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Michael Lettau, U.S. Bureau of Labor Statistics

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Michael Lettau

U.S. Bureau of Labor Statistics

Abstract

The Employment Cost Index for wages and salaries is based on a comparison of the average wage rates for the same set of jobs across a three-month interval. Employment for the majority of the jobs remains the same over the three months. However, if the index were based solely on the jobs for which their number of workers decreased, it would have shown wage growth of over 50 percent from December 2001 to December 2011. Conversely, if the index were based solely on the jobs for which their number of workers increased, it would have almost no wage growth over the same ten years. Therefore, this article describes how the jobs are defined and chosen for the ECI sample, and it explores how such high wage growth for jobs losing workers, along with such low wage growth for jobs gaining workers, affects the growth in the Employment Cost Index for wages and salaries overall.

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Employment Changes in Jobs and Their Effect on the Employment Cost Index

Two features distinguish the Employment Cost Index (ECI) from most other compensation series for the United States.

- In additional to wages and salaries, the ECI reports statistics on an employer's costs for benefits, such as the cost for health insurance and retirement plans.
- The growth rate in the ECI over time is determined by the three-month change in compensation for a sample of jobs.

The second of these features is perhaps less well understood by users, so it will be the focus of this article. The calculation of the ECI is based on the formula for a Laspeyres index. A Laspeyres index tracks the change in the average price for a set of goods over time, in which the quantity for each good, and hence its weight in the average, is held constant. The appendix to this article provides detailed information on how the Laspeyres formula is adapted to the ECI. Essentially, a "job" serves the role of the good, and the average wage among the workers in the job serves the role of the price for the good. Therefore, it is important for users to understand how the ECI obtains its sample of jobs and the corresponding compensation data.

The Sample of Jobs

In a process that began during the 1990s and stretched into the early 2000s, the ECI was integrated with the Employee Benefit Survey and the Occupation Compensation Survey Program to form the National Compensation Survey (NCS), so the data for the ECI now come from the NCS sample. There are several stages to the sampling procedure for the NCS. Chapter 8 of the *BLS Handbook of Methods* describes the initial stages that determine which establishments are selected for the NCS sample. Of primary interest here is the final stage, which determines the jobs within the selected establishments for which the NCS will collect compensation data.

Typically, the BLS data collector (usually referred to in NCS documentation as the BLS field economist) begins the final stage of the sampling by obtaining a list of the establishment's employees. From this list, a small number of names are chosen, usually four, six, or eight depending on the size of the establishment. Then, for each of the names selected, the chosen employee is grouped with any other employees from the establishment who hold the same job. This job becomes a unit of observation in the NCS sample. For example, suppose a retail store has been chosen to be in the NCS sample, and John Smith is one of the four workers randomly chosen from the employee list. Suppose further that the store classifies John Smith as a cashier, and that it also employs two other cashiers. These three cashiers collectively will form a unit of observation in the NCS, and average compensation data among these three workers will contribute to the calculation of the ECI.

The collection manual for the National Compensation Survey gives detailed instructions for how workers should be grouped into jobs. It instructs the BLS data collector to use the "most narrowly defined job level" recognized by the establishment when grouping the workers into jobs. The manual states that "duties and responsibilities should be defined broadly. For example, if the selected job is a machine operator, do not make a distinction between the types of machine actually operated unless the job description specifies a particular machine." However, workers who differ in full-time/part-time status, union/nonunion status, or time-paid/incentive-paid status are not to be classified as being in the same job. Continuing the example above, if John Smith is a full-time cashier, the other two cashiers will be considered to have the same job as him only if they also work full-time. Also, the data collector is not "to consider longevity steps within a single establishment job to be a separate job unless the job duties differ between steps or grades."

Importantly, the manual tells the data collector to "make sure that the job is identifiable from one collection period to the next. You must be able to identify the occupation selected for each update period." In order to calculate any index number, some piece of information – often the price – must be collected for the same unit in consecutive periods. Therefore, the unit of observation for the ECI must exist in at least two consecutive periods three months apart. Jobs selected for the NCS are actually scheduled to remain in the sample for much longer, currently about twenty data collections (four times a year for approximately five years), so there must be a reasonable expectation that the unit will remain viable for that length of time. An individual worker might quit, be promoted, or otherwise change job duties, so the labor services that the worker provides would not be comparable from one period to the next. This leads the NCS to use the job as its unit of observation instead.[1]

Details about the Jobs

The data in the NCS provide some opportunities for a better understanding of this unit and its potential effect on the ECI. Although the ECI itself relies only on the average compensation among workers in the job for its calculation, the data collector attempts to collect the individual wage rates for all of the workers in the job. Thus, there is information available about the number of workers in a job and, perhaps more importantly, there is information on the extent to which the number of workers in a job changes over time.

To explore these topics, this article uses data for the forty quarters from March 2002 through December 2011. Only data from jobs in private industries are used, and this article will concentrate on wages and salaries only rather than total compensation. The appendix gives further details about the calculations, including how the index formulas are adapted to the statistics reported here. The results are mostly based on observations in which data were collected for both the current and prior periods. When the BLS data collector is unable to collect the actual wages, the wage rate is imputed to maintain the sample's representation of the population. Unless noted otherwise, these imputed values are not included in the analysis.

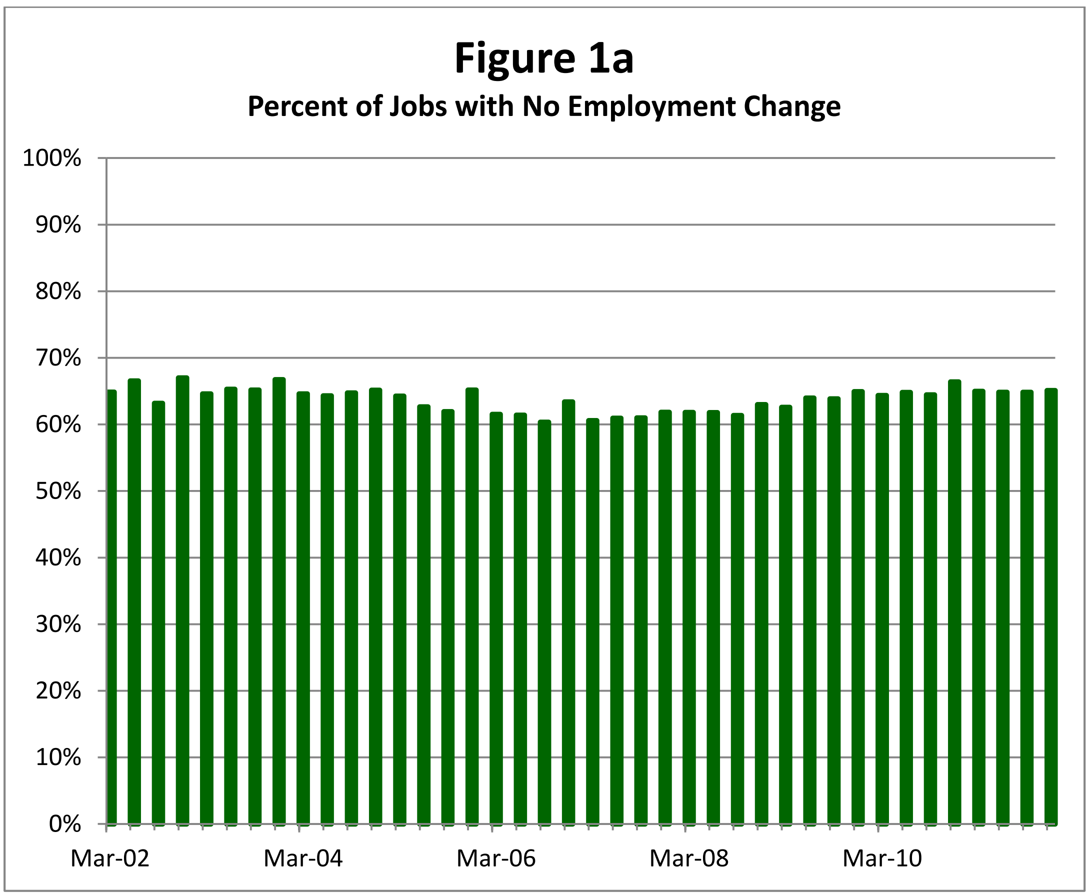
[1] See Schumann (2011) for further description of the sampling of jobs in the National Compensation Survey.

For the 40 quarters between March 2002 and December 2011, the average number of workers in a job was 37.8. However, a few of the jobs have an extremely large number of workers, which drives the average up. The median number of workers in a job is four, and 29 percent of jobs have only one worker, so the majority of jobs have a much smaller number of workers than the average. The seventy-fifth percentile for the number of workers in a job is 16, and the ninetieth percentile is 62 workers.

Changes in the Jobs over Time

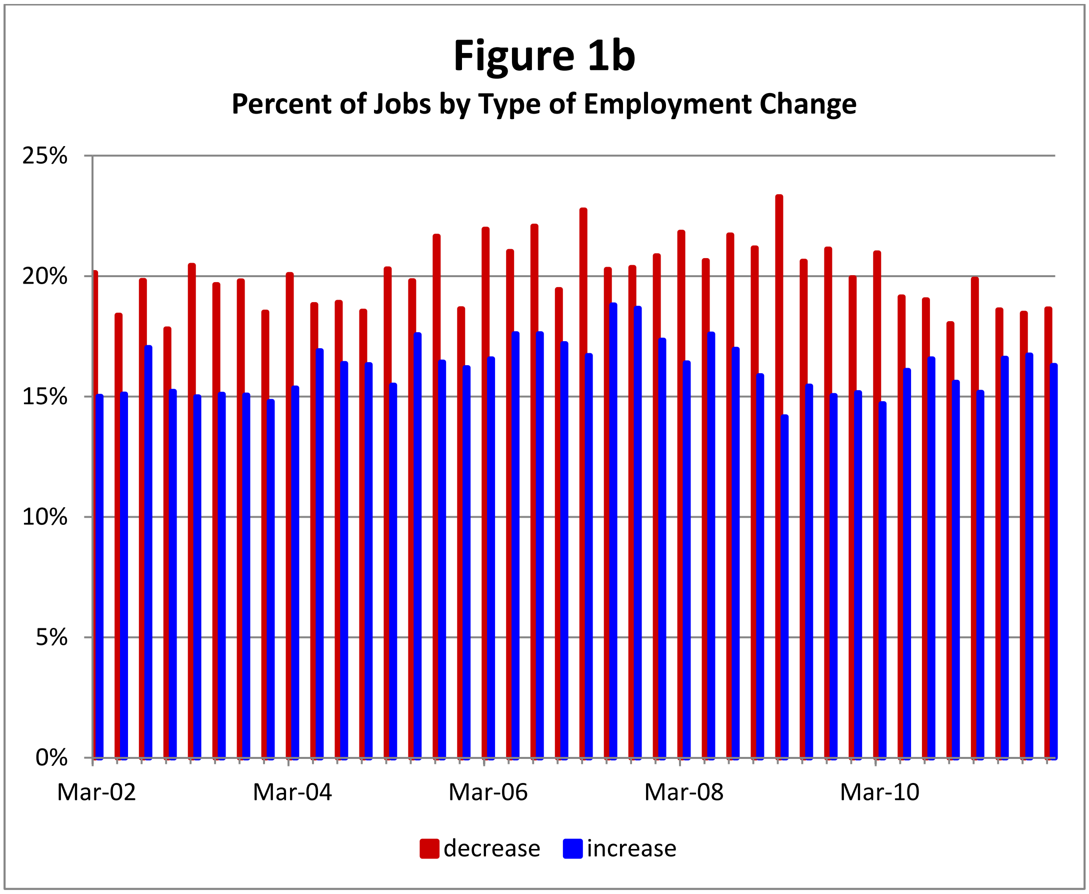
The estimation of an index number depends on the ability to collect the price for the same good over time. For the ECI, the goal is to collect the employer's compensation cost for the same labor input in periods three-month apart. A change in the number of employees indicates that the job has changed at least along this one dimension.

Figure 1a shows the percent of jobs with no change in employment between the prior and current period for each quarter between March 2002 and December 2011.



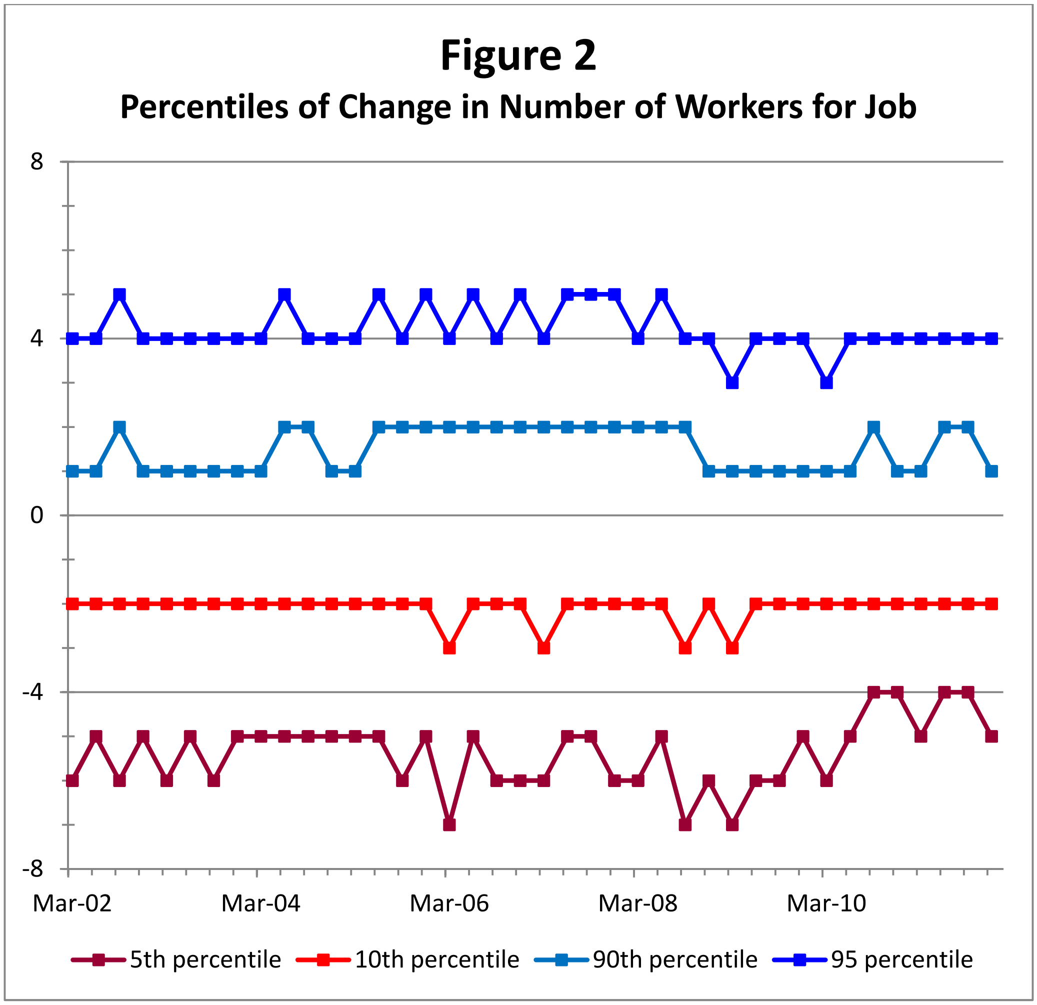
The percentage stays within a relatively narrow band over the 40 periods, ranging between 60.3 and 67.0 percent.

The remaining 33 to 40 percent of jobs had an employment change between the prior and current period. Figure 1b shows the proportion with an employment decrease versus an employment increase.



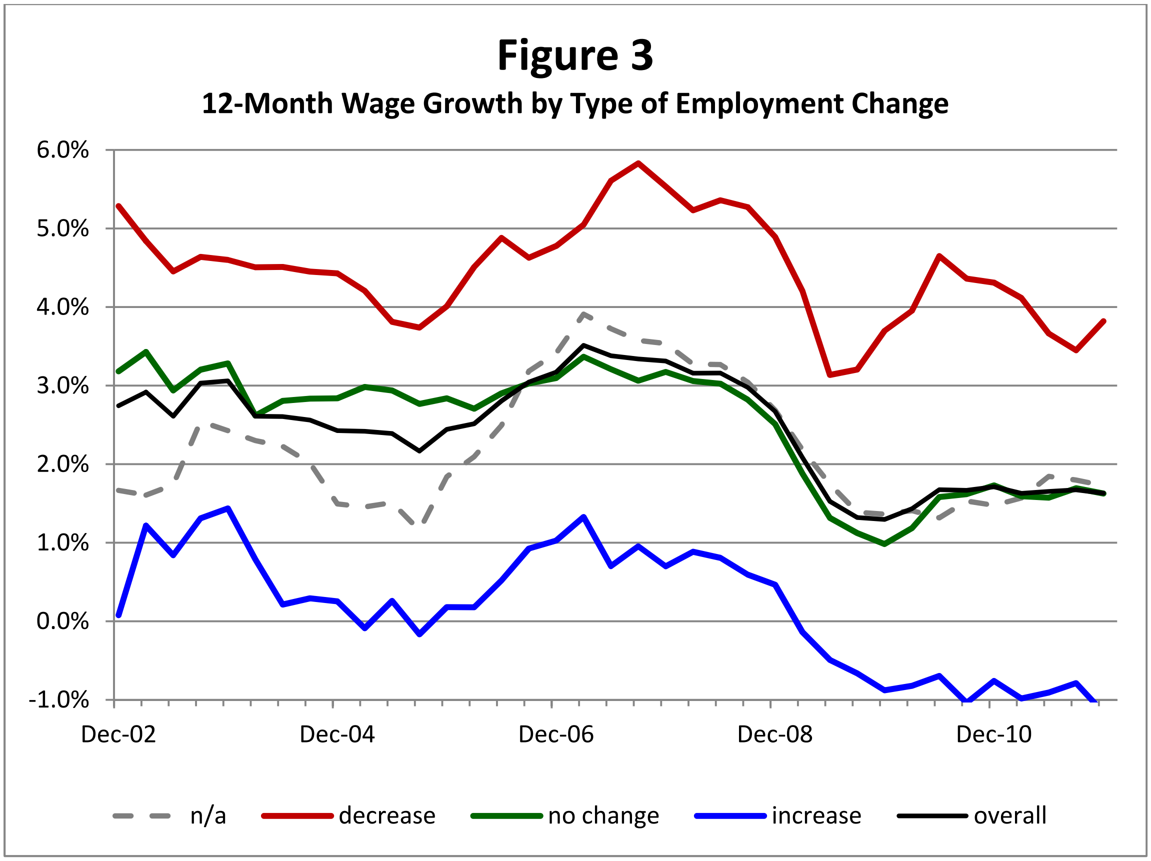
The proportion with an employment decrease ranges from 17.8 to 23.3 percent and the proportion with an employment increase ranges from 14.2 to 18.8 percent. Jobs with an employment decrease do consistently outnumber jobs with an employment increase, usually by two to six percentage points. The largest differential was 9.1 percentage points for the change between December 2008 and March 2009, when both the proportion of jobs with an employment decrease was its highest at 23.3 percent and the proportion of jobs with an employment increase was its lowest at 14.2 percent. This led to the average number of workers in the matched sample of jobs between December 2008 and March 2009 to decline by about two workers from 36.6 to 34.6. Some of the largest losses in private employment from the recession of the late 2000s occurred during these months from late 2008 to early 2009.

Figure 2 shows some percentiles in the distribution of the change in employment within a job for each period from March 2002 through December 2011.



Jobs with no change in employment make up the majority of jobs with collected wage data in both periods, so the median and other percentiles near the middle of the distribution are all zero. Because employment decreases consistently exceed employment increases, the negative values for the lower percentiles tend to be slightly larger in magnitude than the positive values for the corresponding higher percentiles. For example, the fifth percentile ranges between -7 and -4, while the ninety-fifth percentile ranges between 3 and 5. With the three-month changes from all 40 periods combined, the average change in the number of workers within a job is equal to -0.34.

To users of the ECI, the important issue is whether the change in employment for a job systematically affects the ECI as a measure of compensation growth. Figure 3 compares the twelve-month growth in wages for groups defined by the job's employment in the current period relative to its employment in the prior period. The Appendix describes the formulas used to calculate these growth rates. They are based on the ECI formula for special wage indices, which the ECI uses to calculate indices that refer to a subpopulation of workers not defined by an industry or occupation group, such as the published ECI for union workers. The series for all jobs ("overall") in Figure 3 corresponds to a replication of the published ECI for wages and salaries among private workers.

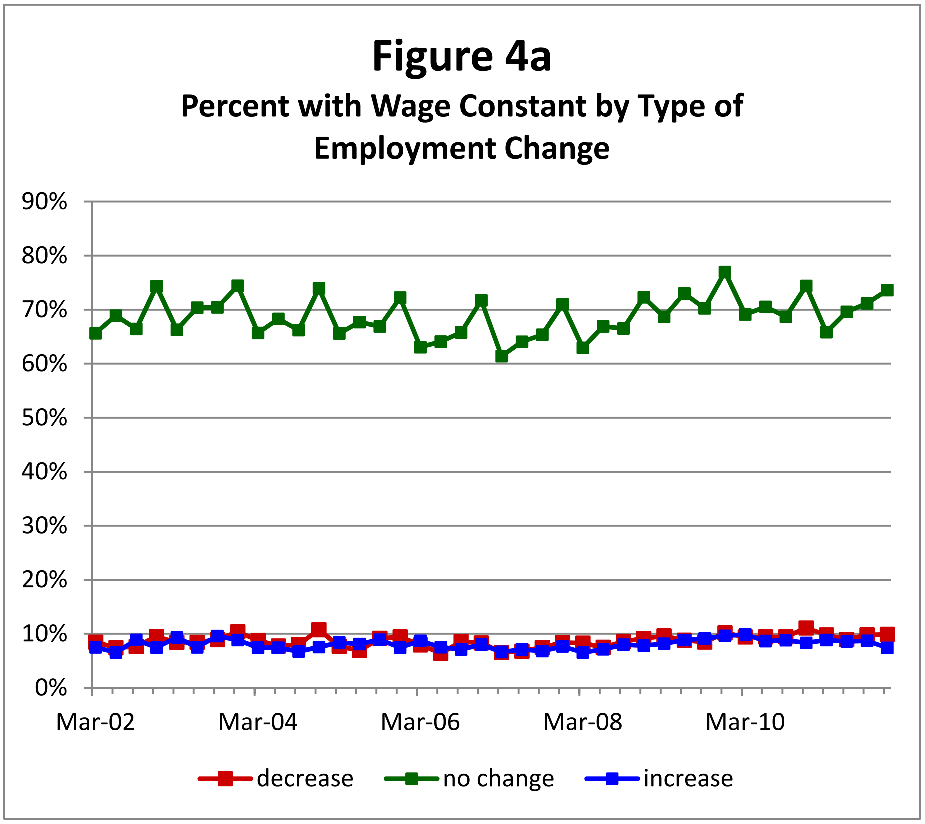


The pattern for wage growth among jobs with the same number of workers in both the current and prior period ("no change") closely follows the pattern in wage growth overall, which is not particularly surprising because they make up a majority share of the total. Among jobs with a change in employment, however, there is a consistent ordering to their wage growth. The wage growth among jobs with an employment decrease is always higher than the growth among jobs overall, while the wage growth among jobs with an employment increase is always lower than the growth among jobs overall. As a twelve-month rate, the average wage growth is 4.53 percent among jobs with an employment decrease from March 2002 through December 2011, compared to just 0.13 percent among jobs with an employment increase. For further reference, the twelve-month wage growth equals 2.44 percent for jobs overall, 2.52 percent for jobs with constant employment, and 2.16 percent for jobs with imputed wage data ("n/a").

Keep in mind that a change in employment for the job does not affect the weight that the job receives in the ECI. The weight for a job is determined when the establishment first enters the NCS. The ECI holds this weight constant for all subsequent periods, even if employment for the job increases or decreases. All that matters for the formula is the change in the job's average wage. The results from Figure 3 similarly hold the weights constant between the periods, so the employment change is only used to sort the jobs into the categories.

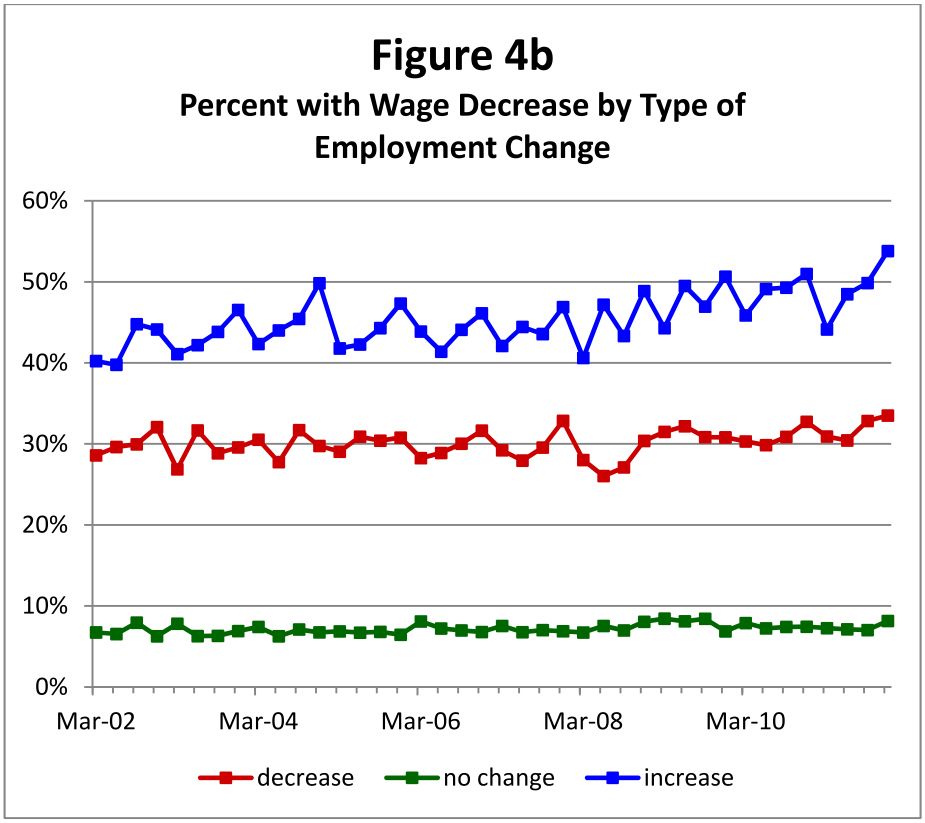
The results in Figure 3 suggest a composition effect. Jobs expand by adding workers who earn less, on average, than the incumbent workers in the job, while jobs contract by losing workers who earn less, on average, than the workers who remain in the job. This leads to lower growth in wages for jobs with an increase in their number of workers and higher growth in wages for jobs with a decrease in their number of workers.

The results in Figures 4a and 4b explore another dimension of this apparent composition effect. Figure 4a shows the percent of jobs with no change in the average wage between the current and prior periods by the type of employment change.



Among jobs with the same employment in both periods, at least sixty percent of them, and often more than seventy percent of them, also have the same average wage in the two periods. In contrast, only about ten percent of jobs with either an employment increase or decrease have the same average wage in both periods.

Figure 4b then shows the percent of jobs with a decrease in the average wage between the current and prior periods; that is, the average wage for the current period is actually lower than the average wage for the job three months prior.



Fewer than ten percent of jobs with the same employment show a decrease in the average wage, whereas about 30 percent of jobs with an employment decrease show a decrease in the average wage, and 40 to 54 percent of job with an employment increase show a decrease in the average wage.

A final thing to keep in mind about the results in Figure 3, Figure 4a, and Figure 4b is that the same employment in both the current and prior periods for a job does not necessarily mean that the two average wages refer to an identical group of workers. For example, the job may have had one worker in the prior period and one worker in the current period, but it could be that a new worker replaced the former worker during the intervening three months. The BLS data collector makes no attempt to keep track of the individual employees. Nonetheless, the results in the Figures 3 through 5 suggest a lesser composition effect for jobs with no change in employment relative to jobs with either an employment increase or an employment decrease.

Alternative Index Formulas

Because the average growth in wages tends to be so much higher for jobs with a decrease in employment than for jobs with an increase, the ECI is potentially sensitive to how much weight these respective types of jobs receive in its calculation. With the current Laspeyres formula, the proportion of jobs with an employment decrease consistently exceeds the proportion with an employment increase, even during periods with an overall increase in aggregate employment among private workers.

The NCS converts a job's probability of selection for the survey into its sample weight for the ECI calculation, where the probability of selection is roughly proportionate to the job's employment during the period in which it was first chosen. Thus, the value for the sample weight, which is held constant for all subsequent periods that the job remains in the sample, reflects the job's employment when it was selected for the sample. This procedure is largely consistent with a Laspeyres index, which uses the quantity for a good from a past period as the weight variable for the price of the good. However, some alternative index formulas, such as the formula for a Paasche index, would ideally use a sample weight based on a job's employment in the current period instead.

In an article from the June 1997 issue of the *Monthly Labor Review*, and then in an update from the December 2002 issue, BLS researchers reported ECI estimates based on alternative index formulas, among them a Paasche index. A Paasche index tracks the change in the average price for a set of goods over time with the quantity of each good set to its value in the current period. In other words, it compares the current average price level to the average price level for a previous period using quantity weights from the current period. These articles found very similar growth rates for the ECI under the Laspeyres and Paasche formulas. However, they applied the current employment weights for the Paasche index only to 720 industry-occupation cells, which is the higher level of aggregation in the ECI calculation. The lower level of aggregation, which starts with the average wages for the jobs, was not modified. (See the Appendix for details.) Therefore, for this article, chained versions of the Laspeyres and Paasche indices were calculated that additionally adjust the sample weight for the job's change in employment since its selection. Although the weight adjustments do not perfectly account for all of the changes in the composition of employment since the job entered the survey, they do make these indices more consistent with the underlying theory.

The appendix describes the details of the calculations for the alternative indices. Most importantly, the sample weights are adjusted so that employment for the previous period determines the job's contribution to the chained Laspeyres index, while employment for the current period determines the job's contribution to the chained Paasche index. For example, all else equal, the chained Paasche index will give a job twice the weight if the job's employment goes from two workers in the period t-1 to four workers in period t compared to the chained Laspeyres index. Conversely, if a job's employment goes from four workers to two workers, the chained Paasche index will give it only half the weight.

Table 1 shows the average wage growth for the alternative indices for March 2006 through December 2011, converted to a twelve-month rate. Because these growth rates refer to a shorter time span than the results in Figures 1 through 4b, the first row of results shows the average growth using the current Laspeyres formula at both levels of aggregation.

Table 1

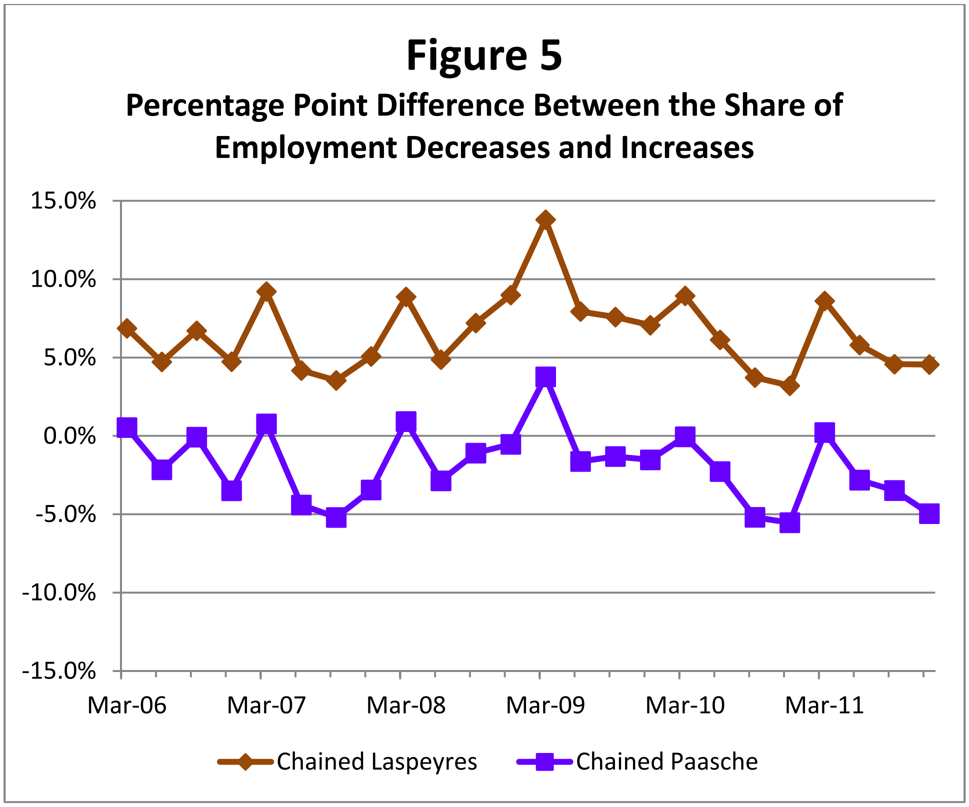
Average 12-Month Wage Growth and Share of Jobs by Type of Employment Change for March 2006 through December 2011

	overall	employment decrease	employment constant	employment increase	employment n/a
Annual Wage Growth					
Laspeyres	2.30%	4.50%	2.18%	-0.10%	2.36%
Chained Laspeyres	2.47%	4.61%	2.29%	0.48%	2.37%
Chained Paasche	2.28%	4.22%	2.28%	0.29%	2.44%
Share of Jobs with Employment Data					
Laspeyres	---	20.5%	63.0%	16.5%	---
Chained Laspeyres	---	24.3%	57.9%	17.8%	---
Chained Paasche	---	20.1%	58.0%	22.0%	---

For the chained Laspeyres index, a job's original sample weight is multiplied by the ratio of the job's employment in period t-1 to its employment from the initiation period. Also, for the higher level of aggregation, employment weights for the industry-occupation cells from period t-1 are used instead of from the base period. These two changes lead to average twelve-month wage growth of 2.47 percent.

For the chained Paasche index, the job's original sample weight is multiplied by the ratio of the job's employment in period t to its employment from the initiation period, and employment weights for the industry-occupation cells from period t are used. Average twelve-month wage growth for the chained Paasche index is somewhat lower than for the chained Laspeyres index at 2.28 percent. The bottom part of the table shows the share of jobs by the type of the employment change. The shares for the three index methods are all based on the same set of jobs. However, the shares differ because a job's weight in each calculation is chosen to match its contribution to the corresponding index. Unlike the two Laspeyres indices, the share of jobs with an employment increase is higher than the share of jobs with an employment decrease for the chained Paasche index.

Figure 5 further elaborates on the effect of the Laspeyres and Paasche formulas on the shares for the types of employment changes. It shows the share of employment decreases minus the share of employment increases, measured in percentage points, for each time period. For example, if the average values from Table 1 where used, the percentage point difference for the Chained Laspeyres Index would equal 6.5 percent points (24.3% minus 17.8%), while the percentage point difference for the Chained Paasche Index would equal -1.9 percentage points (20.1% minus 22.0%).



Over the six years, the peaks and troughs of the differences are very similar for the alternative indices. For both of them, the percentage points by which employment decreases exceeded employment increases was the greatest between December 2008 and March 2009, at the height of job losses during the recession. Beyond the ups and downs, however, the Chained Paasche formula consistently lowers the share of employment decreases compared to the Chained Laspeyres formula, to the point where employment increases outnumber employment decreases for the majority of the periods. This leads in part to lower wage growth overall relative to the Chained Laspeyres Index. The different weighting scheme also leads to lower wage growth among the jobs with an employment decrease, which further contributes to the lower overall wage growth.

Implications for the ECI

In an article from the September 2001 issue of the *Monthly Labor Review*, John Ruser discusses many facets of the Employment Cost Index. When discussing the possible effects of the business cycle on the ECI, he postulates that less-experienced, lower-paid workers are more likely to exit jobs during economic downturns, which would add to a countercyclical component to the ECI. The higher growth rate for wages among jobs with a decrease in employment from Figure 3 aligns with this scenario. However, this appears to occur in all periods, not just during economic downturns. Combined with the fact that, for the published ECI, the share of jobs with an employment decrease consistently exceeds the share of jobs with an employment increase, it raises the concern that the ECI growth rate for wages and salaries is higher than it should be, at least if one assumes that jobs with employment increases and decreases should more or less balance each other out in the long run.

This article attempts to address this issue by comparing growth rates under alternative index formulas. The chained Paasche index, for which the share of employment increases exceeds the share of employment decreases, does show lower wage growth than the chained Laspeyres index, but only by a relatively small amount. Thus, in practical terms, the low growth rate in wages among jobs with an employment increase largely offsets the high growth rate among jobs with an employment decrease, which results in a relatively small net effect on the ECI for wages and salaries.

Viewed more broadly, some degree of change to the labor input, however the ECI were to define it, is probably inevitable, given the continual movement of workers in and out of jobs in the labor market. One cannot always hold the labor input constant between periods in strict accordance with the Laspeyres formulation. The NCS procedure for selecting and updating the average wages for jobs gives BLS data collectors the flexibility to adapt the unit of observation to the structure of the establishment's workforce, thereby maximizing the amount of data that can be collected and the number of workers that can be kept within the scope of the ECI. However, as this article shows, it also leads to variation in the number of workers in jobs across the establishments in the sample, and it leads to changes to the number of workers within a job over time. Therefore, it is important for the BLS to make users aware of these features to the ECI.

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Appendix

ECI Formula for Wages and Salaries

In an article from the May 1982 issue of the *Monthly Labor Review*, Don Wood reviews the formulas used in the calculation of the Employment Cost Index. The ECI divides employment into types of labor, which are defined by an occupation group within an industry group (for example, sales and related occupations in telecommunications industries). Since March 2006, the ECI has defined 522 types of labor for workers in private industries based on the NAICS industry and SOC occupation codes. Prior to then, starting in March 1995, it defined 720 types for private industries based on the SIC industry and Census occupation codes.

Using the subscript i to denote the types of labor, the ECI for wages and salaries among private workers is based on an aggregation of "cost weights" for the types. The ECI for period t, denoted by $\mathrm{I_t}$, equals the following.

$$(1)\quad \mathrm{I_t} = \frac{\sum_{\mathrm{i}} \mathrm{CW_{it}}}{\sum_{\mathrm{i}} \mathrm{CW_{i0}}} \times 100, \text{ where } \mathrm{CW_{it}} = \mathrm{E_{ib}}\widehat{\mathrm{W}}_{\mathrm{it}}$$

The cost weight for labor type i in period t is denoted by $\mathrm{CW_{it}}$ in equation (1). It equals employment for labor type i in a base period, denoted by $\mathrm{E_{ib}}$, multiplied by the type's wage in period t, denoted by $\widehat{\mathrm{W}}_{\mathrm{it}}$. The calculation of this wage begins with the average wage rate among jobs of type i in the NCS sample for an initial period 0. This initial wage is then updated each period by the type's average wage for period t divided by its average wage for period t-1, where the two averages are based on jobs in NCS sample for both period t and t-1. See Don Wood's article or Chapter 8 of the *BLS Handbook of Methods* for further details about the updating process.

The ECI formula most closely matches the format of a Laspeyres index at the level of the industry-occupation cells. This is the level of aggregation at which the cost weights are calculated. Nonetheless, the article describes the job as essentially being the good in the ECI's application of the Laspeyres formula to labor market because the update ratios for the cell are calculated using the same set of jobs in both the numerator and the denominator, with the same sample weight for a job applied to both of the average wages. Thus, the sample weight can be viewed as a quantity measure for the job that is held constant between the current and prior periods.

ECI Formula for Special Wage Indices

For an index that refers to a subpopulation of workers, but where the subset is not defined by an industry or occupation group, the ECI uses a modified formula. It makes use of the cost weights from equation (1). In his article, Don Wood reviews the application of this formula to the index for union workers, hence the superscript u in his example. Here, the more general notation of d for "domain" will be used. The ECI for domain d in period t equals the following.

$$(2)\quad \mathrm{I_t^d} = \mathrm{R_t^d} \times \mathrm{R_{t-1}^d} \times \ldots \times \mathrm{R_1^d} \times 100$$

The formula for the wage relative for domain d in period t, denoted by R_t^d in equation (2), equals the following.

$$(3)\quad R_t^d = \frac{\sum_i CW_{it-1}\left(\frac{E_{it-1}^d}{E_{it-1}}\right)\left(\frac{\overline{W}_{it-1}^d}{\overline{W}_{it-1}}\right)\left(\frac{\overline{W}_{it}^d}{\overline{W}_{it-1}^d}\right)}{\sum_i CW_{it-1}\left(\frac{E_{it-1}^d}{E_{it-1}}\right)\left(\frac{\overline{W}_{it-1}^d}{\overline{W}_{it-1}}\right)}$$

The formula has several terms, so it makes sense to view them individually. The cost weight for labor type i from equation (1) equals the wage for the labor type multiplied by its employment in a base period, so it is much like the aggregate labor cost for workers of this type had employment remained at its base value. Two factors then adjust this cost weight to the workers specifically in the domain. First, the cost weight is multiplied by the share of employment for the domain relative to total employment, which is denoted by $\left(\frac{E_{it-1}^d}{E_{it-1}}\right)$ in equation (3) and calculated as the sum of the sample weights among the jobs in the domain divided by the sum of the sample weights across all jobs of labor type i. Second, the cost weight is further multiplied by the average wage for jobs in the domain relative to the average wage for all jobs of the type, which is denoted by $\left(\frac{\overline{W}_{it-1}^d}{\overline{W}_{it-1}}\right)$ in equation (3). Both factors are calculated using the jobs in the NCS sample for period t-1 that are also in the NCS sample for period t.

The key term to the formula for the wage relative R_t^d is really the final term in the numerator, denoted by $\left(\frac{\overline{W}_{it}^d}{\overline{W}_{it-1}^d}\right)$. It equals the ratio of the average wage among jobs from the domain in the current period to the average wage among jobs from the domain in the prior period for the type of worker. The same set of jobs is used for both averages, and the sample weight for a job is the same in both the numerator and the denominator of the ratio. The two occurrences of $\overline{W}_{it-1}^d$ in the numerator of R_t^d actually cancel each other out in the calculation. They are left in equation (2) to aid with the interpretation of the formula.

Figure 3 from the article shows the growth rate in wages for four values of d: jobs with an employment decrease, jobs with no change in employment, jobs with an employment increase, and jobs with missing employment data. The twelve-month growth rate for domain d in period t equals $\left(\frac{I_t^d}{I_{t-4}^d} - 1\right) \times 100$. For the statistics in this article that do not refer to wage growth, such as the statistics on the number of workers in a job, the sum of the sample weights by industry-occupation cell is benchmarked to the cost weight for wages and salaries from the prior period CW_{it-1}. This makes the job's contribution to the statistic more in line with its contribution to the ECI.

Formulas for Alternative Indices

Equations (4) and (5) show the formulas for a chained version of the Laspeyres index, and equations (6) and (7) show the formulas for a chained version of a Paasche index.

$$(4)\quad I_t^L = R_t^L \times R_{t-1}^L \times \ldots \times R_1^L \times 100$$

$$(5)\quad R_t^L = \frac{\sum_i CW_{it}^L}{\sum_i CW_{it-1}^L} \times 100 \text{, where } CW_{it}^L = E_{it-1}\widehat{W}_{it} \text{ and } CW_{it-1}^L = E_{it-1}\widehat{W}_{it-1}$$

$$(6)\quad I_t^P = R_t^P \times R_{t-1}^P \times \ldots \times R_1^P \times 100$$

$$(7)\quad R_t^P = \frac{\sum_i CW_{it}^P}{\sum_i CW_{it-1}^P} \times 100 \text{, where } CW_{it}^P = E_{it}\widehat{W}_{it} \text{ and } CW_{it-1}^P = E_{it}\widehat{W}_{it-1}$$

Instead of using employment from a fixed base period, the chained version of the Laspeyres index strings together a series of Laspeyres indices, each of which compares wages between period t and period t-1 using employment from t-1 in the calculations of the cost weights. The chained version of a Paasche index is similar, except that it uses employment from period t in the calculation of the cost weights.

In the previous *Monthly Labor Review* articles from June 1997 and December 2002, the wage for the labor type i, denoted by $\widehat{W}_{it}$ in equations (5) and (7), was the same one used for the published ECI from equation (1). The chained indices in this article adjust the NCS sample weight for the job's employment change since its period of initiation. For the chained Laspeyres index, the sample weight is multiplied by the ratio of the job's employment in period t-1 to its employment in the initiation period. For the chained Paasche index, it is multiplied by the ratio of the job's employment in period t to its employment in the initiation period.

Equation (8) and (9) show the formulas for the chained Laspeyres and the chained Paasche wage relatives using these adjusted sample weights.

$$(8)\quad R_t^{CL} = \frac{\sum_i CW_{it}^{CL}}{\sum_i CW_{it-1}^{CL}} \times 100 \text{, where } CW_{it}^{CL} = E_{it-1}\widehat{W}_{it}^{CL} \text{ and } CW_{it-1}^{CL} = E_{it-1}\widehat{W}_{it-1}^{CL}$$

$$(9)\quad R_t^{CP} = \frac{\sum_i CW_{it}^{CP}}{\sum_i CW_{it-1}^{CP}} \times 100 \text{, where } CW_{it}^{CP} = E_{it}\widehat{W}_{it}^{CP} \text{ and } CW_{it-1}^{CP} = E_{it}\widehat{W}_{it-1}^{CP}$$

The wage for type i in period t, when calculated using sample weights adjusted to period t-1 in the update ratios, is denoted by $\widehat{W}_{it}^{CL}$. The wage for type i in period t, when calculated using the sample weights adjusted to period t in the update ratios, is denoted by $\widehat{W}_{it}^{CP}$.

Equations (10) and (11) show the formulas used for a chained Laspeyres index for a domain. The superscript L indicates that term was calculated using the sample weights adjusted to period t-1.

$$(10)\quad I_t^{CL(d)} = R_t^{CL(d)} \times R_{t-1}^{CL(d)} \times \ldots \times R_1^{CL(d)} \times 100$$

$$(11)\quad R_t^{CL(d)} = \frac{\sum_i CW_{it-1}^{CL}\left(\frac{E_{it-1}^{L(d)}}{E_{it-1}^{L}}\right)\left(\frac{\overline{W}_{it-1}^{L(d)}}{\overline{W}_{it-1}^{L}}\right)\left(\frac{\overline{W}_{it}^{L(d)}}{\overline{W}_{it-1}^{L(d)}}\right)}{\sum_i CW_{it-1}^{CL}\left(\frac{E_{it-1}^{L(d)}}{E_{it-1}^{L}}\right)\left(\frac{\overline{W}_{it-1}^{L(d)}}{\overline{W}_{it-1}^{L}}\right)}$$

Equations (12) and (13) show the formulas used for a chained Paasche index for a domain. The superscript P indicates that term was calculated using the sample weights adjusted to period t.

$$(12)\quad I_t^{CP(d)} = R_t^{CP(d)} \times\ R_{t-1}^{CP(d)} \times \dots \times R_1^{CP(d)} \times 100$$

$$(13)\quad R_t^{CP(d)} = \frac{\sum_i CW_{it}^{CP}\left(\frac{E_{it}^{P(d)}}{E_{it}^{P}}\right)\left(\frac{\overline{W}_{it}^{P(d)}}{\overline{W}_{it}^{P}}\right)}{\sum_i CW_{it}^{CP}\left(\frac{E_{it}^{P(d)}}{E_{it}^{P}}\right)\left(\frac{\overline{W}_{it}^{P(d)}}{\overline{W}_{it}^{P}}\right)\left(\frac{\overline{W}_{it-1}^{P(d)}}{\overline{W}_{it}^{P(d)}}\right)}$$