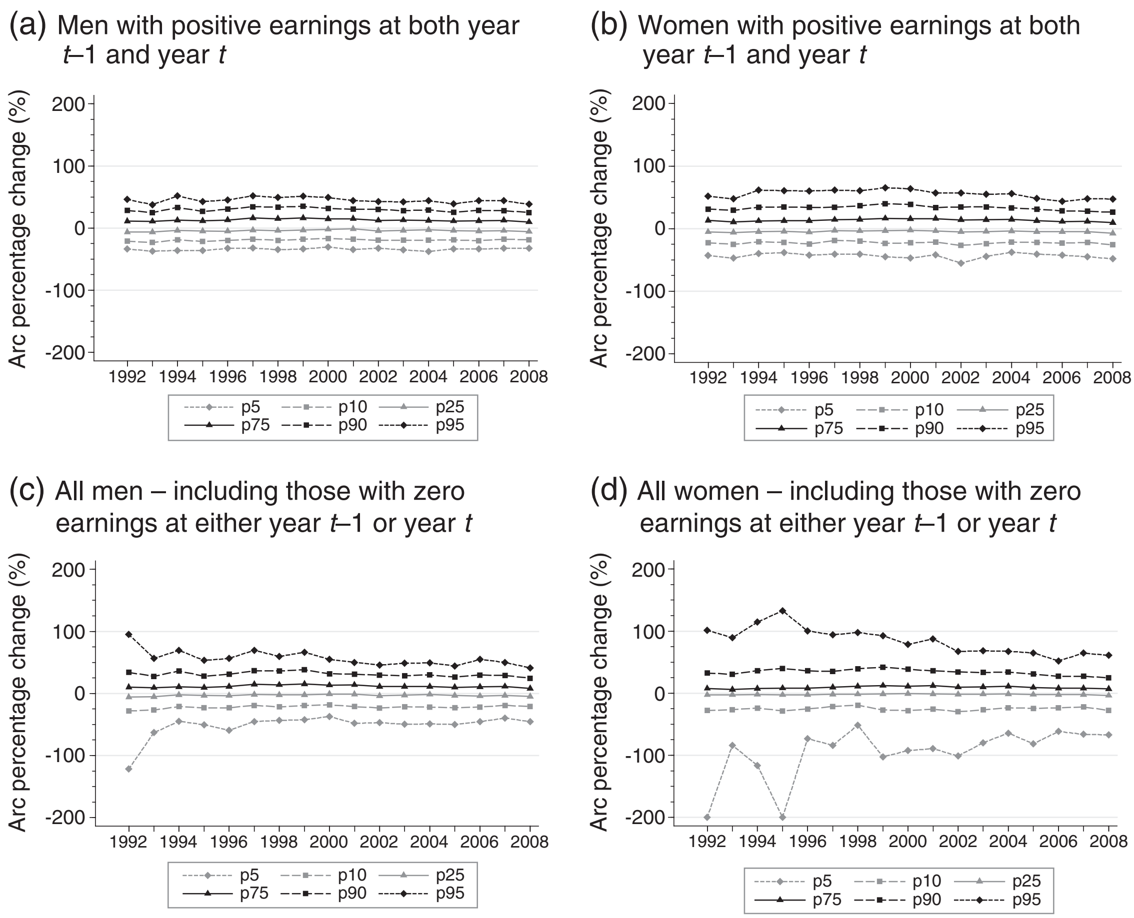

Fig. 2. Quantiles of the distributions of earnings changes for British men and women, including and excluding men with zero earnings. Notes: Authors' estimates are from BHPS data. Year labels refer to year t for earnings changes between $t-1$ and t.

women reflects flat trends in all sections of the earnings change distribution; it is not a matter, say, of there being a decline in large earnings changes being offset by a rise in small earnings changes. Turning to labour market volatility for men, we see that the faster rate of decline observed in the 1990s in aggregate volatility is due to a marked decline during this period in the magnitude of earnings increases and decreases for the individuals near the tails of the distribution. For women, for whom labour market volatility declined more continuously over the period as a whole, we see that this reflects a decline in the magnitude of earnings increases and earnings decreases for the individuals near the extremes of the distribution (as for men but to a greater extent), but this decline occurred over the whole period (unlike for men).

Do these time-series patterns for men and women reflect what is happening to earnings changes among individuals with a job at both $t-1$ and t, to the earnings changes associated with transitions into and out of employment, or to the proportions of individuals retaining, losing, or gaining employment? The contrasting trends for earnings and labour market volatility suggest that trends in employment transitions and the earnings changes associated with them are the relevant factors. The volatility decomposition analysis presented in the next Section provides a formal framework for answering these questions.

5. Accounting for volatility trends: decomposition analysis

We exploit the fact that, for a population of individuals that is exhaustively classified into a set of mutually-exclusive groups, the variance of a quantity for the population at a particular date, V, is equal to the sum of the 'within-group' variance plus the 'between-group' variance (See Celik et al., 2012; Ziliak et al., 2011.). The within-group variance is the weighted sum of the variances within each group, where a group's weight is equal to the group's size expressed as a proportion of the total population size (the subgroup 'population share'). The between-group variance is the variance in the population that would arise were each individual to be attributed with the mean value of the quantity for his or her group.

We decompose labour market volatility measured by the variance of individuals' arc percentage change in earnings ($V = I^2$), and four groups of individuals are defined depending on employment attachment at $t-1$ and at t:

- Group '11': with positive earnings at both $t-1$ and at t, and with variance V_{11}, mean M_{11}, and subgroup population share P_{11}.
- Group '00': with zero earnings at both $t-1$ and at t, and with variance V_{00}, mean M_{00}, and subgroup population share P_{00}.
- Group '01': movers from non-employment to employment, and with variance V_{01}, mean M_{01}, and subgroup population share P_{01}.
- Group '10': movers from employment to non-employment, and with variance V_{10}, mean M_{10}, and subgroup population share P_{10}.

The arc percentage earnings change is zero for every group member of group 00, and hence $M_{00} = 0$ as well. For every member of group 01, the arc percentage change is $+200$ and hence M_{01} equals $+200$. Similarly, $M_{10} = -200$. The population mean arc percentage earnings change, M, equals $P_{11}M_{11} + P_{00}M_{00} + P_{01}M_{01} + P_{10}M_{10} = P_{11}M_{11} + 200(P_{01} - P_{10})$, where $P_{11} + P_{00} + P_{01} + P_{10} = 1$. Since $V_{00} = V_{01} = V_{10} = 0$, the within-group variance is equal to V_{11} weighted by its population share P_{11}. The remainder of the total variance is accounted for by the four group-specific terms that comprise the between-group variance: for each group, the term is the square of the difference between the group's mean and the population mean, weighted by the group's population share.

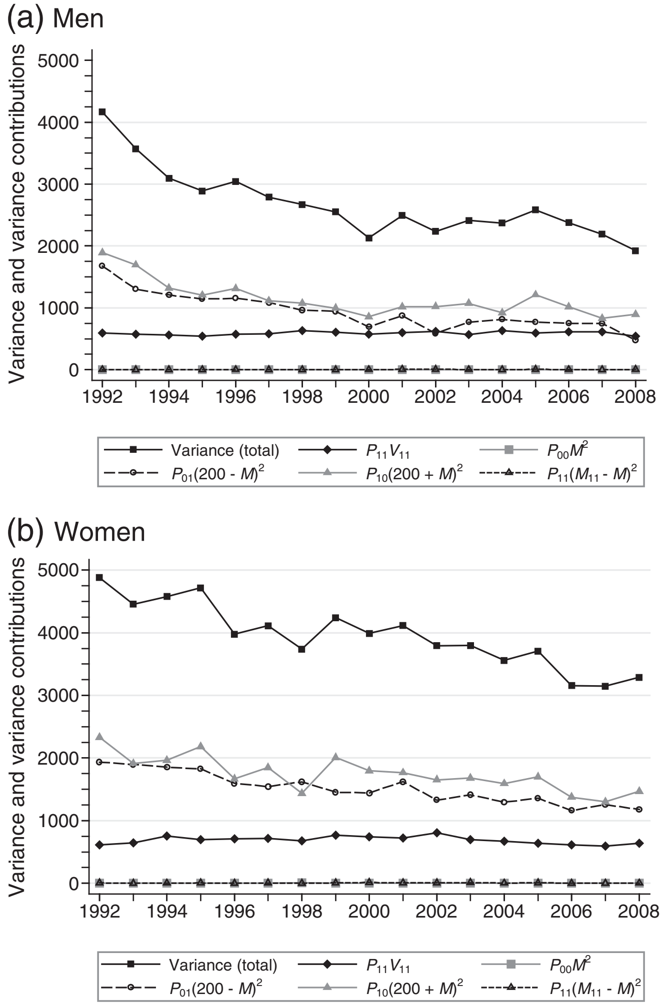

Fig. 3. Decomposition of labour market volatility by employment attachment, British men and women. Notes: Authors' estimates are from BHPS data. The measure of volatility is $V = I^2$ (see main text). The decomposition formula is shown in Eq. (3). The values of the variance and variance contributions, and the latter expressed as a share of the total variance, are tabulated by year and sex in Cappellari and Jenkins (2013b: Appendix Table A1).

It follows that labour market volatility in any given year can be written as the sum of five terms:

$$V = P_{11}V_{11} + P_{00}M^2 + P_{01}(200–M)^2 + P_{10}(200 + M)^2 + P_{11}(M_{11}–M)^2. \tag{5}$$

We can therefore account for trends in labour market volatility V by examining the changes over time in each of the five terms on the right-hand side of Eq. (5) and in their constituent components.

The trends in V and the five variance contributions are shown in Fig. 3 for men and women. Observe that the magnitude of the fall in labour market volatility is greater when calculated using V rather than I. For example, for men, the decline in V between 1992 and 2008 is around 54% (compared with 32%) and, for women, the fall is 18% (compared with 8.3%). For both sexes, earnings volatility accounts for virtually none of the fall in labour volatility in the 1992–2008 period since $P_{11}V_{11}$ does not change over time. The between-group contributions to labour market volatility from groups 11 and 00, $P_{00}M^2$ and $P_{11}(M_{11} - M)^2$, also do not change over time, and both are negligible in size in any case. Instead, the fall in V is attributable to declines in the between-group

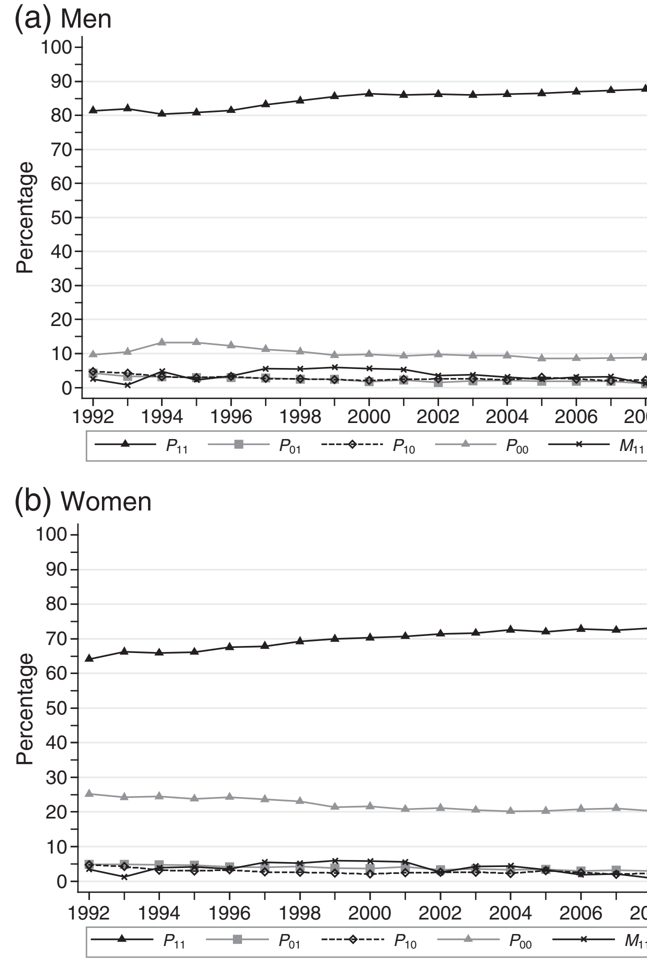

Fig. 4. Employment attachment rates (%), and conditional mean earnings changes (M_{11}): British men and women. Notes: authors' estimates from BHPS data. Employment attachment rates P_{11}, P_{01}, P_{10}, and P_{00} are defined in the main text.

contributions associated with transitions into and out of the labour market. For men, the rate of decline in $P_{01}(200 - M)^2$ and in $P_{10}(200 + M)^2$ is fastest in the early 1990s when V also fell fastest, whereas for women, the trend downwards in these two terms occurs more continuously over the period as a whole.

The trends in the variance contributions are themselves attributable to changes in the proportions of persons in each of the four labour market attachment groups and changes in M_{11} and V_{11}. The trends in P_{11}, P_{00}, P_{01}, P_{10}, and M_{11} are shown in Fig. 4. The pattern of mean earnings

Table 1
Labour market volatility (V) in Britain, 1992 and 2008, by sex: observed versus counterfactual estimates.

	Observed		Counterfactual	
			A	B
	1992	2008	2008	2008
Men	4169	1925	4073	1926
Women	4881	3288	4824	3288

Notes: Authors' estimates from using BHPS data. Calculations based on the decomposition formula V shown in Eq. (3). Counterfactual A assumes that group population shares (employment attachment rates P_{11}, P_{00}, P_{10}, P_{10}) are fixed at their 1992 values in 2008 and M_{11} and V_{11} are as observed in 2008. Counterfactual B assumes that M_{11} and V_{11} are fixed at their 1992 values in 2008 and the group population shares are as observed in 2008.

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changes among group 11 is a flat inverse U-shape for both men and women: M_{11} rises from less than 5% per year during the early 1990s to around 5% for the decade between the mid-1990s and mid-2000s, and then declines to less than 5% per year again subsequently.

The most perceptible changes over time are in the group population shares (employment attachment rates). Specifically, the proportion of men in group 11 rises from just below 81% at the start of the 1990s to around 86% at the start of the 2000s, after which the rate of increase is somewhat smaller (the group's share is 88% in 2008). The rise primarily reflects a shift from the proportion of men in group 00: the share decreases from just over 13% in 1994 to around 9% in the late-2000s accompanied by decreases in the shares in the other two groups. The population share of group 01 falls from just over 3% in 1994 to just over 1% in 2008; for group 10, the corresponding change is from just over 3% to just over 2%. For women, the rise in the population share of group 11 is more continuous over the period, increasing from around 66% in 1994 to 73% in 2008, matched by a decline in the proportion in group 00 from around 25% at the start of the 1990s to around 20% in 2008, together with small declines in the other two groups' shares (from just under 5% in 1994 to just under 3% in 2008 for group 01 and from just under 5% in 1994 to just under 4% for group 10). For brevity, annual estimates of V_{11} are not reported; we report the changes between 1992 and 2008 in Table 1. The direction of changes over the years in earnings volatility calculated using V_{11} is of course identical to the direction of changes for I summarized in Fig. 1, but the magnitude of the estimated decline over the period is greater for V_{11} than I. The fall in V_{11} between 1992 and 2008 is −15% for men (compared with −3% for I), and −18% for women (compared with −8%).

We illustrate the importance of the trends in group population shares for explaining trends in labour market volatility with a counterfactual exercise. Using Eq. (5), we can ask what labour market volatility would have been in 2008 were group population shares to have remained as they were in 1992 while M_{11} and V_{11} take their observed values for the two years (counterfactual A) or, instead, we can ask what labour market volatility would have been in 2008 if M_{11} and V_{11} were to have remained as they were in 1992 but group population shares take their observed values in the two years (counterfactual B). The results are summarized in Table 1. If population shares are fixed as in A, then the observed changes in group 11's mean and variance of earnings changes would have reduced labour market volatility between 1992 and 2008, but only slightly: just over 2% of the observed change in V for men, and just over 1% of the observed change for women. In contrast, counterfactual B shows that changes in the group population shares with M_{11} and V_{11} fixed generate estimates for V for 2008 that are virtually identical to those that are observed.

Assembling the evidence, the story that emerges for both men and women is that earnings volatility trends make a negligible contribution to labour market volatility trends between 1992 and 2008. The within-group variance contribution is constant over time, because a small fall in earnings volatility was offset by an increase in the proportion of individuals who are employed for two consecutive years. Instead, the decline in labour market volatility is primarily accounted for by the declines in the proportions of individuals making transitions into or out of employment between two consecutive years. Although these two groups' population shares are small in every year, they are used in the variance decomposition formula to weight a group average earnings change (200% or −200%) that is very large by comparison with the average earnings change in the population as a whole. The finding that labour market volatility trends in Britain are not attributable to earnings volatility trends is of course consistent with what was shown by the trends in quantiles of earnings change distributions presented earlier. The advantage of the approach used in this Section based on the variance as a summary index is that it provides an exact decomposition of the various contributions; the potential disadvantage of the decomposition formula is the particular way in which it aggregates the various components.

What are the drivers of the observed trends? For earnings volatility, the question is more why it hardly changed over the 1992–2008 period. One possible answer is that it reflects the net outcome of offsetting changes for different groups. Celik et al. (2012) analysed whether this was the case in the USA, distinguishing between workers who stayed with the same employer and workers who changed jobs from one year to the next. Using variance decompositions of the type described above, Celik et al. found higher volatility levels among job-changers (as expected), but there was no clear cut association between trends in earnings volatility and changes in job-change rates. We find the same result for Britain (results not shown). Moreover, we also find no systematic explanation for the flat trend in terms of changes in the prevalence of part- and full-time work attachment, or the secular increase in the fraction of workers with educational qualifications to university entrance standard. See Cappellari and Jenkins (2013b) for details.

The downward trend in labour market volatility is correlated with the improvement in macroeconomic conditions from the early-1990s through to 2008. The UK economy experienced a serious downturn at the start of the 1990s, but this was followed by recovery at a steady rate until the turn of the 2000s and then at a slower rate until the onset of the Great Recession. Unemployment rates around 10% in 1992 and 1993 (following two consecutive quarters of negative GDP growth in 1991), but around 5% in 2000 and then steady until they rose sharply in 2008 with the return of negative GDP growth (Gregg and Wadsworth, 2010: Figure 1). The association between labour market volatility and macroeconomic conditions arises from changes in labour market attachment since earnings volatility is flat throughout the period. The rise in P_{11} from the mid-1990s – greater employment attachment – is consistent with the decline in both involuntary and voluntary annual job separation rates between 1997 and 2008 reported by the Office for National Statistics (2011: Figure 1). And the decline in P_{00} is consistent with the decline in the fraction of individuals unemployed for more than a year between 1993 and the mid-2000s (Gregg and Wadsworth 2010: Figure 3).

The trends in P_{01} and P_{10} are consistent with other evidence for Britain about how labour market flow transition rates changed with the macroeconomic cycle between 1992 and 2008. Annual transition rates between unemployment (U), inactivity (N), and employment (E), estimated from Labour Force Survey data, are shown by Elsby et al. (2011, Figure 7) (See also Smith, 2011 who estimates monthly flow transition rates using BHPS data.). For example, Elsby et al. show transition rate UE rising over the period and transition rate EU falling. These same patterns are apparent in our BHPS data once we use labour market state definitions corresponding to theirs and take account of other definitional differences. For instance note that P_{00}, P_{10}, P_{01}, P_{11} are population shares not transition rates, we define employment in terms of having earnings or not (rather than using ILO definitions), and our estimation sample excludes virtually all individuals under the age of 25 (Elsby et al. include all individuals aged 16 and over, and pool data for men and women). We return to the relationship with the business cycle in the transatlantic comparison in the next Section.

6. Britain in comparison with the USA

We have shown that, for both men and women, earnings volatility in Britain changed little between the early-1990s and the late-2000s, whereas labour market volatility for both sexes fell over the same period. How do these results compare with those for the USA?

To answer this question, we switch to using volatility estimates for Britain that are based on annual earnings measures because they are used in US studies. This switch is insubstantial because our headline findings for Britain are the same regardless of whether a current or annual earnings measure is used. See Appendix Figs. A5 and A6. As expected, earnings volatility is larger if calculated using the annual earnings measure rather than current earnings (but the increase is small) and there is also no trend upwards or downwards over time. Labour market

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volatility is also greater when the annual earnings measure is used (more obviously for women than for men), but both measures show a similar downward trend over the period. Trends in employment attachment are also similar for the two earnings measures.

The US literature on volatility provides estimates for the period from the early 1970s through to 2008 (A useful table summarizing the findings of US studies of longitudinal earnings instability is provided by Dynan et al., 2012, Table 3b.). Virtually all studies show that earnings volatility for men increased during the 1970s, but then levelled off somewhat through to the early- to mid-1980s or fell slightly. Findings about what happened thereafter depend on the data set used: in particular, estimates derived from the Panel Study of Income Dynamics suggest a rise in volatility (Celik et al., 2012; Shin and Solon, 2011) whereas those derived using administrative record data or survey data linked to administrative record data suggesting that volatility either remained flat (Celik et al., 2012; Dahl et al., 2011; DeBacker et al., 2013) or at least appear not to have risen (Juhn and McCue, 2012; Monti and Gathright, 2013). Our summary judgment is that there is no clear cut evidence for a trend in men's earnings volatility in the USA between the beginning of the 1990s and 2008 (i.e. we give less weight to the PSID estimates), a result which is the same as our finding for Britain. However, there is much less US evidence about labour market volatility or earnings volatility for women.

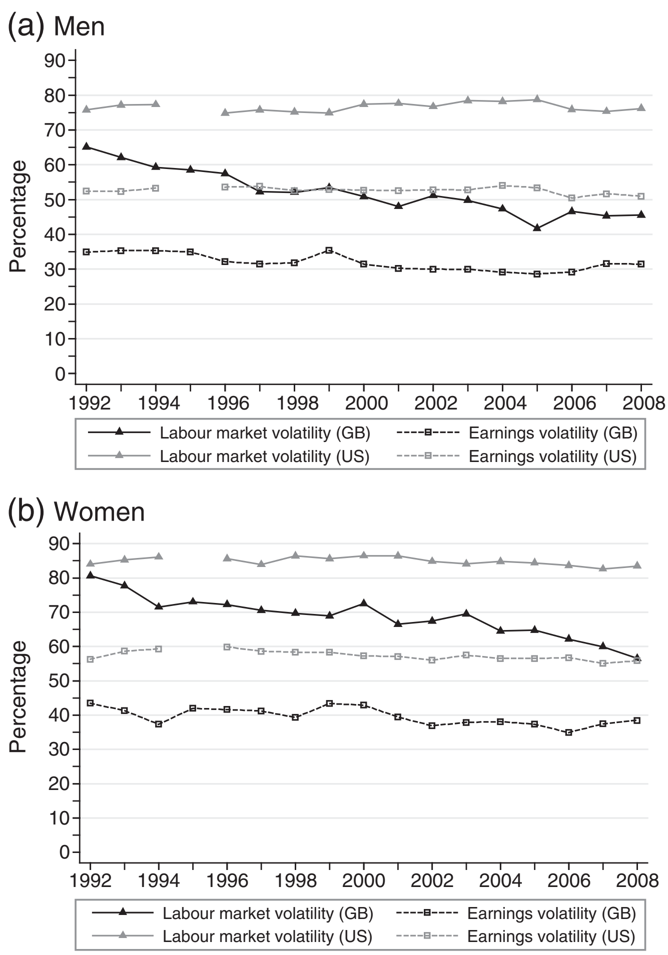

Fig. 5. Earnings and labour market volatility for men and women, Britain and the USA. Notes: The measure of volatility is *I* (see main text). The earnings volatility estimates for Britain ('GB') are based on the BHPS measure of 'annual labour income' (Comparisons of estimates based on current and annual earnings measures are shown in Appendix Figs. A5 and A6). The earnings volatility estimates for the USA ('US') are derived from matched CPS data, and are shown as the 'baseline series' in Ziliak et al. (2011: Figures 1 and 3) which also cover 1973–1991. The discontinuity in the US series at 1995 reflects a major redesign of the CPS.

To continue with our transatlantic comparisons, we therefore focus on the estimates from the US study by Ziliak et al. (2011) for the period 1992–2008. Only their research provides volatility estimates for men and women separately, and for labour market volatility as well as earnings volatility. However, to avoid reliance on a single study, we draw on other research where possible. Our transatlantic comparisons of earnings and labour market volatility are summarized in Fig. 5.

What is clear from the graphs is that earnings volatility is without trend in both Britain and the USA. In addition, the eye is struck by the apparently substantially greater magnitude of earnings volatility levels in the USA. Ziliak et al. (2011) estimate *I* to hover just above 50% for US men whereas the British estimate is around 30%. The corresponding estimates for women are between 55% and 60% in the USA but around 40% in Britain. Some caution is required when comparing earnings volatility levels, however, because other US studies suggest that estimates of the same volatility measure differ across data sets and samples. For example, Celik et al. (2012, Figure 1) using matched-CPS data report levels of *S* for US men that are around 10 percentage points lower than the corresponding estimates of Ziliak et al. (2011, Figure 3), though also with a relatively flat trend (with one exception discussed shortly). The reason for the differences may be the use of different samples (Ziliak, Hardy, and Bollinger use men aged 16–60; Celik et al. use men aged 25–59). Also, the two studies report rather different CPS match rates. Either or both of these factors is also likely to be responsible for the fact that Celik et al. (2012: Figure 1) report a substantial spike increase in men's earnings volatility between 2007 and 2008, whereas Ziliak et al. (2011: Figure 3) report virtually no change over the same interval.

Celik et al. (2012: Figure 1) also report two series of estimates for men based on Survey of Income Program and Participation panels (but a discontinuous series) and LEHD data derived from unemployment insurance administration records. Over the 1990s and 2000s, the SIPP series for *S* tracks the matched-CPS one, but estimates for each year are about 5 percentage points smaller (the LEHD estimates are about 10 percentage points larger than the matched-CPS ones), but the level is always above 30%. This is the level of our British estimates of *S* for men (see Appendix Fig. A3), although based on current rather than annual earnings (and survey rather than administrative data). The transatlantic differential in earnings volatility levels is confirmed if *P* is used as the volatility measure: see OECD (2011: Figure 3.1) for men and women combined.

In sum, it appears that earnings volatility levels for men are greater in the USA than in Britain — this is shown by all the data sources with the exception of the discontinuous SIPP series.

Turning to labour market volatility rather than earnings volatility, it is clear that volatility levels are substantially greater in the USA than in Britain and there is a downward trend in Britain that does not occur in the USA: see Fig. 5. According to Ziliak et al. (2011), labour market volatility in the USA hardly changed over the 1992–2008 period, remaining at about 75% for men and just under 85% for women. In Britain, labour market volatility fell for both sexes. The transatlantic differential is about 10 percentage points at the beginning of the 1990s for men (less for women) but around 30 percentage points by 2008. Again we may ask whether the comparisons are robust to choice of measure and data set, and the problem is that few other estimates are available. We are aware only of the estimates of *I* for US men provided by Celik et al. (2012: Figure 2), derived from matched-CPS data. These confirm the transatlantic differential and difference in trend. Celik et al.'s estimates for the 1990s and 2000s range between 60% and 70%, i.e. around 10 percentage points lower than those of Ziliak et al. (2011) – see our comments above – but are still well above our corresponding British estimates (and with a different trend).

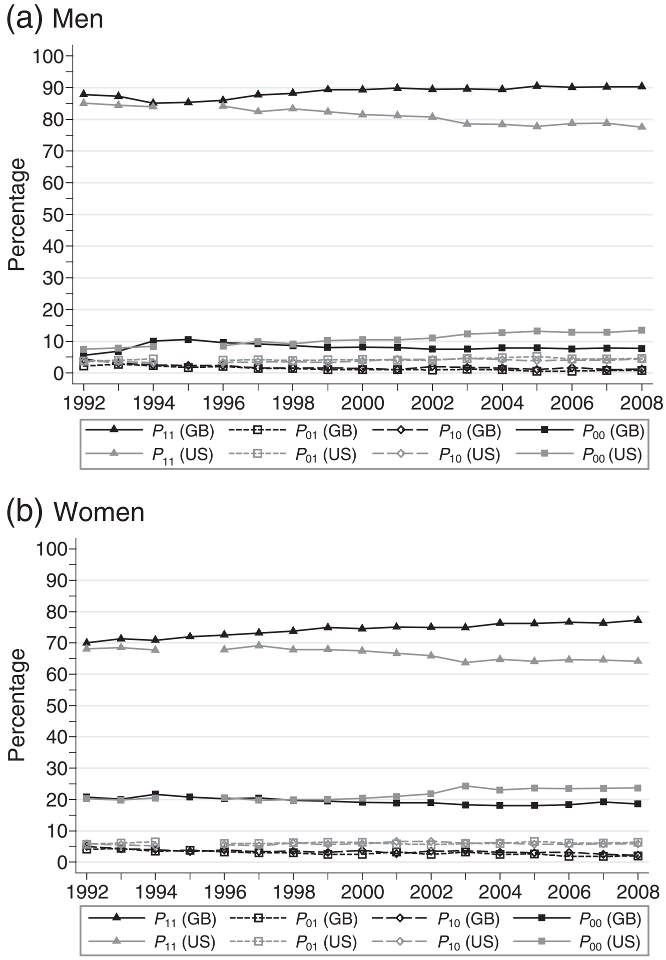

Fig. 6. Employment attachment rates (%) for men and women, Britain and the USA. Notes: Employment attachment rates P_{11}, P_{01}, P_{10}, and P_{00}, are defined in the main text. See also the notes to Fig. 5.

One additional US feature that many researchers have pointed to is that earnings volatility for men is higher during recessions: see e.g. Cameron and Tracy (1988), Celik et al. (2012), Shin and Solon (2011), Ziliak et al. (2011). Similarly, Moffitt and Gottschalk (2012) report that the transitory variance of men's earnings is larger in recessions (Although these papers point to the empirical association, none of them discuss the reasons why it may arise.). In contrast, Ziliak et al. (2011) using their full run of data from the early 1970s report that women's earnings volatility is lower during recessions.

Ascertaining whether a relationship between volatility and recessions also holds for Britain is constrained by the fact that the period of observation (1992–2008) is shorter than the period spanned by the US PSID and matched-CPS data sets (back to the start of the 1970s). Indeed, the period covered by the BHPS spans only one cycle from trough to trough. However, since the decline in labour market volatility in Britain is correlated with macroeconomic recovery, there is some sort of business cycle story at play. This must arise via changes in employment attachment, since earnings volatility is flat through the period. And it is in trends in employment attachment rates that another interesting transatlantic contrast appears. See Fig. 6 which compares Ziliak et al. (2011) estimates of employment attachment rates with our British estimates.

For British men, the proportion of individuals with two consecutive years in employment (P_{11}) fell slightly during the early-1990s recession and then recovered to around 90% by 2000 and then remained constant thereafter. The proportion of men with two consecutive years not in employment (P_{00}) rose in the recession to reach around 10% and then fell back again, while the proportions moving into or out of employment declined slightly. This picture is in sharp contrast to that for US men, for whom P_{11} fell continuously throughout the period and P_{00} increased (P_{01} and P_{10} are relatively small and did not change much in absolute terms.). Put another way, employment attachment rates for the US and British men appear to be similar at the start of the 1990s but marked differences open up by 2008. Fig. 6 shows this is the case for women as well as men.

We have not found other studies that allow us to directly benchmark these trends. However, the estimated declines in P_{01} and P_{10} for the USA (which are not very perceptible in Fig. 6 given the scales used) are consistent with the declining rates of job separations and hires reported by Hyatt and Spletzer (2013) using three administrative data sets (similar administrative data do not exist for the UK). As discussed in the previous Section, trends in employment rates are related to underlying labour market flow transition rates, and we note that there is evidence that levels and trends in labour market transition rates differed between the USA and the UK over this period. According to Elsby et al. (2013: Figure 2), UE and EU transition rates levels are substantially lower in the UK than the USA and, moreover, the upward trend in the UE rate is greater in the UK than the USA. Our findings are thus also consistent with the OECD's conclusion, based on a different summary measure of volatility, that '[c]ountries with the most dynamic labour markets – as measured by hiring, firing and quit rates – tend to have a relatively low incidence of earnings volatility' (OECD, 2011: 154).

7. Summary and conclusions

We have argued that straightforward measures of volatility provide a means to examine not only instability in earnings among those who are employed, but also instability in the labour market as a whole, i.e. also including workers without a job. This same property makes these measures well-suited to analyse volatility for women as well as men (virtually all previous studies of earnings instability of all kinds have been for men only). Using BHPS data, we have provided new British evidence about earnings and labour market volatility for both men and women.

We have shown that in Britain, and for both sexes, earnings volatility changed little between 1992 and 2008, but there was a fall in labour market volatility. Although earnings volatility trends over this period appear flat in both the USA and Britain, the decline in labour market volatility that occurred in Britain is not apparent in the USA. And, in so far as there is a relationship between volatility and the business cycle, it appears to arise in Britain via changes in employment attachment rates rather than in changes in earnings volatility as in the USA. In any case, there are intriguing transatlantic differences in the trends in employment attachment rates.

Our research leaves a number of unresolved questions. For example, what explains the transatlantic differences in levels and trends in volatility that we have identified? Regarding levels, it is often said that the US labour market is more flexible than the British one, with employment arrangements less governed by collective bargaining arrangements, employment protection legislation, and so on (Nickell, 1997). One might conjecture that this labour market flexibility is reflected in relatively greater instability in earnings and employment attachment for US workers compared to their British counterparts. Our estimates are consistent with this hypothesis but, as we have pointed out, different data sets (and samples) can tell different stories. Explaining the differences in trends in volatility is a harder task. Our decomposition analysis suggests that differences in aggregate trends can arise via multiple routes: differences in trends in earnings volatility, mean earnings changes, and labour market attachment rates. Further work is required to disentangle the roles of the various elements.

Another outstanding question is: what has happened to earnings and labour market volatility in the period after the onset of the Great Recession, not covered by the data sets for Britain or the USA that were cited in this paper? For Britain, a promising source for future work on earnings and labour market volatility is the panel data version of the Annual Survey of Hours and Employment, also employed in its earlier guise (as the New Earnings Survey panel) by Dickens (2000) and Kalwij and Alessie (2007) to fit parametric earnings component models.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.labeco.2014.03.012.

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