How Much Are Workers Getting Paid?
A Primer on Wage Measurement

The Council of Economic Advisers
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Executive Summary

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A primary way that economic policies affect American families is through the wages they receive in the labor market. However, despite the importance of wages for evaluating economic performance, there are a number of limitations in the traditional measures—especially during periods when the labor force is growing and new workers are entering the workforce. This report outlines four such concerns about traditional wage measures, and their effects on observed compensation growth.

First, many of the official wage statistics fail to incorporate additional employment benefits such as bonus pay, health insurance and contributions to retirement savings. These additional benefits have made up an increasing share of compensation in recent years, so the growth in total compensation has been greater than that seen for cash wages alone. Ignoring bonus pay and other benefits is particularly misleading during the past year when over 6 million workers have benefitted from the tax cuts in the form of pay raises, better benefits, and bigger bonuses. Second, because those entering the workforce for the first time or after a period of not working generally have less work experience than those who have been continuously employed, these new workers also often have lower wages. As a result, when tracking the average wage of those working at a given point in time, these new workers will create the appearance of lower wage growth than workers are actually experiencing. Third, when measuring real wages, it is necessary to properly measure inflation in the economy. When using the Personal Consumption Expenditure Price Index (PCEPI)—which is preferred by many economists, including those at the Federal Reserve—we observe faster real wage growth than when using the commonly reported Consumer Price Index for Urban Consumers. Fourth and finally, as a result of personal income tax cuts resulting from the Tax Cuts and Jobs Act of 2017, real after-tax income has been rising faster than pre-tax income. These lower personal income taxes are also not captured in official wage statistics.

Once these adjustments have been incorporated to better reflect the actual experiences of workers, real compensation growth over the past year has been substantially higher than that observed in headline wage measures. Over the past year (2017:Q2–2018:Q2), real average hourly after-tax compensation has risen by 1.4 percent, well above the near-zero real wage change suggested by headline measures. An alternative to CEA's approach is to take the Atlanta Federal Reserve's Wage Growth Tracker nominal cash wage growth, adjust for taxes and fringe benefits, and deflate with the PCEPI, in which case real after-tax compensation growth is 1.9 percent over the same period.

Introduction: Measures of Compensation as Indicators of Economic Performance

The American economy is growing again, but many in the media, policy circles, and academia have been puzzled by what appear to be stagnating real wages.[1] The hourly amount that workers are paid can be an important indicator of economic performance and economic policies. It can measure the value of work to an individual and his or her family in terms of what work adds to the family's purchasing power, at the same time that it indicates the pecuniary incentive to work. Changes in real wages also reflect labor productivity changes, due to technological change, capital deepening, deregulation, or other factors that increase the value of work to employers.[2] But how wages are measured turns out to greatly affect estimates of their level and trend over time.

Several national wage measures are regularly released by Federal agencies and private institutes, including average hourly earnings of payroll employees, median weekly earnings, the employment cost index, employer costs for employee compensation, hourly employee compensation, and the Automatic Data Processing (ADP) Workforce Vitality Index. The purpose of this report is to explain the relationships among the available measures and their value as indicators of labor market performance, refer to the related academic literature, and offer conclusions about what has happened to worker pay during the most recent economic expansion.

To begin, we note several features of the available wage data that provide an incomplete picture of the economic value of national wages. Most national measures of wages focus on a ratio that has cash earnings in the numerator and a denominator of either time worked or time paid, measured in hours or weeks. Wage changes are then calculated as the difference between the current value of such a measure and what this measure was in a previous month or year. But because cash earnings do not include the important fringe benefits available in many jobs, and the usual measures neither net out payroll and income taxes owed as a consequence of working nor add tax credits (e.g., the Earned Income Tax Credit that supplements wages), this approach misses an important part of the economic value of work for the worker and his or her family. It also misses an important part of the net value of work for employers because cash earnings exclude the employer taxes and regulatory obligations associated with payrolls.[3]

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[1] See Long (2018), OECD (2018), Chetty et al. (2014), and Guvenen et al. (2017), respectively.

[2] Labor productivity affects wages regardless of whether the labor market is competitive, "monopsonistic," or "monopolistic."

[3] The existence of taxes, regulations, and market power also means that the marginal employee's economic benefit from work is less than employer cost.

Moreover, cash earnings are naturally measured in dollars and are thus affected by changes in the value of a dollar over time due to inflation.

In addition to the difficulty with focusing on cash earnings in the numerator, the denominator in the calculation poses additional challenges for an accurate assessment of wage changes. Although not all wage data do so, it is important to distinguish between hours paid and hours worked, because a number of employers pay their employees while they are not at work—on vacation, sick leave, or parental leave. As is recognized in the Bureau of Labor Statistics (BLS) productivity statistics, hours worked rather than hours paid is the proper denominator for measuring either productivity or what a worker received per hour worked (BLS 2015).

Moreover, all the current data measures begin with a sample of individuals who happen to be employed at the time of the survey (or a sample of jobs held by those individuals). But the people employed today make up a somewhat different group than those who were employed last year, and a quite different group than those who were employed a decade ago (Jeong, Kim, and Manovskii 2015). Movements of people in and out of the workforce systematically bias the usual wage growth measures away from being reliable indicators of individuals' experiences.[4] Every year young, inexperienced people enter the workforce, and thereby they are included for the first time in the national average, at wages below those of more experienced workers.[5] And every year, some of the most experienced, and highly paid, workers retire and thus cease to be included in the national average. Both these life cycle events substantially reduce the national average wage, and would do so even if there were no workers experiencing a wage decline.[6] All these issues can be addressed, and valid inferences can be obtained, by properly using the various publicly available wage data.

In sum, much of the commentary about wage growth is influenced by confusion about proper measurement. We find that the usual real (inflation-adjusted) wage measures understate how wages have increased during this expansion for at least two of four primary reasons: They omit the value of fringe benefits, they fail to adjust for changes in the composition of the workforce, they do not use the best deflator for converting nominal (not inflation-adjusted) wages to real wages, and some of them use hours paid rather than hours worked.

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[4] Similar approaches are sometimes used to measure labor productivity or employer cost: taking output or compensation per hour worked without any adjustment for changes in the composition of the workforce. Much of the discussion that follows therefore applies to the measurement of labor productivity and employer cost.

[5] "Workforce" refers to the set of people employed (although not necessarily at work, because they could be on paid leave), which differs from the labor force in that the workforce excludes the unemployed.

[6] This is not to say that national averages are uninteresting. A payroll tax collector might be concerned if the national average cash earnings were declining solely due to workforce entry and exit. But much of the policy and media interest is in what individual workers experience.

Holding the composition of the workforce constant, the annual growth rate of real wages over the past year (2017:Q2–2018:Q2) has been almost 1 percentage point higher than the usual wage measures deflated with the Consumer Price Index (specifically, the Consumer Price Index for Urban Consumers, CPI-U).[7] In other words, real wages grew 1.0 percent rather than the 0.1 percent that is usually reported from the monthly "Real Earnings" release.

Moreover, taking into account the personal income part of tax reform (the Tax Cuts and Jobs Act of 2017), which can also increase the economic value of work for employees in a way that is not reflected in the usual measures, after-tax real (after inflation) compensation grew 1.4 percent over the past year. Growing at 1.4 percent per year, the average household income increases more than $2,000 in two years, beyond that required to keep up with inflation, and more than $4,000 in four years.

An alternative to CEA's approach is to take the Atlanta Federal Reserve's Wage Growth Tracker nominal cash wage growth, adjust for taxes and fringe benefits, and deflate with the PCEPI, in which case real after-tax compensation growth is 1.9 percent over the same period.

Sources of Wage Data

There are three primary sources of wage data produced by the Federal government, as well as additional sources that are tracked by private firms: (1) the Current Employment Statistics survey of establishments, which is the source of wage data reported by the U.S. Department of Labor's BLS on a monthly basis; (2) the National Compensation Survey of establishments, which is used to construct the Employment Cost Index reported by the BLS every third month; and (3) the Current Population Survey of households, which is used to track wages for demographic groups. Table 1 and figure 1 provide summaries of the available data, and this section briefly describes each of these sources, as well as their relative advantages and disadvantages.

[7] The Consumer Price Index for All Urban Consumers (CPI-U) is commonly referred to simply as the CPI.

Table 1. Summary of Wage Growth Measures

Source/Series	Percent Change Over Past 12 Months or 4 Quarters		Fringe Benefits	Hours Paid or Hours Worked?	Frequency
	Wage Measured Hourly	Wage Measured Weekly			
Current Employment Statistics / Average Earnings	2.7	3.0	N	Paid	Monthly
Current Population Survey / Median Earnings of Full-Time Workers	N/A	2.0	N	Paid	Quarterly
National Compensation Survey / Employment Cost Index (ECI)	2.7	N/A	Y	Worked	Every Third Month
National Compensation Survey / Employee Costs for Employee Compensation (ECEC)	2.9	N/A	Y	Worked	Every Third Month
Atlanta Fed's Wage Growth Tracker	3.7	N/A	N	Paid	Monthly
Productivity and Costs / Compensation per Hour	3.2	N/A	Y	Worked	Quarterly
ADP Workforce Vitality Index	3.0	N/A	N	---	Quarterly

Sources: Bureau of Labor Statistics; ADP; CEA calculations.

Note: The Current Population Survey (CPS) and Current Employment Statistics (CES) do include the fringe benefits of paid leave. The CPS variables help distinguish hours worked from hours paid, although this information is not used in constructing the median earnings and Wage Growth Tracker series. ADP data are released quarterly, but the quarterly release provides data for individual months. The CPS data are collected monthly, but wage growth data are computed and released on a quarterly basis. The National Compensation Survey (NCS) measures a pay period every third month, as opposed to quarterly surveys that use payroll information for all three months of the quarter. The measures based on the CPS and NCS include private sector as well as government workers, whereas the CES, Productivity and Costs and the ADP Workforce Vitality Index include only private sector employees, with the Productivity and Costs further excluding nonbusiness employers. Two additional wage measures are also shown in the Appendix to this report.

Figure 1. Wage Growth Measures
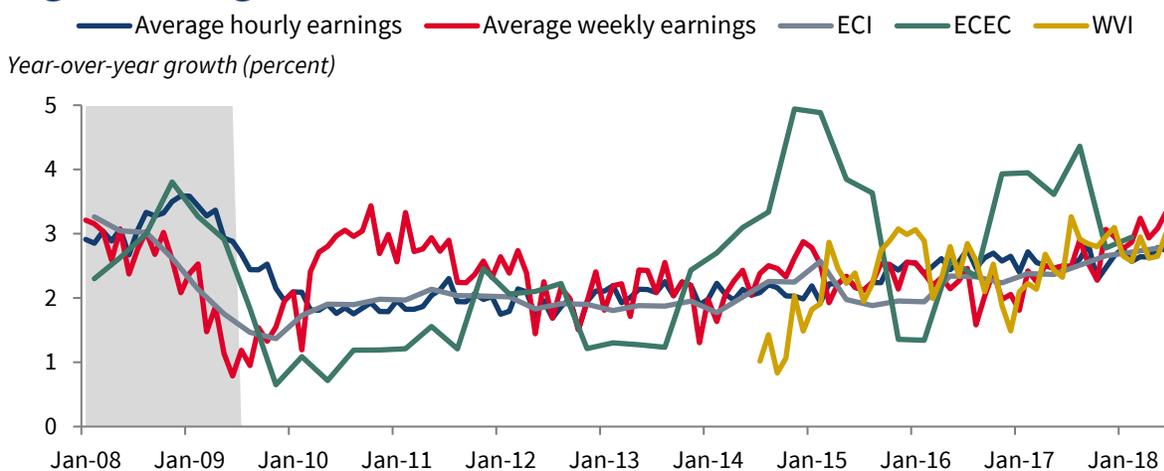
Sources: Bureau of Labor Statistics; ADP; CEA calculations.
Note: Average hourly and average weekly earnings are through July, WVI through June, ECI through 2018:Q2, and ECEC through 2018:Q1. Average hourly and weekly earnings are released monthly, while ECI and ECE are released every third month.

The Bureau of Labor Statistics' Current Employment Statistics Survey

The BLS's Current Employment Statistics (CES) survey is conducted monthly and includes data from approximately 149,000 businesses and government agencies (BLS 2018a). As part of the survey, each private sector establishment reports its total hours of work paid as well as the gross payrolls during the reference pay period, including overtime pay but excluding any bonus payments.[8] The total payroll measure excludes any noncash fringe benefits, such as contributions to health insurance or retirement plans.

Earnings data from this survey benefit from the high frequency of reporting as well as the large number of establishments surveyed, which yields increased precision for wage estimates. However, despite the wide use of this measure for tracking wage growth, it does have drawbacks (Carson 2015). In particular, it does not include information on the characteristics of workers. Consequently, if the composition of the workforce changes, the average wage gains reported from this survey will incorporate these composition effects along with the wage changes for individual workers.

The National Compensation Survey

The National Compensation Survey (NCS), also administered by the BLS, is conducted every third month across a representative set of establishments in the United States that are typically

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[8] The reference pay period includes the 12th of the month. Hours includes paid time off for vacations and sick leave.

contained in the sample for 3 years for those in the private sector and 10 years for State or local governments (BLS 2018c). The BLS chooses establishments and State/local government organizations from different sample geographic areas. During the initial visit to an establishment, the BLS asks the employer for its list of employees and constructs a representative sample of jobs (using predetermined rules) that will be tracked. The data include about 6,600 private establishments with 27,300 occupations and 1,400 State/local government establishments with 8,000 occupations (BLS 2018b). Using these data, the BLS constructs the Employer Cost Index (ECI) to track the average wages of each type of job and the percent changes in total compensation and benefits costs, as well as the Employer Costs for Employee Compensation (ECEC) measures, to track the average cost to employers for wage and nonwage benefits per hour worked. The NCS distinguishes hours paid from hours worked.

One of the primary advantages of the ECI and ECEC is that they measure both wage and nonwage compensation, including roughly 20 different categories of nonwage benefits, such as paid leave, health insurance, and retirement plans. Because the data are based directly on employer responses, there may be less measurement error, at least relative to household survey data (Duncan and Hill 1985; Bound and Krueger 1991). However, data reported by firms on wages and benefits are for specific positions, not for individual employees. To the extent that people are moving from low-paid jobs to high-paid jobs, the ECI would not record a wage increase, whereas household surveys and ECEC would (BLS 2017).[9]

The Current Population Survey

Both the NCS and CES earnings data discussed above are based on data provided by employers rather than individual workers. This limits the ability to consider trends in these wage data for demographic groups. It also means that it is not possible to track the experiences of individual workers.

The Current Population Survey (CPS), which is administered by the Census Bureau, is a monthly household-level survey that asks a subset of respondents about their usual earnings at their main job.[10] Similar to the CES survey, earnings reported in these data include cash wages as well as overtime pay, but exclude bonuses and noncash fringe benefits. These data consider

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[9] The ECI is specifically designed to measure the overall cost of labor "free from the influence of employment shifts among occupations and industries" (BLS 2018b).

[10] Respondents are included in the sample for 4 months, are out of the sample for 8 months, and then return to the sample for an additional 4 months. The earnings questions are only asked of respondents in the last of each 4-month period in the sample. "Usual" earnings are determined by each respondent rather than being defined for them. However, the BLS notes that if a respondent asks for a definition, the interview defines the term as "more than half the weeks worked during the past 4 or 5 months" (BLS 2018c).

only wage and salary earners, and exclude those who are self-employed. They also only include wages at the individual's primary job but exclude any secondary employment.[11]

The BLS reports median weekly wages from the monthly CPS on a quarterly basis, separated for full-time and part-time workers, as distinguished in table 1. As is the case with both the NCS and CES data, the reported statistics from this survey reflect the current composition of the workforce. Hence, as discussed further in the next section, if new workers enter the labor market and have lower weekly wages than those previously working, this will reduce the reported median weekly wage growth compared with what individuals are experiencing.

The CPS data can be used to measure hours worked as distinct from hours paid, although CPS-based wage measures derived from the usual earnings and usual hours questions effectively measure hours paid because during each week of paid leave a worker gets his or her usual earnings without working the usual number of hours (Stewart 2014).

Private Sources of Wage Data

In addition to the measures of wages tracked by the Federal government, several private companies monitor wage trends. ADP, for example, produces the Workforce Vitality Index (WVI). The WVI is a quarterly measure of total real wages at the national, regional, and industry levels for different types of workers. Categories of workers available within this index are job holders, job switchers, new job entrants, and job leavers. The WVI is composed using data from 333,000 U.S. companies that employ 24 million workers, and it is aligned with the BLS's Quarterly Census of Employment and Wages (ADP 2014). The WVI is similar to the Federal Reserve Bank of Atlanta's Wage Growth Tracker, in the sense that the same worker is tracked over time. Using ADP's payroll databases, it is possible to also track the same worker across jobs, which allows for comparisons of wages preceding and after job switches. ADP data also provide demographic variables for firms and employees, which allows wage growth to be separated by firm size, gender, occupation, and age.

Although the WVI addresses some of the concerns inherent in the other approaches, we do not focus on it (among other private sector measures), for two reasons. First, the WVI only began to be issued in 2013, making it difficult to compare and contrast with other measurement strategies simply because of the scarcity of data points. Second, many private sector measures

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[11] The Annual Social and Economic Supplement to the CPS, conducted each March, has additional income and earnings information—including earnings from secondary employment. We do not focus on these data here, however, because they only yield annual earnings data and are released less frequently than the other measures discussed.

are based on data that cannot be replicated by the Federal government because the information used to produce the series is proprietary.

Quantitative Differences across Wage Growth Measures

Given the differences among the available measures of nominal wage growth, and between these measures and what we need to know to evaluate labor market performance, we now turn to a discussion of the quantitative implications of these differences for understanding nominal and real wage growth. There are three main implications. First, omitting the inclusion of nonwage compensation understates growth in total compensation per hour worked by 0.2 percentage point per year in recent years, both by understating the numerator and exaggerating the denominator (table 3). Second, failing to account for differences in the composition of the marginal worker entering the labor force over the business cycle understates real wage growth by 0.3 percentage point per year (table 3).[12] And third, using the CPI-U, rather than the PCEPI, overstates price increases and understates real wage growth by 0.5 percentage point (see figure 8 below). We now discuss each of these implications in detail. Taken together, the composition-constant annual growth rate of real wages over the past year (2017:Q2–2018:Q2) has been almost 1 percentage point higher than the usual wage measures deflated with the CPI-U. In other words, real wages grew 1.0 percent rather than 0.1 percent.

Cash Compensation, Paid Leave, and Other Fringe Benefits

Because individuals are compensated in ways other than wage and salary income, it is important to measure compensation more broadly—that is, by including benefits, such as employer-paid health insurance premiums, paid leave, and retirement plans. As seen in figure 2, in 2018, nonwage benefits represent just over 30 percent of employer costs in 2018. Additionally, the share of compensation coming from benefits has risen over time.[13]

Including nonwage benefits with financial compensation is important for measuring wage growth because these benefits represent an alternative form of compensation that employees receive and whereby they are categorized based on their underlying preferences. For example, Sullivan and To (2014) show that nonwage characteristics within a job are important for explaining job mobility and the value of jobs among workers. The role of nonwage

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[12] Because the average hourly earnings measure is only among private sector workers, each of these adjustments excludes government workers and focuses only on those who work in the private sector.

[13] Because our purpose is to assess the difference between hourly compensation and the CES hourly wage, figure 2 defines fringe benefits to include bonus and paid leave. In the National Accounts, these items would be considered wages and salaries rather than "supplements to wages and salaries."

compensation is especially important given that its share of overall employee compensation has been increasing over time.

Figure 2. Fringe Benefits as a Share of Total Compensation

Percentage of hourly compensation
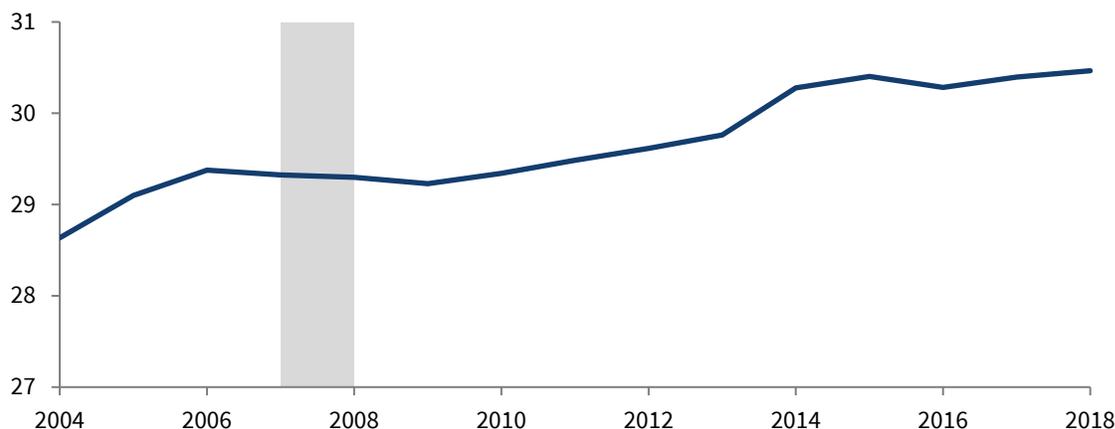
Sources: National Compensation Survey ECEC; CEA calculations.
Note: Among private sector workers. Benefits include paid leave, supplemental pay and bonuses, insurance, retirement benefits, and legally required employee benefits. Quarterly results are averaged to produce annual values. 2018 are the results for Q1.

Wage measures are ratios of earnings to hours or weeks. The CES and CPS wage numerators tend to count paid leave, overtime, and a shift in pay as earnings, but exclude all other fringe benefits and bonuses. This by itself causes wages to be underestimated; and during periods when other fringe benefits are a growing share of compensation, it also causes wage growth to be underestimated. To put it another way, the CES and CPS estimates of wage growth can be improved by adjusting them for the share of compensation that includes other fringe benefits, as measured in the ECEC. We find this adjustment by itself to add 0.05 percentage point to annual wage growth over the past year and 0.15 percentage point over the past five years.

A number of reports also show an increase in paid leave benefits during recent years (Greenfield 2018; Kaiser Family Foundation 2017; Miller 2018). This poses no problem for the numerator of the CES and CPS wage measures, but it does cause hours paid to increase more than hours worked. From the ECEC, in the first quarter of 2018, the employer costs of paid leave are approximately one-tenth the cost of wages from time worked. For a full-time, full-year worker, this is consistent with just under 24 days of paid leave (including vacations, holidays, and sick leave) over the course of a year. As indicated by the increase in the costs of paid leave relative to wages reported in the NCS, workers are getting an average of a half day more paid leave this year than they were five years ago. In other words, wage growth measures based on hours paid need to be adjusted upward to reflect the slower growth of hours worked relative

to time paid. We find this adjustment by itself to add 0.12 percentage point to annual wage growth over the past year and 0.05 percentage point over the past five years.

Figure 3 shows the extent to which the two adjustments, when combined, add to the growth in cash wages per hour paid. The adjustments are essentially showing the amount by which the growth in compensation per hour worked exceeds the growth in cash wages per hour paid. In 2017 and 2018, the excess has been about 0.16 percentage point on average. This is worth keeping in mind as we turn to sources that are based on only cash compensation per hour paid but also permit other types of analysis and adjustments.

Figure 3. Additional Growth of Total Compensation Relative to Wages Alone

Percentage points
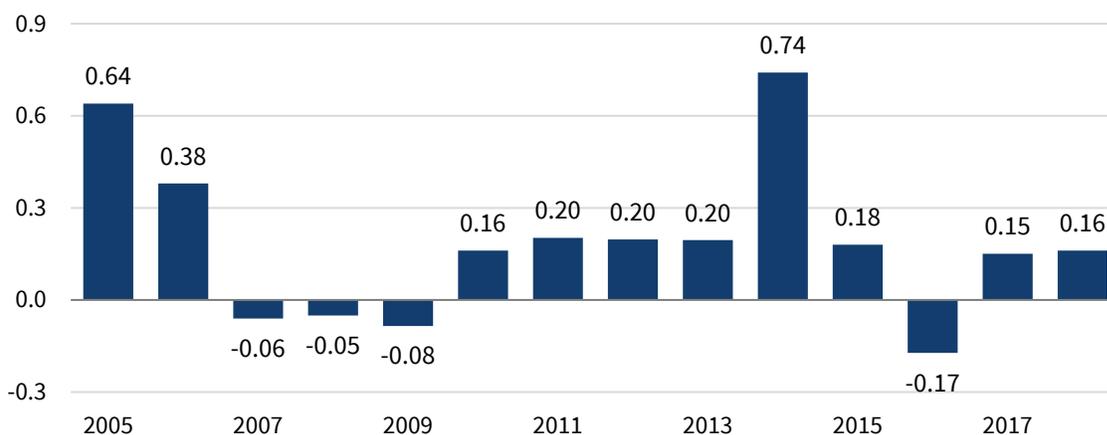
Sources: National Compensation Survey ECEC; CEA calculations.
Note: Private sector workers. Quarterly results are averaged to produce annual values. 2018 compares the Q1 of 2018 to Q1 of 2017.

### *Incomes Grow When People Join the Workforce*

Beyond generally increasing the number of hours worked among those employed, the expanding economy also increases the number of people who are working at any given time. These workers who find jobs are going from having zero earnings while not working to having positive earnings once they are.

One way to incorporate the earnings of the newly employed is to consider the average weekly earnings per adult (including those with no earnings). Figure 4 does this, showing the average change in aggregate wages in the CPS data for each year-over-year period.[14] It then

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[14] Topcoded earnings in the CPS result in an understatement of wages and understates wage growth over time as the share of workers with topcoded earnings are increased. Topcoded wages in the CPS are adjusted using the 1.4

decomposes this into the share due to increases in the average earnings of those who are working and the share due to increases in the fraction of adults who are working.[15] During periods of economic expansion, rises in the share of adults who are working increase total aggregate earnings and, consequently, earnings per adult. Over the period from 2017 through 2018, the growing fraction of adults who are working has increased the growth rate of average weekly earnings per adult by an average of 0.6 percentage point.

Figure 4. Decomposing Growth in Adult Weekly Earnings
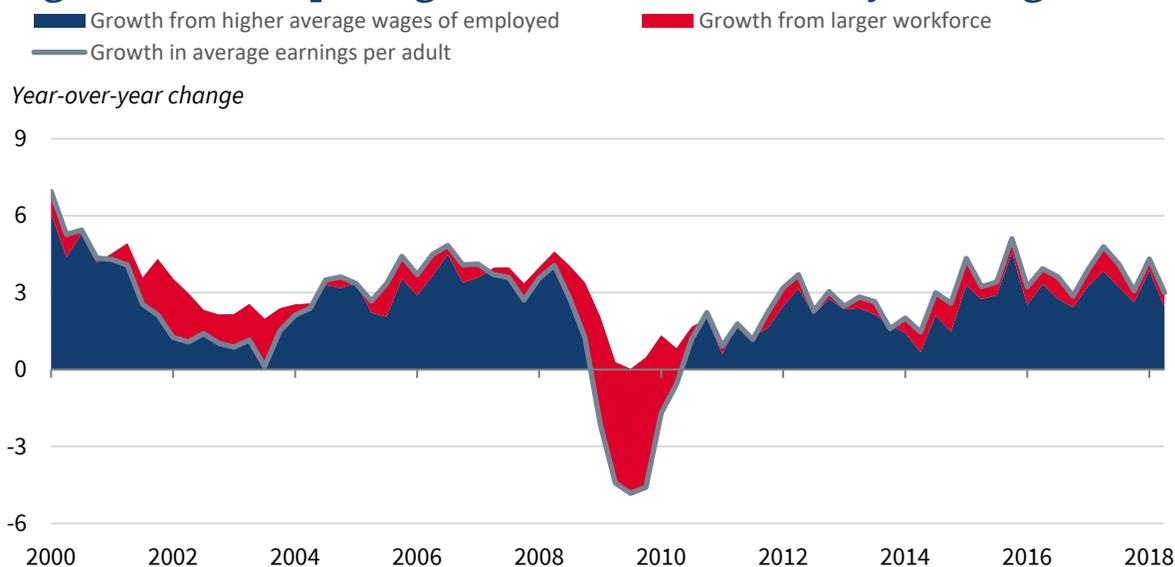
Sources: IPUMS (CPS); CEA calculations.
Note: Figure includes adults age 15 and older, including those with no earnings.

Composition Effects

Labor economics research widely recognizes that wage patterns are often quite different when adjusted for composition effects. As Daly and Hobijn (2017) put it, "changes in the composition of the labor market are important for understanding aggregate real wage growth."[16] Here, we first offer definitions of composition effects and explain their relationship to the age-wage profile. We then explain why composition effects are particularly acute during economic

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factor multiple from Lemieux (2006). Armour, Burkauser, and Larrimore (2016) find that this is a conservative adjustment.

[15] Formally, this calculation separates the increases in average earnings per adult $(N_{t+1}{}^*W_{t+1})/P_{t+1} - (N_t{}^*W_t)/P_t$—with N as the number of workers, W as the average weekly wages of each worker, and P as the adult population—into $(W_{t+1} - W_t)^*(N_t/P_t) + (W_{t+1})^*[(N_{t+1}/P_{t+1}) - (N_t/P_t)]$, where the first term is the growth due to higher wages among those working and the second term is the growth due to more workers as a share of the population.

[16] See also Mulligan and Rubinstein (2008), who find that many of the aggregate patterns of female wage growth are driven by composition effects.

expansions, such as the one being experienced now. Several methods for quantifying the composition effects are used.

As typically measured, both average and median wages are affected by composition changes. Most of this section focuses on average wages, due to their prevalence in the pool of available measures (as discussed in the first section), but it also presents some results related to median wages.

As an introduction to composition effects, consider the pattern of average hourly earnings by age illustrated in figure 5. Hourly earnings are normalized so that 100 is the average wage shown in the figure.

Figure 5. Normalized Average Hourly Earnings by Age

Normalized hourly earnings (100 = average hourly earnings)
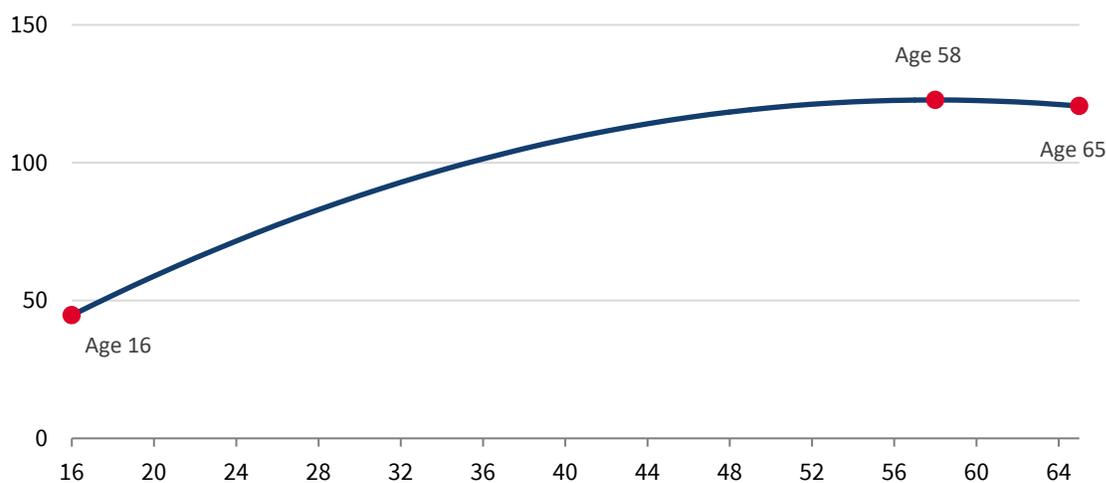
Sources: IPUMS (CPS); CEA calculations.
Note: This figure is based on 2018 CPS data. The trend is generated on the basis of those who are 16 and older. Earnings are normalized according to average hourly earnings, $25.28, for those age 16–65.

Normal life cycle entry into the labor market occurs at young ages (the left side of figure 5) and workers retire at older ages (the right side of the figure).[17] We can illustrate the economically significant effect of the composition bias of national averages by using a simple example that assumes a steady state, in which the working population is uniformly distributed across ages 16 to 65 and the curve is unchanged over time. Based on the life cycle earnings profile given in figure 5, this means that even if the national average hourly compensation is constant, the average individual sees his or her wages increase by about 2 percent per year. The composition

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[17] Although figure 5 is based on all adult workers, some people will delay entry into the workforce to obtain additional education. However, the same principle of rising earnings as workers age and gain additional experience will still apply among those who do not start working until their early 20s.

bias comes from those who are retiring who earn more than the average and the entry of young adults who earn less than the average.

Simply put, the change in the national average wage understates the actual change that individuals experience because of the life cycle of wages and returns to experience. This amount is almost 2 percent per year, even in the absence of a rise in average wages for the cross section of people working at any given time.

In a simpler world, the age and demographic profiles of the workforce would be the same each year. In this case, changes in the national average wage would at least indicate the amount by which the age profile shown in figure 5 shifts up or down over time. But in reality, the characteristics of the workforce vary because the rates and composition of workforce entry and exit vary. The Baby Boom, which refers to the extraordinary fraction of the nation's population that was born in the period from immediately after World War II through the early 1960s, recently reached retirement age. According to the U.S. Census Bureau, in 2018, nearly 3.7 million people will turn 65. This is about 1 million more people per year reaching retirement age than was the case at the beginning of the decade.[18] With this extraordinary fraction of the population retiring, the downward bias of aggregate wage changes is also extraordinary. Demographics aside, entry and exit into the labor market vary over the business cycle. During a recession, the entry of inexperienced workers slows, and those losing their jobs also tend to have less work experience than average, which artificially (relative to what individual workers experience) increases the national average wage (Bils 1985; Solon, Barsky, and Parker 1994; Mulligan 2012). The reverse tends to occur during an expansion, such as the expansion that is occurring now, which drags down the national average wage below the wage growth experienced by individuals even more than is normally the case.

An economic expansion also pulls the national average wage below the amount by which the age profile given in figure 5 shifts upward over time. For example, the profile could be shifting upward, yet the national average would stay constant as the workforce expanded to include more young people than it did before the expansion. Therefore, two types of composition adjustments are of interest:

- Adjustments to *hold people constant* and thereby add in, among other things, the normal life cycle growth discussed above. Such an analysis necessarily looks at a population whose age and years of work experience are increasing. People-constant analysis shows what is happening to individuals, such as the movement along the life cycle profile shown in figure 5.

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[18] U.S. Census Bureau (2018).

- Adjustments to *hold demographic characteristics* constant, including age. Such an analysis necessarily looks at different people over time in order to hold age constant, but strives to follow a population with other demographics also held constant. Such a demographics-constant analysis shows how the curve in figure 5 is shifting upward (or downward) over time.

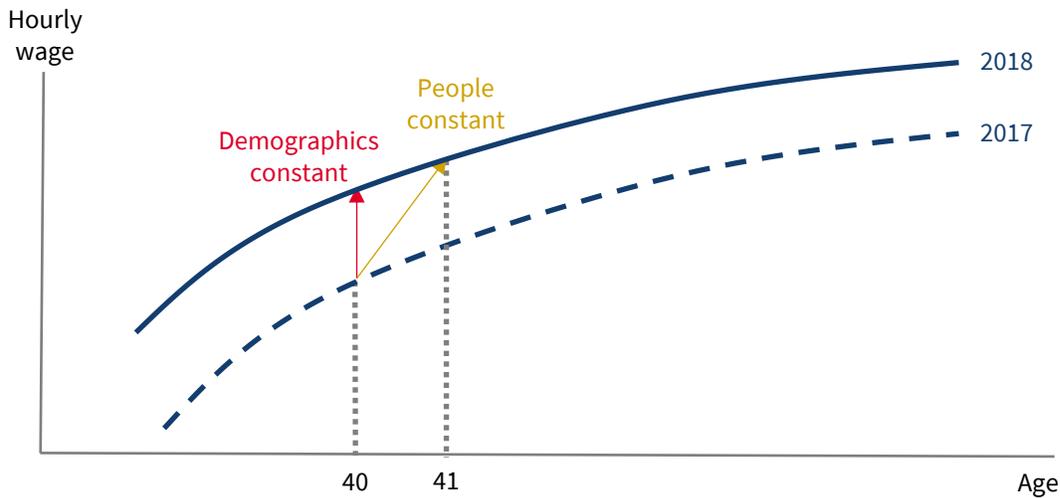## Figure 6.Two Types of Composition Adjustments

Figure 6 zooms in on the wage-age profile presented in figure 5 near the age of 40. Figure 6 shows one hypothetical wage-age profile for 2017 and another for 2018. Demographics-constant analysis (the red arrow) asks how much more a 40-year-old earns in 2018 than in 2017. People-constant analysis (the yellow arrow) asks how much the person turning 40 years old in 2017 will earn in 2018, when he or she is 41 years old.

This report focuses on the composition changes from 2013 to 2018, when the fraction of the population at work has been increasing significantly, as shown by the semiannual data given in figure 7. During such times, the potential for composition changes to mask wage growth is particularly high because not only is the normal life cycle operating but low-skill workers are also joining the workforce.

Figure 7. Employment-to-Population Ratio Year-over-year Change, 2011–2018

Percentage points
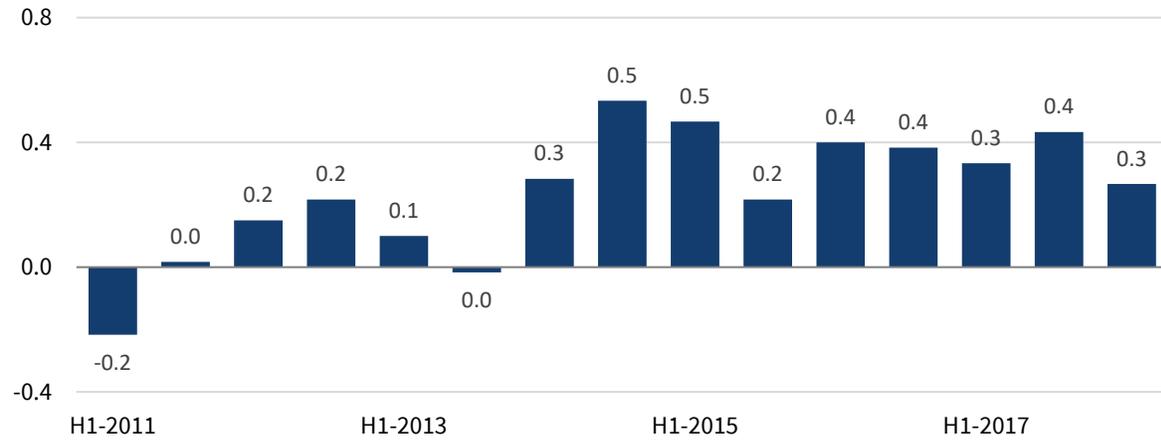
Sources: Bureau of Labor Statistics; CEA calculations.

Reconciling Composition Effects

Table 2 displays estimates made using various methods for determining the composition bias. The first method compares the time series for the average log wage with the time series for the average log wage adjusted for demographic changes by including the demographic variables in a log wage regression together with time effects.[19] The difference between the average annual growth of the former and the latter is the composition bias estimate. A negative estimate means that unadjusted wages, such as those given in table 1, grow more slowly than adjusted wages. A bias of –0.3 percentage point means that the unadjusted growth rates shown in table 1 are too low by 0.3 percentage point per year.[20]

It is easy to see how demographics have especially changed during the expansion, and in a direction to reduce the national average below what it would otherwise be. For example, young adults age 16 to 34 have increased as a share of workers, from 34 percent in 2010 to more than 35 percent in 2018. Because young people (Jeong, Kim, and Manovskii 2015) tend to have lower wages, as discussed above, with all else remaining the same, the average wage declines as a

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[19] This regression is based on CPS data for private, nonfarm workers, excluding tipped workers. It also adjusts for topcoding in earnings using the topcode correction described previously.

[20] For example, the 2.7 percent growth in table 1 becomes 3.0 percent growth once adjusted. Note that education is excluded from the "demographic characteristics," which means that wages that increase over time due to more people attending college are counted as a wage increase rather than a "composition bias" to be eliminated.

result.[21] However, changes in other demographic characteristics of the workforce that are related to earnings beyond age will also influence the national average wage.

Table 2. The Composition Bias in Average Hourly Wage Growth Rates

Method	Composition Bias Estimate (percentage points per year)	Adjustment Type
Log hourly wage regression with demographic regressors	–0.29%	Demographics-constant
Increase the 2013 workforce by 2.9%, assigning them wages of half the mean.	–0.31%	Demographics-constant
Increase the 2013 workforce by 2.9%, assigning them wages of approximately $7.25 per hour.	–0.43%	Demographics-constant
Recent unemployment changes processed with the Solon-Barksy-Parker model	–0.54%	Demographics-constant
Addendum (see note): Balanced worker panels from Daly and Pedtke (2018)	–1.5 to –2.0%	People-constant

Sources: Solon, Barsky, and Parker (1994); Daly and Pedtke (2018); IPUMS (CPS); CEA calculations.
Note: The EPOP increased 2.9 percent over this period, which is a fact used in the second and third rows of the table. People-constant composition adjustments reflect multiple adjustments to the national averages: labor market returns to experience and age as well as a demographics-constant composition bias, which is a minority of the total adjustment. For the log hourly wage regression, demographic regressors are an age quadratic, indicators for sex, race, Hispanic ethnicity, marital status, and disability status.

Imputation approaches can help illustrate the amount by which the changing composition affects the usual wage measures, because the composition bias can be simply understood as the product of two numbers: (1) the fraction of the population with potentially different characteristics, and (2) the gap between the average wage of this group and the overall average wage. The fraction of the population that could potentially have different characteristics is made up of new entrants into the labor market. We take this as the change in the employment-to-population ratio, which is 2.9 percent of the ratio from 2013 (an increase of 1.7 percentage points). For this group, we then consider the gap between their

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[21] Admittedly, the CPS does not measure all the personal characteristics that might indicate a person's hourly wages—including, for example, cognitive and noncognitive skills—which are important determinants of individual labor market outcomes (Heckman, Stixrud, and Urzua 2006). As a greater fraction of people are employed, the presence in the workforce of these unobserved hourly wage determinants changes, especially because people with lower wages find it easier or more advantageous to have a job during an expansion as compared with a recession. Altonji, Elder, and Taber (2005) suggest one procedure that helps gauge the significance of these unobserved determinants, which involves assuming that unobserved characteristics are, on average, changing in the same direction and amount as the observed changes. Their paper explains how to obtain an "identified set" for the composition bias, which has high end equal to the –0.29 percentage point shown in the top row of table 2. However, the lower end is too far from zero to be informative in this case.

average wage and the overall average wage. If these new workers with potentially different characteristics earn half the overall average wage, then the composition bias is essentially what was estimated with the regression approach.[22]

A more extreme assumption, to obtain an upper bound for the composition effect, would be to assume that all these new workers (the 2.9 percent increase in the employment-to-population ratio) earn the federal minimum wage. This would result in an estimated composition bias of –0.43 percentage point per year. This exercise leads us to the conclusion that, from a demographics-constant perspective, the effect of composition bias on wage growth cannot have been much further from zero than –0.4 percentage point per year since 2013. During periods when the employment-to-population ratio is not growing, or when it is declining, the demographic composition effect would be closer to zero or positive.

Solon, Barksy, and Parker (1994) use aggregate and panel data to assess the degree to which composition bias varies over the business cycle. By not emphasizing the overall amount of composition bias, their model can also be used to assess the degree to which demographics-constant composition bias would be different while the unemployment rate has been falling in recent years, as opposed to a time frame when the unemployment rate is constant. Table 2 shows the result applied to the 2013–18 change in the unemployment rate: –0.54 percentage point per year, which is a bit further from zero than the –0.4 percentage point upper bound on the composition effect estimated above based on the employment-to-population ratio. We therefore conclude that the composition bias during the recovery is likely about –0.3 percentage point per year, and we use –0.29 percentage point per year from our log wage regression results as our preferred estimate for the 2013–18 period.[23] In other words, adding 0.29 percentage point per year to, for example, the CES measure of wage growth yields an improved demographics-constant estimate that reflects how much wages are growing over time for persons with given demographic characteristics.

A person-constant procedure for correcting wage growth for the changing composition of the labor market is to track the wages of continuously employed workers.[24] The Federal Reserve Bank of Atlanta (table 1) and Daly and Pedtke (2018) (table 2) implement person-constant

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[22] Note that half the average hourly cash wage is about $12.50 per hour in 2017 and is about 1 standard deviation to the left of the mean.

[23] Changes in the age, race, and ethnic makeup of the workforce are the dominant factors leading to this estimate in the log wage approach.

[24] For ease of exposition, we refer to workers who are employed in the same month one year apart as continuously employed. However, the Federal Reserve Bank of Atlanta's Wage Growth Tracker does not observe employment in the intervening months, so there may be intervening periods of nonemployment.

procedures.[25] Both use the panel nature of the CPS to observe the changes of the wages of each worker from one year to the next, excluding anyone who works in only one of the two observation periods. The person-constant approach removes the composition effects of entry and exit into the workforce, but also conflates experience-based raises with general wage growth (as illustrated in figure 6).[26]

This method is particularly useful for considering the earnings trends that each worker is experiencing, because it follows the same individual from one year to the next, rather than considering population averages. The median nominal hourly wage growth of continuously employed workers over the past year was 3.7 percent (Federal Reserve Bank of Atlanta), and was about 3.5 percent for workers employed continuously and full time (Daly and Pedtke 2018).

As less-skilled people enter the workforce and constitute an increasing share of workers, not only is the national average wage pulled down but so also is the median wage. We therefore also consider the composition effects at the median, using a quantile regression version of the first row in table 2. This puts the composition effect on the growth of the median wage at about −0.4 percentage point per year.[27]

Nominal versus Real Wages

Given the presence of inflation, dollar increases in wages do not necessarily reflect increases in the purchasing power of wages or increases in what workers produce. Here, we focus on the purchasing power of wages, in which case nominal wages (that is, wages measured in dollars) are converted to real wages by dividing by a price index for consumer goods, which is a measure of the dollar cost of consumer goods.[28] Two price indices are commonly used for this purpose: the Consumer Price Index for Urban Consumers (again, more precisely known as the CPI-U, where "U" stands for "urban") and the PCEPI.[29] Figure 8 shows how the CPI-U often shows systematically more inflation than the PCEPI. In the past year, the CPI-U has shown

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[25] The 3.7 percent from the Federal Reserve Bank of Atlanta is the three-month moving average from May through July of year-over-year wage growth, using its series that reweights observations to match the current characteristics of wage and salary workers. The report by Daly and Pedtke (2018) is the latest update to a series of papers by Daly and coauthors using this approach, including Daly Hobijn, and Pedtke (2017) and Daly and Hobijn (2017).

[26] Because the Atlanta Fed's Wage Growth Tracker looks at individual-level growth rates, the results are noisy and they employ various strategies to alleviate outliers.

[27] Without any adjustments, the mean and median grew at about the same rate during the expansion. That is, composition changes may be masking the fact that composition-adjusted wages are growing faster at the median than on average. CEA continues to do research on this question.

[28] As an indicator of productivity, nominal wages should be divided by a price index for the goods and services that workers produce, which can be different from an index of consumer prices (Lawrence 2007).

[29] Another alternative is the implicit price deflator for the PCE, which is extremely similar to the PCEPI.

roughly 0.5 percentage point more inflation, and thereby 0.5 percentage point per year less real wage growth, than the PCEPI has shown.

Figure 8. PCEPI and CPI–U Inflation

Year-over-year growth (percent)

Sources: Bureau of Labor Statistics; CEA calculations.
Note: The figure plots the year-over-year growth rate of the PCEPI and CPI-U.

The reasons for the difference between the CPI-U and the PCEPI are well known among experts (McCully, Moyer, and Stewart 2007; Boskin et al. 1996), and generally point to the PCEPI as a more accurate index of consumer prices—for four main reasons. First, with its use of a modified Laspeyres formula, the CPI-U tends to exaggerate inflation by ignoring the fact that consumers substitute toward goods and services whose prices rise by less than the average, thereby mitigating some of the effect of the price increases. The PCEPI alleviates this problem by using a Fisher-Ideal formula that frequently updates the basket of goods to reflect changes in consumer behavior as they happen. When the Federal Reserve switched from reporting on CPI-U to PCEPI inflation in the "Monetary Policy Report" (Federal Reserve 2000), one of the justifications for this change was to avoid the upward bias that is present in the CPI-U from the fixed basket weighting approach.[30]

Second, the relative weights given to the various items contained in the CPI-U are different because they come from different sources. Because the CPI-U market basket is estimated from the CES, it is especially susceptible to measurement error and attrition bias (Bee, Meyer, and

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[30] CEA also notes that the Congressional Budget Office uses the PCE price index, and not the CPI-U, to measure inflation (CBO 2018), except when examining the effects of laws in which the CPI-U is specified for indexing purposes (CBO 2016).

Sullivan 2015; Fricker et al. 2015). The PCEPI is produced with data from business surveys, which may contain less measurement error.

Third, whereas the CPI-U captures the out-of-pocket expenditures of urban households, the PCEPI measures all goods and services that are purchased by both households and nonprofit institutions serving households (McCully, Moyer, and Stewart 2007). Fourth and finally, some miscellaneous differences emerge due to, for example, seasonal adjustment factors (McCully, Moyer, and Stewart 2007).

Because there are concerns about an upward bias in the CPI-U that are not present in the PCEPI and because the PCEPI covers a broader array of spending and likely has less measurement error, the PCEPI is likely a more appropriate measure for tracking inflation. To convert nominal wage growth into real (inflation-adjusted) wage growth, we subtract inflation using the PCEPI from the nominal wage growth measures.

Toward Real Wage Growth

This report suggests that much of the commentary about wage growth is influenced by confusion about proper measurement. We survey a spectrum of approaches used to measure real wage growth, discussing the advantages and disadvantages of each one. Taken together, the composition-constant annual growth rate of real hourly wages over the past year (2017:Q2–2018:Q2) has been almost 1 percentage point higher than the usual wage measures deflated with the CPI-U. In other words, real wages have grown 1.0 percent rather than 0.1 percent. In addition, households enjoy more labor income because a greater fraction of the population is working. The hourly wage result is derived in table 3.[31]

The personal income tax provisions of the Tax Cuts and Jobs Act of 2017 (TCJA) also permit workers to keep more of their wages. The Tax Foundation estimates that TCJA will reduce 2018 tax payments and increase after-tax income by 1.8 percent of income on average.[32] This will not be fully reflected in disposable personal income statistics until households file their 2018 tax returns in 2019. For now, while acknowledging the imperfection of this measure, we use the difference in growth rates between personal income and disposable personal income from the second quarter of 2017 through the second quarter of 2018, and we find that the growth rate

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[31] All the additions and subtractions given in table 3 are technically done in logarithms, which in this case are very closely approximated by adding and subtracting growth rate percentages.
[32] The Tax Policy Center (2017) estimates that TCJA increases after-tax incomes by 2.2 percent.

of real average hourly after-tax compensation is so far an additional 0.4 percentage point higher—or 1.4 percent per year.[33]

Table 3. Summary of Components of Annualized Wage Growth

| | 2017:Q2–2018:Q2 | |
	CES	Atlanta Fed
Nominal average hourly cash earnings growth	2.7%	3.5%
ADDING benefits growth to hourly compensation	0.2%	0.2%
ADDING demographic composition correction	0.3%	—
SUBTRACTING growth rate of the PCE price index	2.2%	2.2%
EQUALS real average hourly compensation growth, ignoring taxes	**1.0%**	**1.5%**
ADDING excess growth of disposable income over personal income	0.4%	0.4%
EQUALS real average hourly after-tax compensation growth	**1.4%**	**1.9%**
Addendum: Average hourly earnings growth with no adjustments other than CPI-U inflation	0.1%	0.8%

Sources: Bureau of Labor Statistics; Bureau of Economic Analysis; CEA calculations.
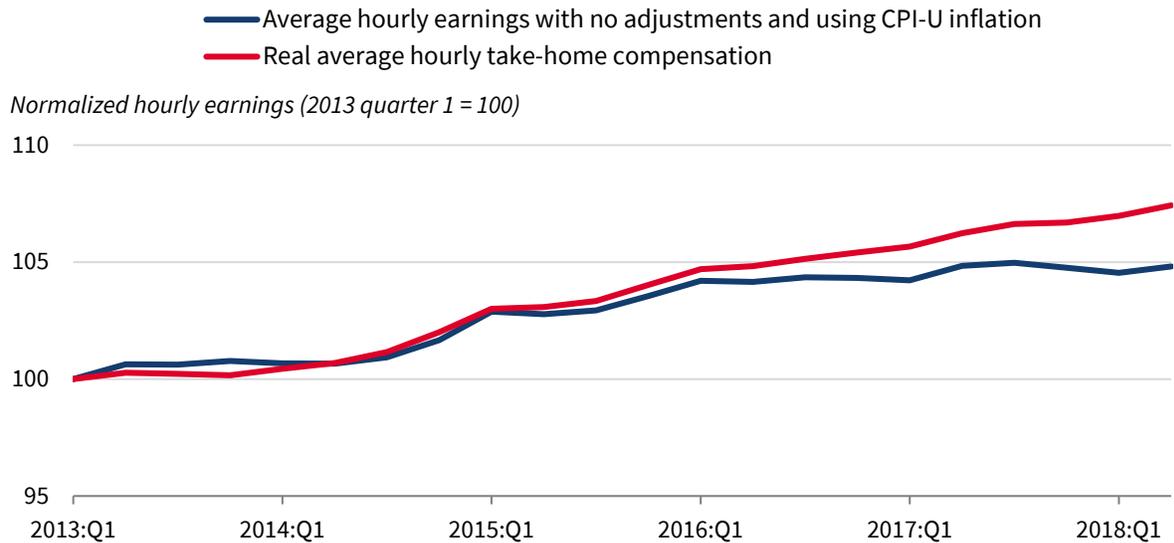Note: The nominal average hourly cash earnings growth from the Atlanta Fed (3.5%) is based on the 3-month moving average for June 2018. The demographic composition correction is based on the average for the expansion from 2013 through 2018.

This report focuses on the demographics-constant approach to measuring wage growth, but it also provides an estimate based on the person-constant approach using the Federal Reserve Bank of Atlanta's Wage Growth Tracker. This measure already includes a demographic composition correction, but does not include the growth in benefits or subtract personal taxes. When adding these adjustments to, and subtracting inflation from, their 3.5 percent nominal wage growth from June 2017 through June 2018, real average hourly after-tax compensation growth is 1.9 percent.[34] However, CEA notes that person-constant approaches also add returns to age and experience and that, for technical reasons, the Atlanta Fed's Wage Growth Tracker has been recently underestimating the wage growth experienced by individuals.

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[33] In addition to wages, personal income includes interest, dividends, rent payments, and government benefits. Similarly, the tax liabilities in the National Accounts will include taxes paid on both wage and nonwage income. While recognizing that both pre-tax income and tax liabilities in the National Accounts exceed those from just wages, the tax adjustment used here assumes that the proportion of personal current taxes (as defined in the National Accounts) in total personal income also applies to wage income alone, which is the focus of this report. This tax adjustment also does not include implicit taxes on employment and earnings, such as the phasing out of benefits and transfers as earnings increase. Corporate income tax cuts are not part of the tax adjustment; in the long run, they increase pre-tax compensation rather than narrowing the gap between personal income and disposable personal income.

[34] In July 2018, they observe nominal wage growth of 3.7 percent. We focus on the 3.5 percent value from June to be consistent in time with the 2017:Q2–2018:Q2 analysis for each of the adjustments.

Figure 9. Growth of Real Average Hourly Take-Home Earnings

— Average hourly earnings with no adjustments and using CPI-U inflation
— Real average hourly take-home compensation

Normalized hourly earnings (2013 quarter 1 = 100)

Sources: Bureau of Labor Statistics; Bureau of Economic Analysis; CEA calculations.
Note: Real average hourly earnings are constructed as described in table 3 using calendar year averages for each adjustment other than the inflation adjustment using the PCE price index.

Incorporating the faster growth of benefits, demographic composition effects, and personal taxes into prior years, hourly earnings growth has been greater during the recovery than without taking these factors into account. This can be seen in figure 9. Over the past 5 years, from the first quarter of 2013 to the second quarter of 2018, average real hourly after-tax compensation has risen by 7.4 percent. Furthermore, average real hourly after-tax compensation is now 1.9 percent above what it was at the end of 2016.

Moreover, still-higher wage growth is to be expected in the future because three types of policy changes are affecting wage growth. Deregulation and business tax reform increase productivity, and therefore real wages, in a cumulative way over time as businesses accumulate more capital. The business tax reform in particular is barely a half year old.

The third type of recent policy changes are the reductions in explicit and implicit taxes on work. The recent recession featured major new Federal disincentives to work, which reduced work and had the side effect of increasing hourly wages and productivity somewhat in the short run as employers had to compete with new safety net programs (Mulligan 2012). The reverse happened more recently because a number of the disincentives were temporary and the Trump Administration has made efforts to eliminate others, such as the renewed enforcement of long-standing work requirements for Federal assistance programs. That is, even without business tax reform, wage growth is expected to be a delayed part of the expansion as business investment adjusts to the higher levels of work and consumption that can occur now that work disincentives have been eliminated or reduced.

With the economy growing again, so too are the real after-tax wages and real incomes of workers. Given the recent changes in economic policy, workers can expect even higher growth rates in the future.

Appendix: Additional Wage Measures

Hourly versus Weekly Earnings

Earnings can be tracked either at an hourly or weekly level.[35] Earnings are typically measured for a pay period, which is often weekly; but for biweekly or monthly pay periods, earnings are converted to a weekly basis. Hourly earnings are usually measured by dividing weekly earnings by the number of weekly hours in the work schedule. Depending on whether the survey captures hours paid or hours worked, this will either reflect earnings per hour worked (which will often be above the contract hourly wage rate because of paid leave) or earnings per hour paid. Hourly earnings make it easier to compare people and jobs with different work schedules. A measure of weekly earnings better reflects the resources that a worker has available to spend, and has the statistical advantage that it requires only one piece of information (earnings) rather than two (both earnings and hours).

During economic declines, workweeks often get shorter because declines in product demand prompt firms to reduce the demand for labor services on not only the extensive margin but also the intensive margin (Cho and Cooley 1994). As a result, the weekly pay of those who are working falls more rapidly than their hourly pay. The reverse tends to occur during expansions. During expansions, as has been the case in recent years, the growth in weekly earnings exceeds the growth in hourly earnings because workers are now getting paid for more hours of work per week. Recognizing that the overall experience of workers is a reflection of both the amount paid for each hour of work and the amount of work that they perform at that wage, average weekly earnings for some purposes can offer a better overall assessment of how workers are faring in the economy.

## *Occupation-Specific Wage Measures*

Although some aggregate statistics on hourly wage growth are based on samples of production and nonsupervisory workers, these statistics are not necessarily representative of all workers in the labor force. Figure 10 plots nominal hourly earnings among production and nonsupervisory employees and the full sample of workers from 2007 to 2018. The correlation between the two year-to-year growth rates is 0.87.

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[35] Occasionally, earnings are also tracked at the annual level when using less frequently updated data, such as the Annual Social and Economic Supplement of the Current Population Survey.

Figure 10. Hourly Earnings Growth in Different Samples

Year-over-year growth (percent)
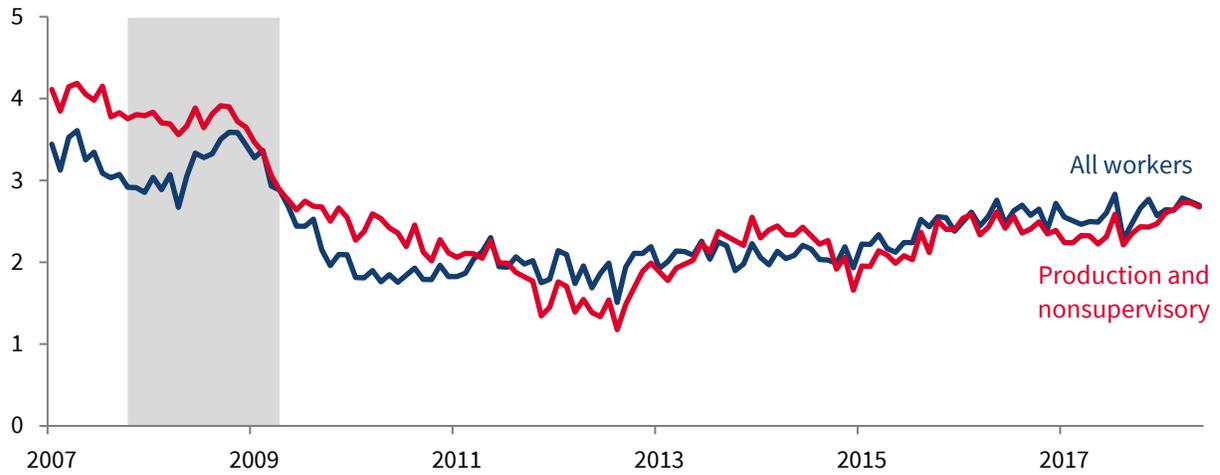
Sources: Bureau of Labor Statistics; CEA calculations.

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