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ABSTRACT

Reconciling the Divergence in Aggregate U.S. Wage Series*

According to data from the Labor Productivity and Costs (LPC) program, average hourly real compensation in the United States has grown consistently over time and become markedly more volatile since the mid-1980s. By contrast, data from the Current Employment Statistics (CES) imply that average hourly real earnings has mostly stagnated and become substantially less volatile. We show that differences in earnings concept and differences in worker coverage account for the majority of this divergence in growth and volatility. The results have important implications for the appropriate choice of aggregate wage series for macroeconomic analysis.

JEL Classification: E01, E24, E30, J30

Keywords: comparison of hourly earnings data, earnings trends, earnings volatility

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1 Introduction

The average hourly real wage is a key indicator for current economic analysis and the focus of much research in macroeconomics. In the United States, two of the most commonly used measures of average hourly wages come from the Current Employment Statistics (CES) and the Labor Productivity and Costs (LPC) program, both published by the Bureau of Labor Statistics (BLS). Over the past several decades, the two wage measures have evolved very differently:

1. The LPC wage was about 30% higher than the CES wage in the early 1970s and has consistently grown since then. The CES wage, by contrast, stagnated from the early 1970s to the mid-1990s. As of 2013, the two series had diverged to the point where the LPC wage was about 85% above the CES wage.

2. The LPC wage was about half as volatile as the CES wage until the mid-1980s. Since then, the volatility of the LPC wage has almost doubled, while the volatility of the CES has dropped by about 50%, so that the LPC wage is now nearly twice as volatile as the CES wage.[1]

The objective of the present paper is to reconcile this divergence in growth and volatility. This is important because the choice of one wage measure over the other has potentially very different implications for a number of key policy and research questions. First, one of the most hotly debated economic topics in recent years concerns the slowdown in wage growth experienced by a large part of the U.S. workforce and the associated decline in the labor share of income. The literature has used both the CES and the LPC to document this "Great Wage Slowdown".[2] Yet, given the above numbers, it should be clear that the two wage series tell different stories about the extent of the slowdown.[3] Second, wage growth is a key input for current economic analysis. Because of its

[1] These results do not depend on whether the 2008-09 recession and the subsequent recovery are included or not.

[2] See Bivens and Mishel (2015) or Sparshott (2015) for examples based on CES data; and Elsby, Hobjin and Sahin (2013) or Karabarbounis and Neiman (2014) for examples based on LPC data. Other studies such as Kearney, Hershbein and Boddy (2015) or Summer and Balls (2015) use data from the CPS. As discussed below, a key part of our analysis is to use CPS data to shed light on the divergence of the CES and the LPC series.

[3] For example, based on the LPC, the labor share (computed as average hourly compensation divided by GDP per hour) fell by 11% over the past 40 years. According to the CES, by contrast, labor share dropped by 37% over the same time period.

monthly availability, business analysts and the press often focus on the CES as their main source.[4] However, over longer time intervals, the CES wage routinely differs from the LPC wage in ways that can substantially affect the economic outlook.[5] Third, wage dynamics play a central role for theories of the business cycle. Since the CES wage and the LPC wage exhibit similar business cycle patterns over the postwar period, researchers have used the two measures interchangeably with little or no justification.[6] But, as highlighted above, this similarity masks important differences for the pre-1980 and post-1980 periods. The choice of wage series therefore has important implications for the ability of competing theories to explain business cycle fluctuations and for our understanding of cyclical adjustments of U.S. labor markets.[7]

Section 2 describes the data and documents the divergence between the LPC wage and the CES wage. Section 3 decomposes the evolutions of the LPC wage and the CES wage into an average weekly earnings component and an average weekly hours component. The key result from this decomposition is that almost all of the divergence between the LPC wage and the CES wage is due to average weekly earnings. Average hours, by contrast, have evolved very similarly in the two data sets.

Based on this finding, Section 4 attempts to account for the divergence of average weekly earnings in the LPC and the CES. Using data from the Current Population Survey (CPS) together with information from the National Income and Product Accounts (NIPAs) and the Internal Revenue Service (IRS), we identify two principal causes: differences in earnings concept (employer-paid supplements such as contributions to pension and health plans and irregular earnings of high-

[4] Also see the Federal Reserve Board's new Labor Market Conditions Index (LMCI), which includes the CES wage as its only measure of labor cost (Chung et al., 2014).

[5] For example, according to the LPC, wage growth in the first quarter of 2015 was 3.3% relative to one year earlier, whereas in the CES, it was only 2.1%.

[6] See for example Cooley and Prescott (1995) who report business cycle results for both the CES wage and the LPC wage without further discussion. Influential quantitative evaluations of modern Dynamic Stochastic General Equilibrium (DSGE) models based on the LPC wage include Smets and Wouters (2004) or Christiano, Eichenbaum and Evans (2005). Studies using the CES wage include Gertler and Trigari (2009) or Gali (2011).

[7] See Champagne and Kurmann (2013), Nucci and Riggi (2013) and Gali and Van Rens (2014) for recent research on the empirical challenges for DSGE models in generating the type of increase in wage volatility observed in the LPC data.

income individuals included in the LPC but not in the CES); and differences in worker coverage (all non-farm business workers for the LPC versus production and non-supervisory workers in private non-agricultural establishments for the CES).[8] The two differences combined account for the bulk of not only the divergence in growth and volatility over the past decades but also the initial level differences of the two earnings series.

Our strategy of using alternative data sources to shed light on the divergence of the two earnings series is predicated by the fact that the establishment records underlying the LPC do not contain information on worker occupation and do not distinguish between regular and irregular earnings. It is therefore impossible to directly quantify the importance of differences in earnings concept and worker coverage.[9] Instead, we combine individual earnings data from the May supplements and the monthly outgoing rotation group (ORG) extracts of the CPS to construct an average earnings series that is based on a very similar earnings concept as the one used by the CES but at the same time is representative of all workers.[10] We then augment this series with estimates for supplements from the NIPAs and estimates for earnings of high-income individuals, as tabulated from IRS data by Piketty and Saez (2003), to quantify the importance of differences in earnings concept. In turn, we exploit industry and occupation information in the CPS May/ORG to assess the role played by the narrower worker coverage in the CES.

An important byproduct of our analysis is that supplements and irregular earnings account for almost all of the difference between LPC earnings and CPS May/ORG earnings. The result suggests that despite well-documented issues with measurement error in the cross-section (e.g. Bound and Krueger, 1991), the CPS May/ORG data provide a reliable average measure of the wages and salaries portion of compensation for all but the highest-paid individuals of the United States workforce. This is interesting because the CPS May/ORG is one of the most widely used

[8] The CES began publishing all-employee wages in March 2006. We will examine this all-employees series at the end of Section 4.

[9] Moreover, the micro data from the CES and the LPC are both confidential and currently unavailable for research purposes prior to the 1990s.

[10] Alternatively, we could have used earnings data from the CPS March supplements. As discussed below, the CPS May/ORG data have several advantages over the CPS March supplements for the purpose of our study.

micro data sets of individual earnings in the United States.

Section 5 of the paper concludes by discussing the implications of our results. We argue that our CPS May/ORG construct provides an interesting alternative measure of average labor earnings because it abstracts from the large and volatile irregular wage and salary portion of high-income individuals but covers the entire working population. Moreover, it can be augmented with an estimate of supplements to take into account the growing importance of non-wage payments for labor compensation.

Our paper contributes to a large literature describing the evolution of labor earnings in the United States. To date, only little effort has been made to compare different measures. The paper closest to ours is Abraham, Spletzer and Stewart (1998), who document the divergence in trends of average hourly wage measures from the NIPAs, the CPS, and the CES, and use individual earnings data from the CPS May/ORG to replicate the CES worker coverage as described above. Building on their insights, our paper makes several contributions both in scope and methodology. First, we focus squarely on the divergence between the LPC wage and the CES wage, because the two series are the ones most commonly used for macroeconomic applications. One implication of this choice is that it highlights the growing importance of supplements, which are included in the LPC but not in any of the other earnings measures. Second, we extend the sample analyzed by Abraham, Spletzer and Stewart (1998) by 20 years and consider not only the divergence in trends but also the divergence in business cycle volatility as well as the initial level differences between the two wage measures.[11] Our results indicate that differences in earnings concept and differences in worker coverage can account for the majority of differences in all of these dimensions. Third, our CPS May/ORG earnings construct includes an estimate for overtime, tips and commissions that is adjusted further for earnings of high-income individuals. Both of these adjustments turn out to be important in establishing that differences in earnings concept explain almost all of the divergence between LPC and CPS May/ORG earnings. The inclusion of overtime, tips and commissions in our CPS May/ORG construct also helps to show that the narrower worker coverage in the CES accounts

[11] The divergence in business cycle volatility of the LPC wage and the CES wage has been noted by Champagne and Kurmann (2013) and Gali and Van Rens (2014). Neither of the two papers analyze the sources of this divergence.

for much of the difference between CPS May/ORG earnings and CES earnings. These conclusions differ from the ones reached by Abraham, Spletzer and Stewart (1998), who only consider usual earnings in their CPS May/ORG measure and therefore cannot reconcile the divergence in the different wage measures as well as we do.

2 Divergent hourly wage series: data and facts

We begin by describing the principal data sources used to construct the different average wage series and then document their evolution over time. Auxiliary data used later in the analysis are described as they are introduced. An online appendix contains details about the data as well as robustness checks.

2.1 Data

We consider three principal data sources. For each of them, we compute an average hourly wage series by dividing average weekly earnings with the respective average weekly hours. All weekly earnings and therefore all hourly wage series are deflated using the Personal Consumption Expenditure (PCE) index from the NIPAs.[12]

The first data source is the CES, which is a monthly establishment survey on employment, payroll and hours that has been conducted by the BLS since 1915. Historical estimates for average weekly earnings, average weekly hours, and average hourly earnings are available for private non-agricultural establishments from 1964 on, but only for production workers in goods-producing industries and for non-supervisory workers in service-providing industries.[13] Earnings comprise regular wage and salary disbursements including overtime during the pay period reported. Tips, commissions and

[12] As Abraham and Haltiwanger (1995) document, the choice of price deflator can have important consequences for the business cycle *cyclicality* of real wages with hours or output. None of our results for the divergence in the different wage series with respect to trend growth and business cycle *volatility* are affected by the use of alternative deflators.

[13] Starting in 2006, the CES started collecting earnings data for all workers in private non-agricultural establishments. We use this information below.

bonuses are included only if earned and paid regularly each pay period. Supplements and gains from exercising stock options are excluded. The average weekly hours series counts all hours paid during the pay period that includes the 12th of the month, including overtime and paid leave. The CES sample has increased in size over the years and currently covers about 145,000 businesses and government agencies representing 588,000 establishments.

The second data source is the LPC program of the BLS, which has reported labor productivity and compensation data for the non-farm business sector quarterly since 1948. Average weekly earnings are computed from average total compensation per employee, which consists of "wages and salaries" and "supplements". Wages and salaries are based on the Quarterly Census of Employment and Wages (QCEW), a mandatory employer-based program for all employees covered by unemployment insurance (UI) that comprises about 98% of U.S. private sector establishments and jobs and includes executive compensation, commissions, tips, bonuses and gains from exercising non-qualified stock options. Supplements are based on estimates by the Bureau of Economic Analysis (BEA) and consist of employer contributions to funds for social insurance, private pension and health and welfare plans, compensation for injuries, etc. Compensation for self-employed workers is estimated by assuming that they earn the same hourly compensation as wage and salary workers and multiplying hourly compensation by an estimate of hours worked by self-employed workers from the Current Population Survey (CPS). The primary source of hours data is the CES. The LPC program converts CES estimates of production/nonsupervisory hours paid to hours worked using hours-worked-to-hours-paid ratios from the National Compensation Survey.[14] Non-production/supervisory hours are estimated by calculating the ratio of non-production to production worker hours using data from the CPS. This ratio is then applied to the production/nonsupervisory average weekly hours. Hours for self-employed workers are estimated directly from the CPS.

The third data source is the CPS, a monthly survey of about 60,000 households sponsored jointly by the U.S. Census Bureau and the BLS. Data on earnings and hours are available from different extracts of the CPS. Following Abraham, Spletzer and Stewart (1998) and Lemieux (2006), we

[14] This ratio accounts for paid leave, but not off-the-clock work. The ratio has been fairly constant over time (0.93), although there is some variation across industries. See Eldridge, Manser, and Otto (2004).

combine information from the annual CPS May supplements for 1973-78 with information from the monthly outgoing rotation groups (ORGs) from 1979 onward to construct annual series of average weekly earnings and hours for the private non-agricultural business sector (excluding self-employment as in the CES).[15] As explained in full detail in the appendix, weekly earnings are computed differently for salaried and hourly-paid workers. For salaried workers, we take reported weekly earnings at the main job, which is defined as compensation normally received and includes overtime, tips and commissions (OTC) and bonuses if earned and paid in each period. For hourly-paid workers, we have available reported weekly earnings, reported hourly wages times hours worked and, starting in 1994, separately reported OTC. For 1994 onward, we compute weekly earnings as the higher of reported weekly earnings and the sum of the reported usual hourly wage times weekly hours worked plus OTC. For the period before 1994, we compute weekly earnings as the reported hourly wage times usual weekly hours worked and adjust this number with an OTC estimate based on 1996-2000 data that depends on gender and education. This provides us with earnings numbers that consistently include an estimate of OTC across both salaried and hourly-paid workers.[16] Moreover, as is usual in the literature, we adjust topcoded individual earnings by a constant factor of 1.3. In Section 4, we experiment with more sophisticated topcode adjustments. Finally, to compute average weekly earnings and average weekly hours, we convert the data from a person basis to a job basis by adjusting earnings and hours for multiple job holdings (MJH) and aggregate the resulting

[15] After removing observations with missing earnings or hours, self-employed, out of the labor force and unemployed individuals, the May supplements yield an average of 42,037 observations per year between 1973 and 1978, and the ORG files yield an average of 173,925 observations per year between 1979 and 2013. We prefer the May/ORG to the March supplement, another CPS extract that contains earnings information, for different reasons. First, the earnings concept in the May/ORG is closer to the earnings concept in the CES. Second, the March supplements only contains information on total hours worked starting in 1976. Third, the ORG portion of the May/ORG contains roughly four times as many observations as the March supplements. Fourth, as Lemieux (2006) shows, the March supplements poorly measure the wages of hourly-paid workers, which make up 60 percent of the workforce.

[16] As the analysis in the appendix shows, using the higher of the reported weekly earnings and the reported hourly wage times weekly hours worked prior to 1994 leads to a discontinuity in the weekly earnings series for hourly-paid workers. This suggests that hourly-paid workers did not fully report OTC in their weekly earnings answer, which is consistent with the assessment by the BLS that led to the inclusion of the separate OTC question starting in 1994 (Polivka and Rothgeb, 1993).

micro data using the CPS Census weights.[17]

Table 1 summarizes the salient features of the three data sources for average weekly earnings and average weekly hours. The table highlights the differences in population coverage and earnings concept – the main focus of the investigation below. While the LPC data cover all workers in the non-farm business sector and have a very comprehensive earnings concept that includes irregular bonuses and benefits, the CES data only cover production and non-supervisory workers employed in private non-agricultural establishments, and use a more restrictive earnings concept that only includes wage and salary disbursements earned and paid in the same period. In comparison, our earnings construct from the CPS May/ORGs ("CPS" henceforth) covers all workers in the private non-agricultural business sector, similar to the LPC data (except for some small differences that we will address below), but is based on an earnings concept that is, aside from tips, the same as the one employed by the CES.[18] We will exploit this "in-between" characteristic of the CPS data relative to the LPC data and the CES data for much of our analysis. Also note that the inclusion of OTC distinguishes our CPS earnings construct from the one by Abraham, Spletzer and Stewart (1998), who do not take into account OTC and therefore employ a more restrictive earnings concept for their CPS series than in the CES.

2.2 Trends

Figure 1 plots the evolution of average real hourly wages (in 2009 dollars) constructed from the three different data sources. Three observations stand out. First, in the early 1970s, the LPC wage is already about 30% higher than the CES wage and the CPS wage. Second, the LPC wage grows at a substantially higher rate over the sample, ending up, in 2013, 84% and 62% higher than the CES wage and the CPS wage, respectively. Third, while the CPS wage grows consistently throughout

[17] Following Abraham, Spletzer and Stewart (1998), weekly earnings on the second job for individuals who report MJH are set to 30% of weekly earnings on the main job, based on questions asked about multiple job holdings in select CPS May supplements. Weekly hours on the second job are set to the average hours on the second job reported in the 1994-2013 ORGs. See the appendix for details.

[18] According to Abraham, Spletzer and Stewart (1998), tips represent only a very small part of total average earnings in the economy.

the sample, although at a lower rate than the LPC wage, the CES wage declines slightly from the early 1970s to the early 1990s, returning to moderate growth thereafter.

2.3 Business cycle volatilities

To compute business cycle volatilities, we take logarithms of the different hourly wage series and extract the business cycle component using the Hodrick-Prescott (H-P) filter.[19] Then, we compute the standard deviations of each series for the pre-1984 period and the post-1984 period. The break in 1984 is motivated by the Great Moderation literature that finds a significant change in output volatility around 1984 (e.g. McConnell and Perez-Quiros, 2000).

Table 2 shows the results. The upper panel reports standard deviations for quarterly series of the LPC wage and the CES wage for the subsamples 1964Q1-1983Q4 and 1984Q1-2013Q4, with standard errors provided in parentheses.[20] The lower panel reports the same standard deviations using annualized data for the samples 1973-1983 and 1984-2013 together with standard deviations for the CPS wage. Both panels also show the corresponding standard deviation of non-farm business real chain-weighted GDP as a benchmark and report the ratio of the standard deviation of the different wage series to the standard deviation of GDP (denoted relative standard deviation).

While the LPC wage and the CPS wage both exhibit only moderate volatility in the pre-84 period, the CES wage is almost twice as volatile during the same period. The volatility of the LPC wage then increases by 60% or more from the pre-84 period to the post-84 period, and the volatility of the CPS wage increases by 15%. In contrast, the volatility of the CES wage drops by almost 50%. Since the volatility of output drops by 40% to 50% between the two periods, the *relative* volatility of average hourly wages increases by a factor ranging from 2.4 to 3.3 in the LPC and the CPS, but remains unchanged in the CES.[21]

[19] The H-P filter constant is set to 1600 for quarterly data and 6.25 for annual data, as recommended by Ravn and Uhlig (2002). As shown in the appendix, results are robust to alternative filtering methods.

[20] Standard errors are computed via the delta method based on Generalized Method of Moments (GMM) estimates. See the appendix for details.

[21] There are other important changes in labor market dynamics between the pre-1984 and the post-1984 sample. As documented by Gali and Gambetti (2009) and Stiroh (2009), both labor productivity and hourly wages experienced

3 Earnings – hours decomposition

Since each of the hourly wage series is constructed as the ratio of average weekly earnings to average weekly hours, it is useful to decompose the evolution of the different hourly wage series into changes coming from each component. We do this for both trends and volatilities.

3.1 Trends

Figures 2 and 3 plot the evolution of real average weekly earnings (in 2009 dollars) and average weekly hours used in the computation of the three hourly wage series. Figure 2 shows that like average hourly wages, there is already a level difference in 1973 between weekly earnings from the LPC and weekly earnings from the two other data sources. After 1973, the LPC and the CPS series exhibit consistent growth, with the LPC series growing at a faster rate. By contrast, weekly earnings from the CES fall substantially between the mid-1970s and the early 1990s before recovering to their 1972 peak in 2005.

Figure 3 shows that weekly hours in the CES and the LPC data exhibit the same pattern of decline over time. This is not surprising since the CES is the primary source of hours for LPC hours. The difference in levels is mainly due to the hours-worked-to-hours-paid adjustment mentioned earlier. In contrast, weekly hours in the CPS are higher from the beginning and fluctuate around a constant level.

To quantify the importance of these differences for the divergence in trends of the different hourly wage series, we use growth accounting techniques. First, we decompose the log difference of each of the hourly wage series into the corresponding log differences of weekly earnings and weekly hours; i.e.

$$\Delta \log w_i = \Delta \log W_i - \Delta \log H_i, \tag{1}$$

where $\Delta \log w_i$ denotes the year-to-year log difference of the hourly wage; $\Delta \log W_i$ the year-to-

a substantial decline in correlation with output and hours starting in the mid-1980s. This decline in business cycle co-movement occurs for both the LPC wage and the CES wage, although it is more pronounced for the CES wage. See the results reported in the appendix.

year log difference of weekly earnings; and $\Delta \log H_i$ the year-to-year log difference in weekly hours from data source $i \in \{LPC, CES, CPS\}$. Second, we decompose the difference in average growth between pairs of hourly wage series into differences in average growth of weekly earnings and average growth of weekly hours; i.e.

$$\overline{\Delta \log w_i} - \overline{\Delta \log w_j} = \left(\overline{\Delta \log W_i} - \overline{\Delta \log W_j}\right) - \left(\overline{\Delta \log H_i} - \overline{\Delta \log H_j}\right), \tag{2}$$

where $\overline{\Delta \log w_i}$ and $\overline{\Delta \log w_j}$ denote the 1973-2013 average log difference in hourly wages from data source i and data source j; and so forth for the other terms.

Figure 4 reports the results of this decomposition. The decomposition confirms that the divergence in average hourly wage growth between the LPC and CES is entirely accounted for by the difference in average weekly earnings growth: average weekly earnings according to the LPC grew on average by 1% per year, while weekly earnings according to the CES grew on average by only 0.1% per year. This confirms that the findings of Abraham, Spletzer and Stewart (1998) hold for a substantially longer sample. In comparison, about two-thirds of the considerably smaller divergence in average hourly wage growth between the LPC and the CPS is due to smaller weekly earnings growth in the CPS (0.6% per year). The remaining third of the divergence in average hourly wage growth is due to the fact that LPC weekly hours decreased over time, whereas CPS weekly hours remained relatively constant.

3.2 Business cycle volatilities

The decomposition of average hourly wages into weekly earnings and weekly hours can also be used to analyze the divergence in business cycle volatility. Specifically, the variance of average hourly wage growth from data source i can be expressed as

$$\sigma_{w_i}^2 = \sigma_{W_i}^2 + \sigma_{H_i}^2 - 2\rho_{W_i,H_i}\sigma_{W_i}\sigma_{H_i}, \tag{3}$$

where $\sigma_{w_i}^2 \equiv Var(\Delta \log w_i)$; $\sigma_{H_i}^2 \equiv Var(\Delta \log H_i)$; and $\rho_{W_i,H_i} \equiv Corr(\Delta \log W_i, \Delta \log H_i)$.

Table 3 shows the pre-1984 and post-1984 volatilities and correlations of the three weekly earnings and weekly hours measures, together with the corresponding hourly wage volatilities from Table 2.[22] Three observations stand out. First, the volatility of weekly earnings increases slightly in the LPC and decreases slightly in the CPS between the pre-1984 and the post-1984 periods; but, overall, the two series exhibit similar volatility.[23] In comparison, the CES weekly earnings series goes from being the most volatile to being the least volatile, with its standard deviation dropping by more than 60% between the pre-1984 and the post-1984 periods. Second, the volatility of weekly hours is about the same in the three data sets and changes very little between the pre-1984 and the post-1984 periods. Third, the correlation of weekly earnings with weekly hours experiences a large drop in all three data sources.[24]

To quantify the effects of these changes in business cycle fluctuations of earnings and hours on the volatility of hourly wages, we perform a similar decomposition. Using equation (3) as the starting point, we decompose the change in the variance of average hourly wage growth between the pre-1984 (a) and the post-1984 (b) periods as

$$\begin{aligned} \sigma^2_{w_i}(b) - \sigma^2_{w_i}(a) &= \left[\sigma^2_{W_i}(b) - \sigma^2_{W_i}(a)\right] + \left[\sigma^2_{H_i}(b) - \sigma^2_{H_i}(a)\right] \\ &\quad -2\left[\rho_{W_i,H_i}(b)\sigma_{W_i}(b)\sigma_{H_i}(b) - \rho_{W_i,H_i}(a)\sigma_{W_i}(a)\sigma_{H_i}(a)\right]. \end{aligned} \tag{4}$$

By manipulating this expression further to decompose the multiplicative parts, we obtain (see the

[22]The above volatility accounting formula holds exactly for first-differenced data. In Table 3, we use H-P filtered data instead, to remain comparable with the rest of the paper. This introduces an approximation error that is, however, only of minor quantitative importance.

[23]This is consistent with recent findings from micro data that, for most individuals, the volatility of labor earnings has remained approximately constant (e.g. Dynan et al., 2007; Jensen and Shore, 2008).

[24]Since LPC hours and CES hours are almost perfectly correlated in both subsamples (0.99 and 0.98, respectively), the slightly larger drop in correlation between earnings and hours in the LPC relative to the CES is entirely due to the different change in cyclical properties of earnings in the two data sets.

appendix for details)

$$\sigma^2_{w_i}(b)-\sigma^2_{w_i}(a) = \left[\sigma^2_{W_i}(b)-\sigma^2_{W_i}(a)\right]+\left[\sigma^2_{H_i}(b)-\sigma^2_{H_i}(a)\right] -2\left\{\begin{array}{c} \frac{\rho_{W_i,H_i}(b)+\rho_{W_i,H_i}(a)}{2}\left[\begin{array}{c}\frac{\sigma_{H_i}(b)+\sigma_{H_i}(a)}{2}\left[\sigma_{W_i}(b)-\sigma_{W_i}(a)\right] \\ +\frac{\sigma_{W_i}(b)+\sigma_{W_i}(a)}{2}\left[\sigma_{H_i}(b)-\sigma_{H_i}(a)\right]\end{array}\right] \\ +\frac{\sigma_{W_i}(b)\sigma_{H_i}(b)+\sigma_{W_i}(a)\sigma_{H_i}(a)}{2}\left[\rho_{W_i,H_i}(b)-\rho_{W_i,H_i}(a)\right]\end{array}\right\}. \qquad (5)$$

We then compare this "change-in-volatility" decomposition for data source i with the corresponding "change-in-volatility" decomposition for data source j.

Figure 5 displays the results of this exercise based on the numbers in Table 3. As the decomposition makes clear, the *decline* in volatility of CES average hourly earnings relative to LPC hourly earnings is primarily due to the drop in volatility of weekly earnings in the CES, accounting for 95% of the relative decline in the volatility of CES hourly earnings. In turn, the increase in volatility of the average hourly wage in the LPC is larger than in the CPS, because the volatility of weekly earnings in the LPC increases slightly while in the CPS it decreases slightly, and because the drop in correlation between earnings and hours in the LPC receives a larger weight than in the CPS (i.e. the *average* volatility of earnings and hours over the two subsamples is larger in the LPC than in the CPS).

In sum, the decompositions show that the differences in trend growth and volatility of LPC hourly earnings relative to CES hourly earnings are primarily due to differences in weekly earnings in the two data sets. Weekly hours only account for a relatively small part of the initial level difference between the two wage measures, but otherwise evolve very similarly.

4 Accounting for the divergence in LPC and CES earnings

Following the lead of Abraham, Spletzer and Stewart (1998), we focus on two potential sources for the divergence of weekly earnings in the LPC and the CES: (i) differences in earnings concept, and (ii) differences in worker coverage. As discussed in the introduction, the similarity of our

CPS construct with the LPC in terms of worker coverage on the one hand, and with the CES in terms of earnings concept on the other, motivates our strategy of using the CPS to isolate these differences. Just as important, the industry and occupation information in the CPS allows us to replicate the CES sample. Our analysis reveals that the two sources can account for the bulk of the different evolution of weekly earnings in the LPC and the CES. We finish with a discussion of measurement issues that are particular to the CES and examine to what extent they may account for the remaining differences between LPC and CES earnings.

4.1 Differences in earnings concepts

As described in Section 2, the LPC earnings concept is total compensation, which includes irregular earnings such as executive compensation, bonuses and gains from non-qualified stock options; as well as supplements consisting of employer contributions to funds for social insurance, private pension and health and welfare plans, compensation for injuries. By contrast, CES and CPS earnings only include compensation that is earned and paid regularly each period, and completely exclude supplements.

To analyze the importance of these differences, we augment the CPS earnings series with an estimate of supplements and an estimate of earnings of high-income individuals who, as we will show, account for a large part of irregular earnings. To make the LPC series comparable to the private non-agricultural establishment universe of the CES, we take out self-employed workers and some other small components from the LPC (and the universe of our CPS sample, which we defined to match that of the CES).[25] As shown in Table 4 and Figure 6, below, the thus adjusted LPC weekly earnings series (labelled "LPC private non-agricultural") is very similar to the original LPC weekly earnings series (labelled "LPC").

[25] Specifically, the universe of the LPC includes, aside from imputed data for the self-employed, agricultural services, forestry and fishing, and government enterprises. These components are not part of the universe of the CES. See the appendix for details of how we adjusted the LPC universe for these components.

Supplements

The LPC does not provide separate information on supplements. As we detail in the appendix, however, it is possible to construct an estimate of average weekly supplements from NIPA income data that can be added to our CPS weekly earnings measure. As Figure 6 shows, the resulting "CPS + supplements" earnings measure is substantially above CPS weekly earnings, with supplements accounting for 65% of the difference in 1973, and for 57% of the difference in 2013. In terms of business cycle volatility, CPS weekly earnings and "CPS + supplements" behave similarly. As Table 4 shows, both series exhibit a slight decline in volatility post-1984, but this decline is small relative to the decline in the volatility of output. The relative volatility of 'CPS + supplements' therefore increases substantially from the pre-84 to the post-84 period.

Earnings of high-income individuals

As we noted earlier, the CPS weekly earnings series excludes irregular earnings. While all workers can in principle receive irregular earnings, we expect the type of irregular earnings that is excluded from the CPS (e.g. year-end bonuses, exercised stock options) to be concentrated among high-income individuals. Using Internal Revenue Service (IRS) records, Piketty and Saez (2003) document that the share of total income going to the top 1% has increased from a stable 8% between the 1950s to the mid-1990s to 23.5% by 2007, mainly due to strong growth in labor income. As long as a substantial part of this labor income growth is driven by irregular, highly variable earnings – and much of the available evidence on high-income earners points this way – the growth of these earnings may account for part of the higher trend growth as well as the larger post-84 increase in volatility of weekly earnings in the LPC relative to the CPS.[26] It also follows that adjusting topcoded (regular) earnings in the CPS by a constant factor, as we and most of the literature do (see Section 2 and the appendix), fails to capture the effect of irregular earnings on average earning

[26] In particular, compensation from stock options may be highly variable because stock options are likely to be exercised in upturns when their value is higher than their fair-market value at the time they were granted. See Mehran and Tracy (2001), who argue that the growth of stock options in the 1990s and their inclusion in compensation at the time of exercise has biased the evolution of compensation upward. The authors also conjecture that increased use of stock options may render compensation more variable. Also see Guvenen et al. (2015), who document that the top-income individuals experience the biggest percent decreases in labor earnings during recessions.

trends and volatility.

To examine this issue, we use information from Piketty and Saez to calculate average weekly earnings for the top 5% of earners and for the remaining 95% for each year in the 1973-2011 period.[27] We then calculate corresponding average weekly earnings for the top 5% of earners and for the remaining 95% using CPS data.[28] Figure 7 shows the results. Weekly earnings for 95% of workers in the CPS (labelled "CPS 0-95") and the Piketty-Saez data (labelled "P-S 0-95") lie essentially on top of each other. For the top 5%, in comparison, there is a widening difference between the two series (labelled "CPS 95-100" and "P-S 95-100", respectively).

Table 5 reports business cycle volatilities for the different series. The results confirm that, for 95% of workers, the CPS and the Piketty-Saez earnings data are almost identical. For the top 5%, earnings volatility in the Piketty-Saez data increases by a factor of almost three from the pre-84 period to the post-84 period. This is in stark contrast with the earnings volatility of top 5% individuals in the CPS, which is very similar to the Piketty-Saez numbers for the pre-1984 period but then increases only modestly during the post-1984 period. These results clearly confirm our conjecture that irregular earnings are quantitatively relevant for high-income individuals, both in terms of trend growth and business cycle volatility, but do not matter for the remaining 95%.

Since the earnings concept in the IRS data used by Piketty and Saez is very similar to the one employed in the LPC, we adjust the CPS weekly earnings series for irregular earnings of high-income individuals using information from Piketty and Saez. Specifically, we take Piketty and Saez' weekly earnings information for the top-income groups (i.e. top 0.01%, 0.1%-0.01%, 0.5%-0.1%,...to 1%-5%) and extrapolate new earnings values of all topcoded CPS individuals for each year from 1973 to 2011 (the last year for which the Piketty-Saez wage data are currently available – see appendix for details). We then add this extrapolation to the "CPS + supplements" series discussed above. As

[27] We use the wages and salaries data from Piketty and Saez (2003) updated up to 2011 (available on Saez's website). See the appendix for details.

[28] We use a 5%-95% split because, in the CPS data, the fraction of individuals with topcoded earnings never exceeds 5%. Other, more narrow definitions of high-income earners would lead to very similar conclusions. Since the Piketty and Saez data does not distinguish between different sectors, we can perform this comparison only on an "all economy" level. We therefore adjust our CPS sample accordingly.

the resulting "CPS + supplements + P-S topcode corrected" series in Figure 6 shows, the corrected CPS earnings measure accounts for about half of the remaining gap between CPS and the LPC earnings, increasing to about two-thirds of the gap between the early 2000s and 2011. As the last row of Table 5 shows, adding these components to CPS earnings helps considerably in accounting for the increase in volatility in earnings in the LPC in the post-84 period.

We conclude from this investigation that differences in earnings concept between the LPC and the CPS explain the bulk of the divergence in weekly earnings from the two data sets, and therefore account for a large part of the divergence between the LPC and the CES wage series. Moreover, the comparison between our CPS weekly earnings measure and administrative IRS data from Piketty and Saez (2003) shows that, for all but the top 5% of workers, our CPS weekly earnings series provides a close fit. This is a remarkable result, suggesting that despite well-documented issues with measurement error in the cross-section (e.g. Bound and Krueger, 1991), CPS earnings provide a reliable *average* measure of the wages and salaries portion of compensation for all but the highest-paid individuals in the U.S. workforce.

4.2 Differences in worker coverage

As described in Section 2, the LPC covers earnings and hours of the near totality of workers in the non-farm business sector (or, alternatively, in private non-agricultural establishments). By contrast, the CES historically asked sampled establishments only about earnings and hours of production and non-supervisory workers.[29] Since the QCEW establishment records underlying the LPC do not contain information on worker occupation and do not distinguish between regular and irregular earnings, it is impossible to analyze the quantitative importance of this difference in worker coverage directly. Instead, we follow the strategy proposed by Abraham, Spletzer and Stewart (1998) and exploit industry and occupation information in the CPS to create a weekly earnings series that replicates the worker coverage in the CES.

[29] In 2006, the CES started collecting earnings and hours information for all workers in sampled establishments. We consider these data at the end of Section 4.

We proceed in two steps. In a first instance, we construct an average earnings series for individuals in the CPS who fit the official BLS definition of production workers in goods-producing industries and non-supervisory workers in service-providing industries (adjusting for OTC and MJH as described in Section 2). As can be seen from Figure 8, the resulting series, labelled "CES replication 1," fails to replicate the pronounced downward trend of weekly earnings in the CES throughout the mid-1990s and thereafter increases at a faster pace.[30] The result confirms, for a substantially longer sample, the findings reported in Abraham, Spletzer and Stewart (1998).

While this result may appear discouraging, Plewes (1982) and Abraham, Spletzer and Stewart (1998) argue that, historically, establishments in service-providing industries often interpreted non-supervisory workers to mean employees who are paid hourly or are non-exempt under the Fair Labor Standards Act; i.e. employees who are paid for all overtime hours worked, and generally perform operational functions such as routine clerical duties or maintenance work.[31]

Following this argument, we implement an alternative definition of production and non-supervisory workers proposed by Abraham, Spletzer and Stewart (1998) that keeps the same definition of production workers in goods-producing industries the same as in "CES replication 1," but categorizes all hourly-paid individuals along with clerical, sales, craft and kindred and operatives occupations in service-providing industries as non-supervisory workers (see the appendix for details). As Figure 8 shows, the resulting series, labeled "CES replication 2," tracks the evolution of observed CES earnings more closely. In particular, this replication generates a downward trend from the 1970s to the mid-1990s and then a return to higher earnings from the mid-1990s onward. At the same time, CES replication 2 lies somewhat below observed CES earnings, especially in the beginning and toward the end of the sample. We discuss possible explanations for this discrepancy at the end of this section.[32]

[30] The sample for this exercise stops in 2002 because occupations definitions in the CPS changed in 2003, making the construction of consistent occupation-specific series difficult.

[31] This misreporting issue was particular to service-providing industries because the non-supervisory classification is not one that establishments would use naturally for other purposes.

[32] Naturally, the same difference in worker coverage may explain the different evolution of weekly hours in the CES and the CPS. Frazis and Stewart (2010) investigate this possibility. They find that both CES replication 1 and 2 with the CPS sample decreases average hours by 1.3 to 1.7 hours, which basically closes the initial gap between

Table 6 compares the business cycle volatility of the two CES replications with the volatility of the observed earnings series from the CES and the CPS. As discussed in Section 2, the volatility of CES earnings is substantially above the volatility of CPS earnings for the pre-1984 sample and then drops markedly in the post-84 period, whereas the volatility of CPS earnings declines only modestly.[33] CES replication 1 accounts for part of the higher volatility of CES earnings in the pre-1984 sample and their larger drop in volatility in the post-1984 sample. CES replication 2 improves upon this picture, accounting for almost all of the difference in pre-1984 volatility between CES and CPS earnings, and for about half of the drop in volatility of CES weekly earnings relative to the volatility of CPS weekly earnings.

The replication exercise with CPS data suggest that the segment of workers for which establishments have traditionally reported earnings in the CES is not representative of average earnings in the non-farm business sector, and that this lack of representativeness accounts for a substantial part of the divergence in trend and volatility between CES and LPC average earnings. This conclusion receives further support from a comparison between the "production and non-supervisory" earnings series of the CES with the "all workers" earnings series that the CES implemented starting in 2006. As Figure 9 shows, average earnings for the "all employees" series lies substantially above average weekly earnings for the "production and non-supervisory workers" series. The figure also shows that the CES "all employees" series is close to our CPS earnings construct, which confirms our finding from above that the CPS provides a reliable account of average regular earnings.[34]

4.3 Taking stock

Table 7 takes stock of the various results. The first row shows the total difference between LPC earnings and CES earnings in terms of the initial 1973 level, the change between 1973 and 2013, the 1973-84 volatility, and the change in volatility pre-84 to post-84, respectively. Subsequent rows

CES and CPS hours. However, neither of the replications can account for the downward trend in CES hours.

[33] Notice that the CPS earnings volatility for the post-1984 period reported here is slightly different from the one in Table 3 because the sample here stops in 2002 instead of 2013.

[34] As we discuss at the end of this Section, the small remaining gap between the CES all employee and the CPS series is likely to be attributable to non-response bias in the CES.

show how much of these differences are accounted for by differences in earnings concept and by differences in population coverage. The last row shows the residual.

The table makes clear that differences in earnings concept and differences in worker coverage account for the majority of not only the divergent evolution of the two earnings measures over time, but also their initial level and volatility differences. Since, by construction, average weekly hours evolve very similarly in the LPC and the CES, differences in earnings concept and differences in worker coverage also account for the majority of the differences in average hourly wages between the LPC and the CES.

4.4 Other sources of divergence

We have shown that differences in earnings concepts and population coverage can account for the bulk of the divergence in historical CES and LPC earnings series. But there are other differences between the two datasets that may have contributed to the divergence in earnings trends and volatility.

As described earlier, the earnings data for the LPC series come primarily from the QCEW, which is an administrative dataset collected for UI purposes and covers nearly all private-sector establishments. In contrast, the CES is a voluntary survey of establishments. While the QCEW's measurement concepts and coverage have remained constant, the collection methods and coverage of the CES have undergone significant changes.

The CES started out in 1915 as a survey of a small number of establishments in four manufacturing industries. Over time, both the sample size and the industry coverage have increased significantly. By the early 1980s, the CES sample was about 180,000 establishments and the program published data for more than 500 industries. But only 30 percent (155 industries) were service-providing, even though service-providing industries accounted for about 57 percent of private sector employment (about 70 percent of total employment). As a result, small establishments, which are disproportionately in services, were under-represented to the point where "*the sample* *in the service sector falls short of representation in the smallest size categories*" (Plewes, 1982).[35] Partly in response to this concern, the BLS expanded the CES sample significantly to about 425,000 establishments by 1989 (additional, more modest expansions occurred thereafter). This expansion improved sample representation and allowed the BLS to increase the number of estimation cells in the service-sector by an additional 82 industries.

Another change occurred in the mid-1990s when the BLS started shifting survey collection from a mail-shuttle form to automated methods. Under the mail-shuttle method, the same form was mailed back and forth between establishments and the BLS without the BLS providing feedback to respondents on how to fill out the form correctly. Under current procedures, data for new respondents are collected via computer assisted telephone interviewing (CATI), whereby interviewers can help respondents provide the correct data. After several months of CATI interviews, respondents are transitioned to automated data collection methods.

A final change arrived in the early 2000s when the BLS switched from a quota sample to a probability sample approach. Under the quota sample approach, the BLS specified the number of establishments required for each industry-size cell and solicited new establishments until the quota was met. Moreover, establishments remained in the sample until they refused reporting or went out of business. As a result, establishments in the CES sample tended to be older than the universe of establishments. Under the new probability sample approach, establishments in each industry-size cell are solicited at random without replacement; and reporting establishments are regularly rotated out of the sample.

These changes improved data quality and the representativeness of the CES sample; but they may have also affected the average earnings series in unexpected ways.[36] Specifically, the under-representation of smaller establishments in service-providing industries in the early part of the

[35] Large establishments account for a disproportionate fraction of employment in the U.S. The CES therefore samples larger establishments at a higher rate as this allows for better coverage and presumably more accurate responses. See BLS (2014) for details.

[36] Since the different changes occurred gradually, they did not result in obvious breaks. Moreover, the published CES average earnings series are computed using a "link-and-taper" estimator, which tends to smooth the effects of changes to the sample. See BLS (2014) for details.

sample may have biased upwards the average earnings series.[37] If that is the case, then the 1980s sample expansion, which made the sample more representative, could have caused the earnings series to trend downward. This could explain why in Figure 8, the CES average earnings series started out above the CPS-based replications but then declined at a faster pace during the 1980s. Concurrently, the change in survey collection methods in the mid-1990s may have reduced misclassification of production and non-supervisory workers, thereby shifting the worker coverage of the CES sample from the one assumed in CPS-based replication 2 towards coverage resembling the one assumed in replication 1. This could explain why the CES average earnings series exhibited stronger growth than replication 2 during the second half of the 1990s.

Ideally, we would want to simulate the effects of these changes using data from the QCEW, which is the sample frame for the CES. Unfortunately, the micro data needed for such simulations are not available.[38] However, we can at least obtain an idea of the effect of the sample expansion of the early 1980s, which occurred primarily in the service sector, by looking separately at goods and service sectors. We find that the CES average earnings series for service-providing industries starts out above its CPS-based replication and then experiences a pronounced downward trend, closing most of the gap with its CPS-based replication by 1980. For goods-producing industries, by contrast, the CES earnings series and its CPS-based replication match each other closely in the beginning of the sample and there is no downward trend. This suggests that the decline in CES average earnings in the early part of the sample was at least partly driven by changes in the service sector. At the same time, the decline in service sector earnings occurs too early to coincide with the sample expansion of the mid-1980s.[39]

[37] Larger and older establishments tend to pay higher wages. However, overssampling larger and older establishments does not necessarily bias average earnings since each industry-size-state cell in the CES is weighted with QCEW employment counts. A slight upward bias could occur, however, if within each cell, the sampled establishments are larger and older than their cell population average.

[38] Even if the microdata were available, the simulations would not perfectly replicate the changes. Although it would be possible to identify CES respondents and determine how the sample changed, the QCEW earnings concepts and worker coverage do not match those in the CES. Also, the QCEW does not have any data on hours.

[39] Moreover, additional calculations based on information in Plewes (1982) and more recent QCEW data suggest that the quantitative effect of underrepresentation of small establishments in the early part of the CES sample was unlikely to be large. Abraham, Spletzer, and Stewart (1998) performed similar simulations to assess underrepre-

Another potential explanation for part of the difference between the CES and LPC earnings series is non-response bias in the CES sample. As documented in a recent BLS study by Groen et al. (2013), the response rates for the CES earnings and hours questions are very low. Between 2007 and 2011, about 53 percent of all establishments sampled by the CES provided all-employee counts; and conditional on reporting the all-employee counts, the response rate for the earnings and hours questions was about 57 percent. This translates into an unconditional response rate of about 30 percent for the earnings and hours questions.[40]

To assess non-response bias, the BLS study matched all establishments sampled by the CES (respondents and non-respondents) to the QCEW, which contains information about earnings for all employees (but not hours). Overall, average earnings in the QCEW of CES respondents that reported earnings was 6.7 percent less than average earnings in the QCEW of all establishments sampled by the CES.

The BLS study covers a relatively short period, so we do not know how response rates and response-rate bias may have changed over time. Moreover, as noted earlier, the QCEW earnings concept differs from the CES earnings concept; and the QCEW does not provide separate information on production and non-supervisory workers, which is the historical coverage of the CES. Even so, the BLS study suggests that non-response bias has had a significant negative effect on CES average earnings in recent years and explains a large part of the difference between the CPS and CES "all-employees" series in Figure 9.[41]

sentation of young establishments and arrived at the same conclusion. Details of these results are available upon request.

[40] Non-response rates for both sets of questions vary by establishment size, with response rates decreasing with establishment size. Response rates also vary by data collection method and length of pay period. In general, establishments either always respond to the earnings and hours questions (about 33 percent of establishments that report all-employee counts for 12 months) or they never respond (about 52 percent).

[41] Actually, non-response bias explains more than the difference between the CPS and the CES "all-employees" series in Figure 9. It is worth noting that, given the differences between the CES and the QCEW, the estimated -6.7 percent bias should be viewed as a ball-park figure.

5 Conclusion

The results of our analysis indicate that the historical average hourly earnings series from the CES is a problematic measure of wages for macroeconomic analysis because it restricts coverage to production and non-supervisory workers, whose earnings have grown more slowly and have become substantially less variable than for the United States workforce as a whole. Moreover, CES earnings do not include supplements, which have become more important over the past decades and now constitute a large portion of total labor compensation. Concurrently, the LPC measure of average hourly compensation comes with the caveat that a large part of its recent trend growth and increase in volatility is driven by a small fraction of high-income individuals. As a result, the LPC wage underestimates the extent of the "Great Wage Slowdown" and overestimates the variability of wages over the business cycle as experienced by the majority of the United States workforce.

Our analysis also shows that the average earnings series we construct from CPS May/ORG data matches almost perfectly the administrative earnings data from the IRS for all but the highest-paid individuals. Our CPS May/ORG construct therefore provides an interesting alternative average wage measure that covers the entire United States workforce but excludes irregular earnings of high-income individuals. Moreover, the CPS earnings series can be augmented with NIPA estimates for supplements to take into account the growing importance of non-wage payments in labor compensation.[42]

Two other advantage of the CPS over the CES and the QCEW are that (i) the micro-data are publicly available; and (ii) the CPS contains a rich set of demographic and job-related variables, making it possible to construct separate average earnings series for different parts of the workforce (see Lemieux, 2006 or Acemoglu and Autor, 2011 among many others). This is particularly relevant for the debate on the "Great Wage Slowdown" and the associated decline in labor share of income.

[42] This does not imply that the CES and the LPC series should be disregarded for macroecononomic analysis. The LPC measure continues to be the most inclusive and most accurate measure of total labor costs. In turn, the new "all employees" series from the CES provides a monthly measure of wages and salaries that covers the entire U.S. workforce. Our CPS measure is in principle also available at a monthly frequency. However, the monthly ORG sample is much smaller than the CES sample; and the micro data necessary for our OTC and MJH adjustments becomes publicly available only with a time lag.

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6 Figures and Tables

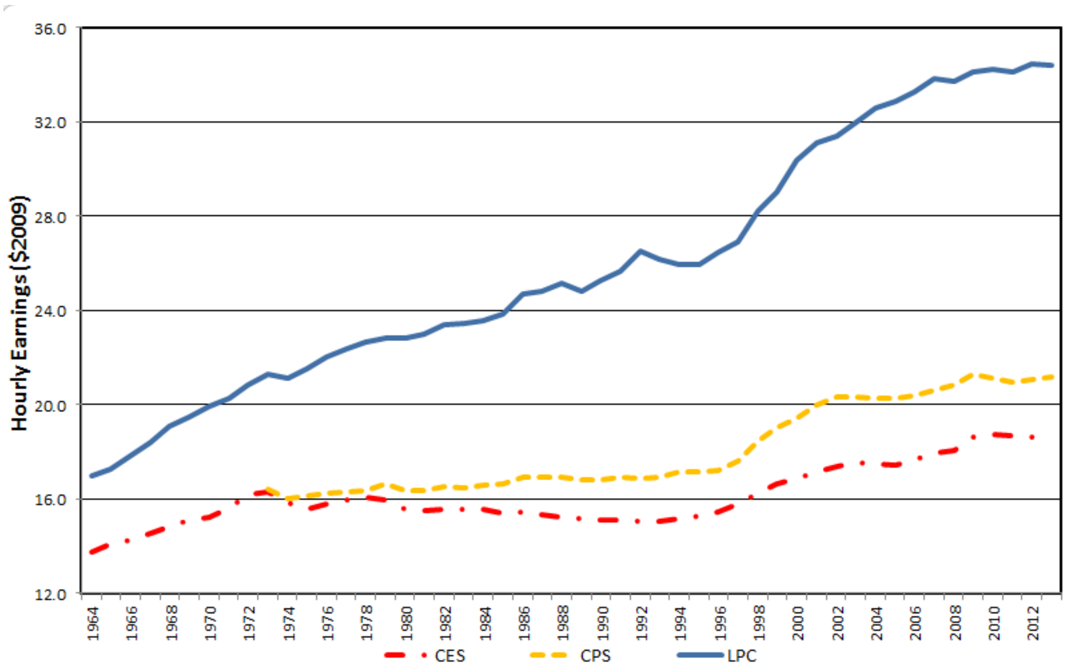


Figure 1. Real average hourly wages.

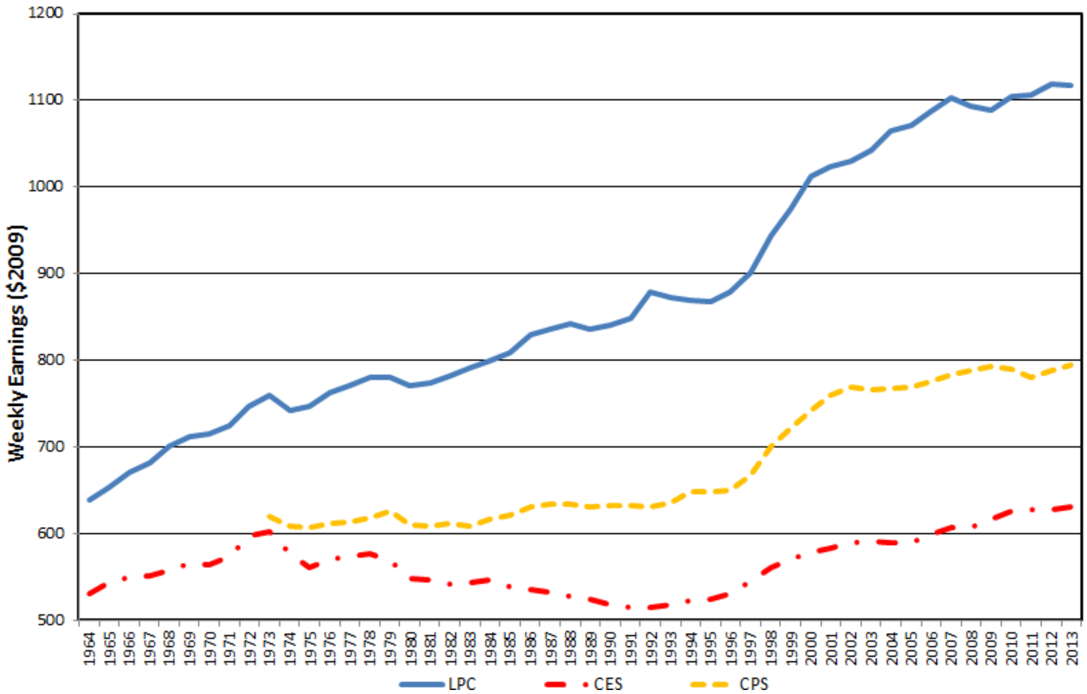


Figure 2. Real average weekly earnings.

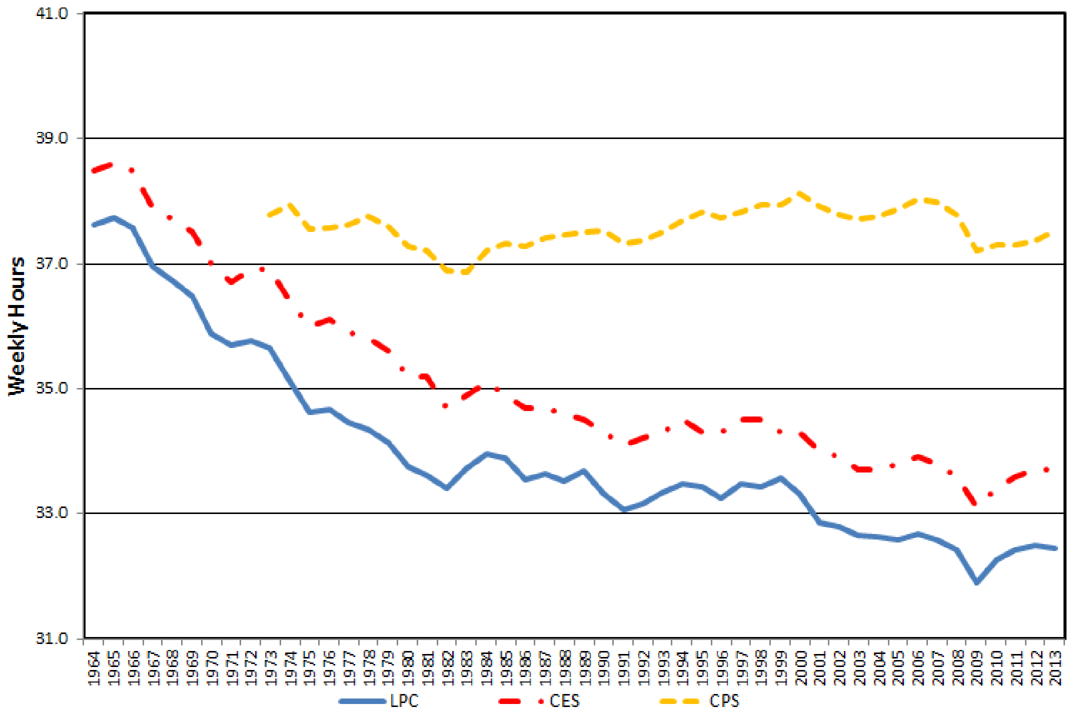
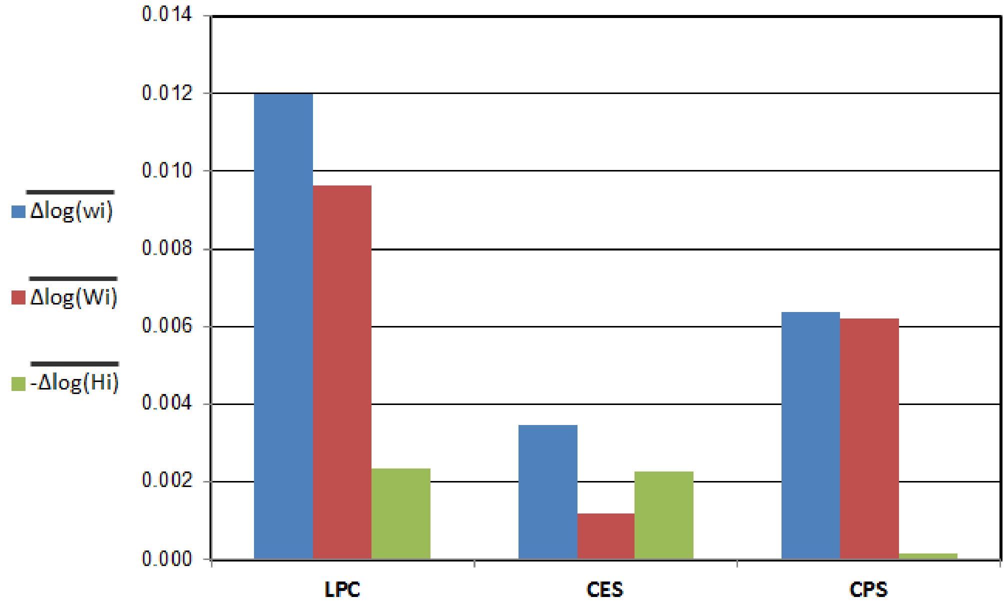


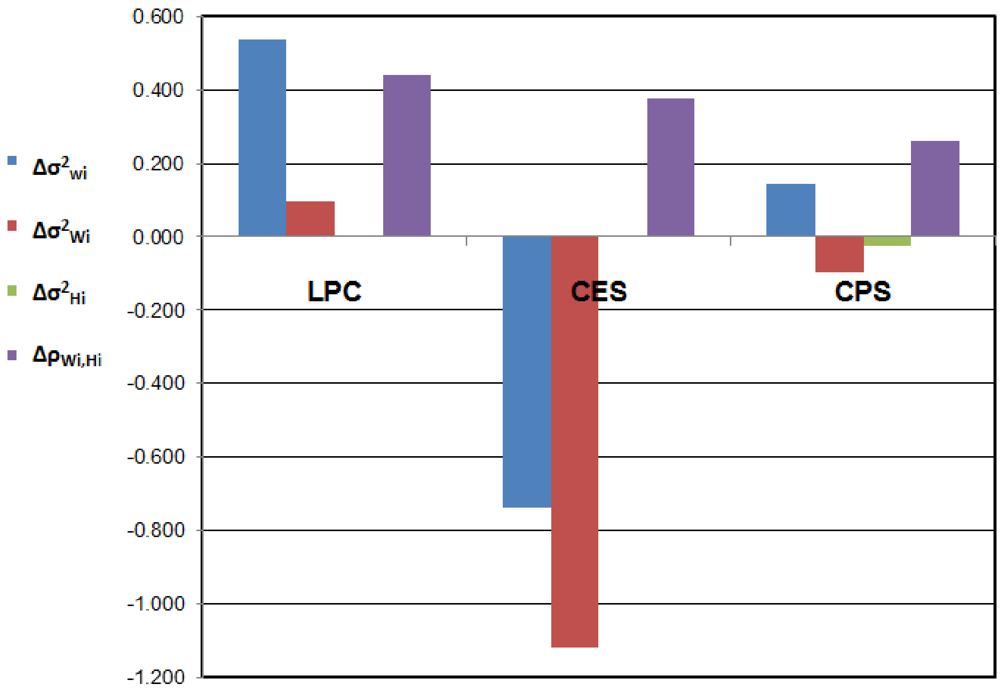
Figure 3. Average weekly hours.



	LPC - CES	%	LPC - CPS	%	CPS - CES	%
$\overline{\Delta\log(w_i)} - \overline{\Delta\log(w_j)}$	0.009	100.00%	0.006	100.00%	0.003	100.00%
$\overline{\Delta\log(W_i)} - \overline{\Delta\log(W_j)}$	0.008	98.96%	0.003	60.98%	0.005	172.06%
$\overline{\Delta\log(H_i)} - \overline{\Delta\log(H_j)}$	0.000	1.04%	0.002	39.02%	-0.002	-72.06%

Note: The figure decomposes average hourly wage log first-differences (blue) between 1973 and 2013 into weekly earnings growth (red) and weekly hours growth (green), i.e. *Δlog(w) = Δlog(W) - Δlog(H)*, where w, W, and H denote the average hourly wage, average weekly earnings, and average weekly hours. The accompanying table reports the contribution of each component in accounting for the difference in hourly wage average growth between the data sources.

Figure 4. Accounting for the divergence in average hourly wage growth.



	LPC-CES	%	LPC-CPS	%	CPS-CES	%
$\Delta\sigma^2_{wi} - \Delta\sigma^2_{wj}$	1.273	100.00%	0.392	100.00%	0.882	100.00%
$\Delta\sigma^2_{Wi} - \Delta\sigma^2_{Wj}$	1.215	95.42%	0.192	48.97%	1.023	116.06%
$\Delta\sigma^2_{Hi} - \Delta\sigma^2_{Hj}$	-0.004	-0.30%	0.025	6.26%	-0.028	-3.22%
$\Delta\rho_{Wi,Hi} - \Delta\rho_{Wj,Hj}$	0.062	4.88%	0.181	46.12%	-0.118	-13.44%

Note: The figure decomposes the change in the variance of the hourly wage (blue) into changes in the variance of earnings (red), the variance of hours (green), and the correlation between earnings and hours (purple) between 1973-1983 and 1984-2013 for the LPC, CES, and CPS data series. The accompanying table reports the contribution of each component in accounting for the difference in hourly wage variance changes between data sources.

Figure 5. Accounting for the divergence in business cycle volatility of average hourly wages.

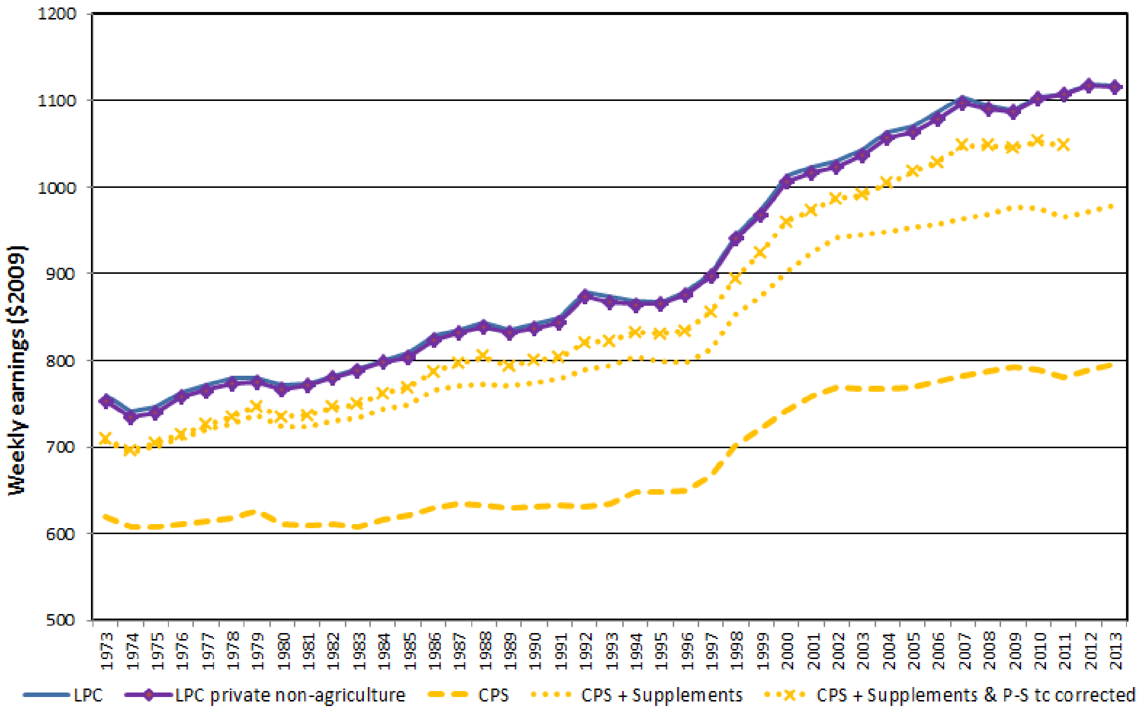


Figure 6. Real average weekly earnings.

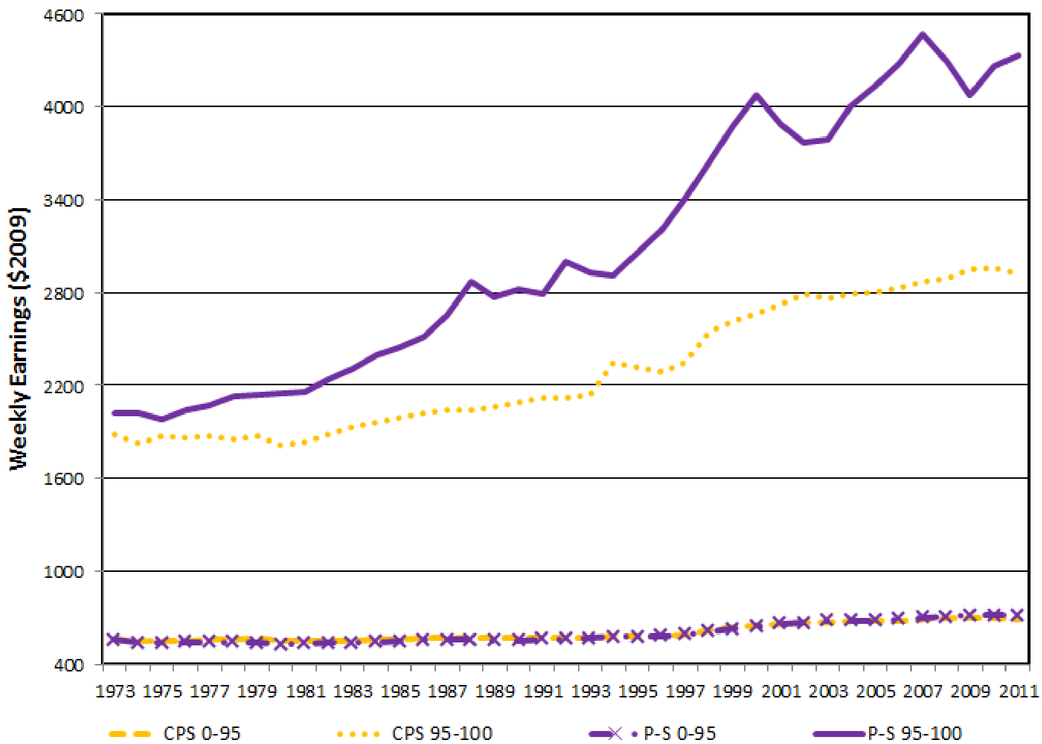


Figure 7. Real average earnings for different income groups.

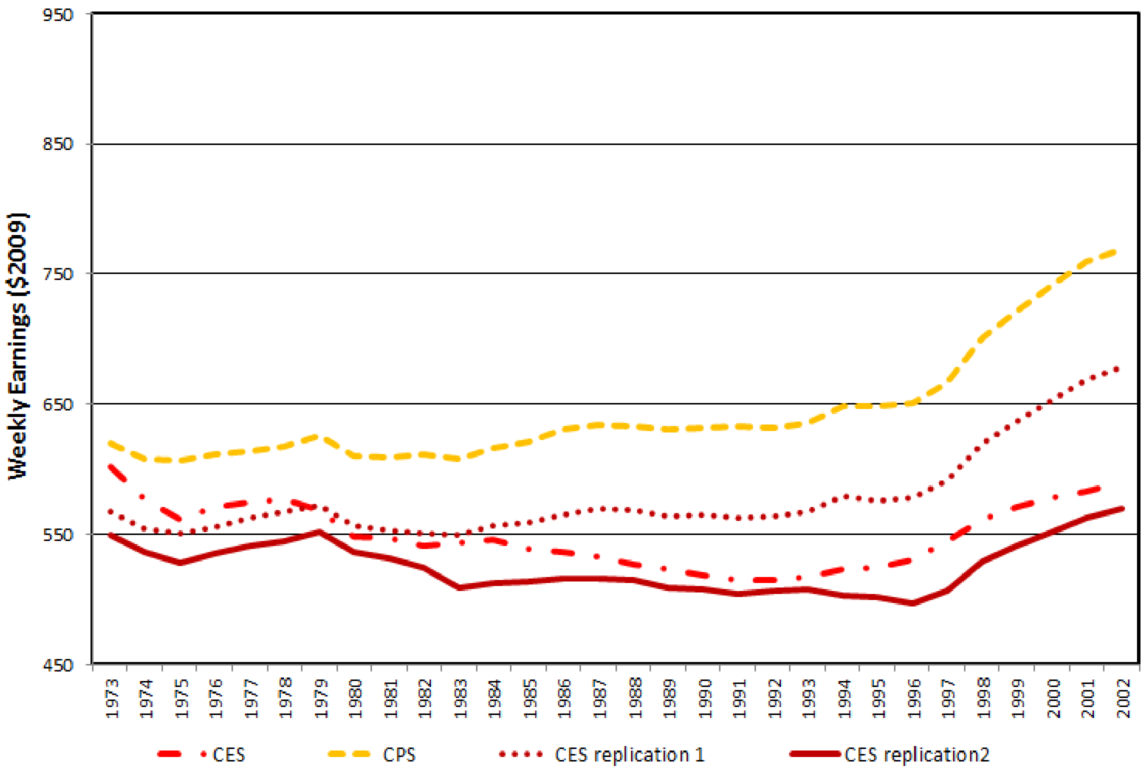


Figure 8. Real average weekly earnings for CPS, CES and the two CES replications.

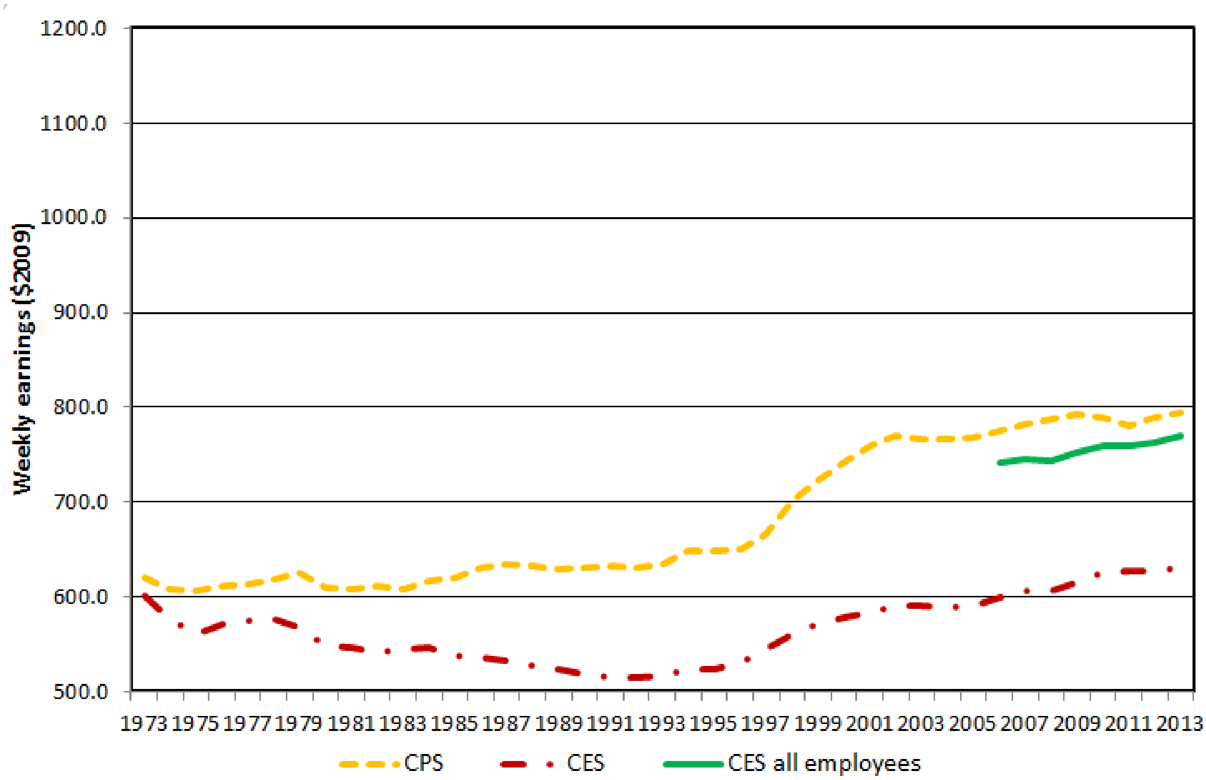


Figure 9. Real average weekly earnings for CPS, CES and CES all employees.

	LPC	CES	CPS
Source	* QCEW; covering 98% of private-sector jobs.	* Establishment survey from BLS. * About 160,000 establishments per month in early 1980s to 588,000 per month today.	* Household survey from BLS and Census. * About 60,000 households per month.
Sample	* 1948 onward; quarterly.	* 1964 onward; monthly.	* 1973 onward; annual. CPS May & ORGs. * 1979 onward; monthly. CPS ORGs.
Population coverage	* All employees in non-farm business sector, including estimate for self-employed.	* Production and non-supervisory employees in private non-agricultural sector, excluding self-employed. * From 2006 on, all employees in private non-agricultural sector.	* All individuals in private non-agricultural sector, excluding self-employed (sample is made representative using Census weights).
Earnings concept	* Wages and salaries. * Commissions, tips, bonuses, gains from exercising stock options. * Supplements (e.g. vacation pay, employer contributions to pension and health plans).	* Wages and salaries. * Overtime, commissions and bonuses only if paid regularly. * No irregular bonuses, gains from stock options or supplements. * No tips, unless reported on employee's tax form.	* Wages and salaries. * Overtime, tips, commissions and bonuses only if paid regularly. * No irregular bonuses, gains from stock options or supplements.

Table 1. Description of main data sources.

	Standard Deviation			Relative Standard Deviation		
	Pre-84	*Post-84*	*Post/Pre-84*	*Pre-84*	*Post-84*	*Post/Pre-84*
Quarterly data						
Output	2.73	1.55	0.57	1.00	1.00	1.00
	(0.31)	(0.19)				
LPC wage	0.65	1.10	1.68	0.24	0.71	2.97
	(0.08)	(0.09)		(0.03)	(0.12)	
CES wage	1.12	0.62	0.55	0.41	0.40	0.97
	(0.19)	(0.07)		(0.07)	(0.04)	
Annual data						
Output	2.90	1.40	0.48	1.00	1.00	1.00
	(0.19)	(0.20)				
LPC wage	0.59	0.94	1.60	0.20	0.67	3.31
	(0.09)	(0.14)		(0.04)	(0.17)	
CPS wage	0.66	0.76	1.15	0.23	0.54	2.38
	(0.10)	(0.09)		(0.04)	(0.10)	
CES wage	1.02	0.54	0.53	0.35	0.39	1.10
	(0.14)	(0.09)		(0.05)	(0.05)	

Notes : Total sample extends from 1964Q1 to 2013Q4 for quarterly data; from 1973 to 2013 for annual data. HP-filtered data. PCE-deflated w ages (2009 dollars). Non-farm business sector. PCE-deflated hourly w ages. P-values are reported for a test of equality of variances across the tw o subsamples. Standard errors computed using GMM and the delta method appear in parentheses below estimates.

Table 2. Business cycle volatilities.

	Standard Deviation or Correlation		
	Pre-84	*Post-84*	*Post / Pre-84**
HP-Filter			
LPC hourly wage	0.59	0.94	1.60
	(0.09)	(0.14)	
LPC weekly earnings	0.84	0.91	1.08
	(0.12)	(0.12)	
LPC weekly hours	0.41	0.45	1.09
	(0.02)	(0.05)	
ρ(LPC earnings, LPC hours)	0.76	0.17	-0.59
	(0.13)	(0.18)	
CES hourly wage	1.02	0.54	0.53
	(0.14)	(0.09)	
CES weekly earnings	1.30	0.50	0.38
	(0.18)	(0.06)	
CES weekly hours	0.41	0.37	0.90
	(0.04)	(0.06)	
ρ(CES earnings, CES hours)	0.77	0.25	-0.52
	(0.11)	(0.17)	
CPS hourly wage	0.66	0.76	1.15
	(0.10)	(0.09)	
CPS weekly earnings	0.80	0.72	0.90
	(0.15)	(0.12)	
CPS weekly hours	0.42	0.31	0.74
	(0.03)	(0.05)	
ρ(CPS earnings, CPS hours)	0.57	0.10	-0.47
	(0.18)	(0.13)	

**Notes* : Annual data 1973-2013, H-P filtered. PCE-deflated earnings (2009 dollars). Standard deviations are multiplie by 100. The first three rows in each of the above panels show standard deviations for the series defined in the left column; the fourth row of each panel shows the correlation coefficient between earnings and hours for each data source. The last column shows the ratio of post-84 to pre-84 for standard deviations, and the post-84 to pre-84 difference for correlations. Standard errors computed using GMM and the delta method appear in parentheses belo estimates.

Table 3. Average real hourly wage volatility change breakdown.

	Standard Deviation			Relative Standard Deviation		
	Pre-84	*Post-84*	*Post/Pre-84*	*Pre-84*	*Post-84*	*Post/Pre-84*
HP-Filter						
Output (nfb)	2.90	1.40	0.48	1.00	1.00	1.00
	(0.19)	(0.20)				
LPC total compensation	0.84	0.91	1.08	0.29	0.65	2.24
	(0.12)	(0.12)		(0.05)	(0.15)	
LPC total compensation (private non-agri)	0.82	0.87	1.07	0.28	0.62	2.21
	(0.11)	(0.12)		(0.05)	(0.15)	
CPS	0.80	0.72	0.90	0.28	0.52	1.87
	(0.15)	(0.12)		(0.05)	(0.13)	
CPS + Supplements	0.82	0.72	0.88	0.28	0.51	1.83
	(0.13)	(0.14)		(0.04)	(0.15)	
CPS + Supplements & P-S topcode values	0.80	0.79	0.98	0.28	0.56	2.03
	(0.13)	(0.10)		(0.04)	(0.13)	

Notes : Total sample extends from 1973 to 2013, except for P-S topcode adjusted series, which ends in 2011. Annual data. PCE-deflated wages 2009 dollars). HP-filtered data. Standard errors computed using GMM and the delta method appear in parentheses below estimates.

Table 4. Business cycle volatilities for various average weekly earnings series.

	Standard Deviation		
	Pre-84	*Post-84*	*Post/Pre-84*
Percentiles			
P-S P0-95	0.87	0.58	0.67
	(0.11)	(0.06)	
CPS P0-95	0.86	0.61	0.71
	(0.16)	(0.11)	
P-S P95-100	1.03	2.75	2.68
	(0.13)	(0.27)	
CPS P95-100	1.15	1.51	1.31
	(0.11)	(0.37)	

Notes: CPS May-MORG data and Piketty-Saez "Top income shares" database. Real Average Weekly Earnings (2009 dollars). Annual data from 1973 to 2011. All economy. All series are H-P filtered.

Table 5. Effect of high-income earners on average earnings volatilities.

	Standard Deviation		
	Pre-84	*Post-84*	*Post/Pre-84*
HP-filter			
CPS	0.80	0.73	0.92
	(0.15)	(0.16)	
CES replication 1	1.01	0.72	0.71
	(0.15)	(0.14)	
CES replication 2	1.22	0.80	0.65
	(0.09)	(0.18)	
CES	1.30	0.50	0.39
	(0.18)	(0.09)	

Notes : CPS May-MORG data. Real Average Weekly Earnings (2009 dollars). Annual data. Sample: 1973 to 2002.

Table 6. Replicating average real earnings volatility from the CES with CPS data.

	Level difference				Volatility difference			
	Initial (1973) level		Change 1973-2013		1973-1984		Change post84 - pre84	
	$	%	$	%	stdev	%	stdev	%
Total LPC-CES	**157.77**	**100.0%**	**327.53**	**100.0%**	**-0.46**	**100.0%**	**0.87**	**100.0%**
Earnings concept	**132.36**	**83.9%**	**188.09**	**57.4%**	**-0.03**	**6.9%**	**0.23**	**25.9%**
(i) Supplements	86.54	54.9%	96.56	29.5%	0.01	-3.2%	-0.02	-2.0%
(ii) Irregular earnings of high-income earners	45.82	29.0%	91.53	27.9%	-0.05	10.1%	0.24	28.0%
Population coverage	**75.97**	**48.1%**	**130.84**	**39.9%**	**-0.40**	**86.6%**	**0.37**	**42.8%**
(i) Type of worker	71.01	45.0%	128.86	39.3%	-0.42	90.5%	0.36	41.0%
(ii) Universe	4.95	3.1%	1.98	0.6%	0.02	-3.9%	0.02	1.7%
Others (residual)	-50.56	-32.0%	8.60	2.6%	-0.03	6.5%	0.27	31.3%

Notes: Contributions to the difference in levels and trend growth (left) between LPC and CES, and to the difference in volatility change (right). Data sources: LPC, CES, CPS May-MORG, NIPA, and Piketty-Saez "Top income shares" database. Real average weekly earnings (2009 dollars). Private non-agriculture sector. Annual data from 1973 to 2013. All series are H-P filtered.

Table 7. Accounting for the LPC-CES average weekly earnings differences.