ESTIMATES OF YEAR-TO-YEAR CHANGE IN COSTS PER HOUR WORKED FROM THE EMPLOYER COSTS FOR EMPLOYEE COMPENSATION SURVEY

INTRODUCTION

The Bureau of Labor Statistics (BLS) annually publishes cost level estimates for employee pay and benefits, known as the Employer Costs for Employee Compensation (ECEC). These cost levels are derived from the Employment Cost Index (ECI), a quarterly measure of the rate of change in employee compensation. Unlike the ECI, which is a Laspeyres, fixed-weight index that eliminates the effects of employment shifts over time among major occupational groups and industries, the ECEC cost level estimates reflect current employment distributions.

This article presents, for the first time, estimates of year-to-year change in the ECEC costs-per-hour-worked of the components of compensation for private industry workers, by industry division and occupational group, and the corresponding standard errors, together with an analysis of the change estimates and how they compare to ECI 12-month percent change and associated standard errors. This article also includes a brief review of the ECEC estimation methodology and sample design, along with an explanation of the balanced-repeated replication method of standard error computation which was used with the ECEC change estimates.

ECEC cost levels measure average compensation levels, whereas ECI indexes measure average change in compensation costs. The ECI was specifically intended to track the rate of change of wages and benefit costs, but some have tried using annual changes in the ECEC, which provides information on actual cost levels for each component of compensation, to accomplish the same goal. As expected, changes in ECEC estimates vary from the ECI estimates of change for the same period, due to different estimation methodology. Over the past decade, ECEC wage and benefit levels have generally grown at a slower rate than ECI wage and benefit indices.

METHODOLOGY AND SAMPLE DESIGN

Both the Employment Cost Index and Employer Costs for Employee Compensation share compensation data obtained from a single sample of establishments. BLS economists obtain wage and benefit information quarterly from each establishment in the ECI survey sample. In order to measure compensation trends uninfluenced by employment shifts among occupational groups and industries, the Bureau calculates the ECI with fixed employment weights, which since December 1994, have been the 1990 employment counts from the BLS's Occupational Employment Survey. (From June 1986 through December 1994, employment counts from the 1980 Census of Population were used.) In addition to employment weights, the ECI uses sample weights (the weight of the establishment occupation in the sample) which reflect both employment in each establishment occupation and the probability of selection of the occupation within the establishment.

These sample weights are the product of the reciprocal of the probability of selection of the sample establishment, the sampling interval used in the occupational selection, and a nonresponse adjustment factor. The sample weights are used to obtain estimates within a fixed employment weighting cell, while the fixed employment weights (described above) are used for estimation across these cells.

The ECI covers all occupations within the private economy (excluding farms, households, and the self-employed) and the public sector (excluding the Federal Government). In March 1996, the ECI sample included about 17,000 occupations within 4,100 firms in the private sector and about 5,000 occupations within nearly 900 establishments in State and local governments.

Establishment sample

BLS statisticians draw the sample of ECI establishments on a probability basis by industry from State unemployment insurance and supplementary files. Industry classification, based on the 1987 Standard Industrial Classification (SIC), as defined by the U.S. Office of Management and Budget, is usually categorized at the 2-digit SIC level. The probability of selection is proportionate to an establishment's relative employment size within the industry.

After 4 to 5 years of ECI data collection, BLS statisticians replace the industry sample in order to reduce the burden on respondents and to keep the sample frame as current as possible. Total sample replacement is gradual, with a set of industries replaced each calendar quarter. The design of this rotation scheme is such that, in absence of typical nonsampling errors, such as those produced by nonresponse, the subsample of quotes with data for both the current and prior quarters properly represents all occupations covered by ECI. In addition, for industries not replaced in a given year, BLS statisticians select a sample of newly-created establishments (birth quotes) to represent establishments that have come into existence since the date of the industry sample frame. In 1996, the BLS Statistical Methods Group introduced a new cross-industry sample replenishment scheme for the ECI, instead of industry-by-industry. Unlike previously, when there was no geographical clustering, this new ECI design is primary sample unit (PSU) based, grouped according to metropolitan statistical areas and non-metropolitan counties.

Occupational sample

Sampling occupations at the most narrowly-defined level in each establishment follows the drawing of the industry sample of establishments for the ECI survey. As is the case with establishment sampling, sample selection for occupations within establishments is on a probability-proportionate-to-employment basis.

During the initial personal visit to collect wage and benefit data, a BLS representative samples occupations. The field economist targets a specific number (depending on establishment employment) of narrowly-defined occupations, with the probability of occupational selection proportionate to the occupational employment size within the establishment. Since June 1986, the ECI survey utilized the occupational definitions used in 1980 Census, based on the Standard Occupational Classification (SOC) system.

The sample weight of a selected occupation is constant during the entire time that it remains in the ECI sample. Thus, ECI estimates for a given period do not strictly reflect the current employment of that period. At the same time, between twenty and twenty-five percent of the ECI sample is replenished every year.

Computing cost levels

Prior to computing the average cost level estimates at aggregate levels, it is necessary to convert wages and salaries to a straight-time hourly rate, and benefit costs to the cost per hour worked.

Cost level estimation at aggregate levels involves the application of a separate adjustment factor to the ECI sample weights in each industry, in order to force the estimates of employment in the industry to agree with the independent counts. These counts are derived from BLS Current Employment Statistics (CES) data. The numerator of this factor is the CES employment count in the industry, and the denominator is the ECI estimate of this employment using the sample weights (prior to this adjustment). Adjusted weights, used to compute cost level estimates, are the product of multiplying the adjustment factor with the sample weights for each industry. This adjustment process is referred to as benchmarking.

The formula for the estimated cost level for total compensation, wages and salaries, or benefits for a domain *D* such as major industrial division or major occupational group, denoted $\hat{X}$ is:

$$\hat{X} = \frac{\sum_{(i,q)\in D}\left(W_{i,q}\overline{Y}_{i,q}\right)}{\sum_{(i,q)\in D}\left(W_{i,q}\right)}$$

where:

$W_{i,q}$ is the adjusted weight for the *q*th quote in the *i*th establishment.

$\overline{Y}_{i,q}$ is the mean compensation, wages and salaries, or benefits for the *q*th quote in the *i*th establishment.

Computing the index

A standard Laspeyres fixed-employment-weighted index, the ECI wage index is the weighted average of the cumulative wage changes within each cell (generally a major occupational group in a 2-digit SIC industry), with base-period wage bills as the fixed weights for each cell. The base-period wage bill is the fixed employment weights from the Census multiplied by the sample-weighted average wage in the base period of June 1989. Index computation for benefits and total compensation proceeds similarly. The formula for the index for quarter *t*, denoted I_t, is:

$$I_t = \frac{\sum\left(W_{o,i}\, M_{t,i}\right)}{\sum\left(W_{o,i}\right)} * 100$$

where:
$M_{t,i} = M_{t-1,i} * R_{t,i}$, and is the cumulative average wage change in the *i*th cell from time 0 (base period) to time *t* (current quarter).

$R_{t,i}$ is the ratio of the current-quarter weighted average wage in the cell to the prior-quarter weighted average wage in the cell, both calculated using matched establishment/occupation wage quotations. The weights applied are the sample weights.

$W_{o,i}$ is the estimated base-period (June 1989) wage bill for the *i*th cell. The wage bill is the average wage of workers in the cell, estimated from the June 1989 ECI, multiplied by the number of workers represented by the cell (the census weight).

Reliability of the estimates

The method used for computing the standard errors for both the 12-month percent change in the ECI and the ECEC cost levels change is called "balanced-repeated replication." This involves the division of each industry sample into a number of variance strata, and then the further division of each sample in every variance stratum into half-samples. Replication of cost level or percent change estimates 64 times follows, using data from one half-sample from each stratum, instead of the data from both half-samples. Each of the 64 replicates has a different combination of half samples. Subtracting the 64 prior year replicates from the 64 current year replicates yields the 64 year-to-year change replicates. Then, calculation of the standard error (the square root of the variance) is possible for the year-to-year change using the 64 change replicates.

The formula used for estimating the variances, VAR ($\hat{X}$), and in turn the standard errors, for *change in cost levels* is:

$$\mathrm{VAR}(\hat{X}) = \sum_{i=1}^{64}\left(x_i - x_o\right)^2 \Big/ 64$$

where:
x_o is the full sample change in level estimate for some characteristic; and
x_i is the *i*th half-sample change in level estimate for the same characteristic.

The formula used for estimating the variances, and in turn the standard errors, for the *index percent changes* is:

$$\mathrm{VAR}\left(\frac{I_{t,o}}{I_{s,o}}\right) = \sum_{i=1}^{64}\left(\frac{I_{t,i}}{I_{s,i}} - \frac{I_{t,o}}{I_{s,o}}\right)^2 \Big/ 64$$

where:

$\frac{I_{t,o}}{I_{s,o}}$ is the change in the index for some characteristic from time *s* to time *t* calculated using the full sample; and

$\frac{I_{t,i}}{I_{s,i}}$ is the change in the index for the same characteristic from time *s* to time *t* calculated using the *i*th balanced half-sample.

RESULTS

Table 1 shows ECEC year-to-year changes in private industry total compensation, wages and salaries, and benefit costs, and associated standard errors. Between March 1995 and March 1996, total compensation increased 40 cents, with a standard error of 9 cents, to a level of $17.49. In percentage terms, as summarized in Table 4, total compensation grew 2.3 percent, with a standard error of 0.5 percent. During the same period, wages and salaries increased 2.7 percent and benefits 1.2 percent, and both of these estimates had a standard error of 0.6 percent. The difference between the percent increase in wages and benefits is significant at the 0.1 level of significance, but not at the .05 level of significance.

In addition to comparing estimates of 12-month change, we computed long term change estimates. Because there is no overlap in the samples which are more than 5 years apart, the covariance term in the formula for the variance of the difference of estimates at least that far apart is zero. This allows using the square root of the sum of the two variance estimates of the cost levels to estimate the standard error of change. The relative errors of the levels of cost estimates are published in the yearly bulletin *Employment Cost Indexes and Levels*, *1975-1996*. This is in contrast to the variances for the 12-month changes which are computed as described in the previous section in order to incorporate the covariance term.

The ten-year change, ending in March 1996, in total compensation was $4.07 with a standard error of 23 cents. For total benefits, the ten year change was $1.31 with a standard error of 8 cents, while for wages and salaries the change was $2.75 with a standard error of 16 cents. In percentage terms, benefits grew faster than wages and salaries, 36.5 percent and 28 .0 percent respectively, with the difference significant at the .05 level of significance.

Table 2 and Table 3 show ECEC year-to-year change in employer costs per hour worked for employee compensation and their corresponding standard errors by major industrial division and major occupational group respectively. The March 1995-March 1996 change in total compensation costs for the individual goods-producing industries ranged numerically from $.21 to $.89. The corresponding changes in the service-producing industries ranged numerically from $.22 to $1.20. Despite that numerically there is a large range among the individual industries, one cannot draw any meaningful statistical conclusions about these differences, even at the .1 level of significance. Likewise, for individual white-collar, blue-collar, and service occupations, cost level changes for total compensation ranged numerically from -$.01 to $1.00. Again, we did not detect any significant differences among each of the individual occupational groups.

We also compared in broader terms the aggregate goods-producing industry to the aggregate service-producing industry over the most recent one year period and the aggregate white-collar, blue-collar and service occupations. Unfortunately, we have not computed the standard error for these aggregate groupings using the approach described in the previous section and were forced to calculate the standard error for the change as the square root of the sum of the variance estimates of the cost levels, which tends to overestimate the standard error because it does not subtract out the effect of the covariance term. We found that for the year ending March 1996, the goods-producing industry division increased $.52 with a standard error of $.57, while service-producing cost levels increased $.40 with a standard error of $.25. The aggregate white-collar, blue collar, and service occupations increased $.60, $.35 and $.22, respectively, with standard error of $.40, $.32, and $.14, respectively. Neither the differences between these aggregate industries nor among these aggregate occupational groups were statistically significant, even at the .1 level of significance.

However, over a 10-year period, such comparisons do yield differences that are statistically significant. Total compensation costs for the goods-producing industry grew $5.41 for the 10-year period ending in March 1996, while service-producing cost levels increased $3.87, with standard errors of $.49 and $.25, respectively. For the same period, white-collar workers total compensation increased $5.54, while that of blue-collar workers increased $3.61 and service workers increased $2.18, with the three corresponding standard errors, $.39, $.28 and $.14 respectively. At the .05 level of significance, the increase in compensation for goods-producing industries was significantly larger than for service-producing industries. While, as ascertained by a multiple comparisons test, the increase for white-collar workers was larger than that for blue-collar workers, which in turn was larger than that for service workers.

ECEC and ECI Compensation Levels and Trends

Over the period, March 1986-96, private industry compensation costs rose 40.5 percent as measured by the ECI and 30.3 percent as measured by the change in cost levels, with standard errors of 2.2 and 1.9, respectively. The growth in wages and salaries amounted to 35.2 and 28.0 percent, for the ECI and cost levels, with standard errors of 2.9 and 1.9, respectively, while benefits rose 54.9 and 36.5 percent with standard errors of 2.2 and 2.4, respectively. In annual terms, these increases correspond to an annual growth rate of 3.1 for wages and salaries, and 4.5 percent benefits for the ECI indices, while the annual growth rate for the ECEC levels was 2.5 percent for wages and salaries, and 3.2 percent for benefits. The differences in percent change between the ECI and the ECEC for compensation, wages and salaries, and benefits were all significant at the .05 level of significance.

Table 4 shows trends in compensation of private industry workers, measured by 12-month dollar changes and percent changes in the ECEC and percent changes in the ECI and their corresponding standard errors. Although these differences between the ECI and ECEC are significant over the long term, they are not significant over the 12-month period from March 1995-1996. For example, from March 1995 to March 1996, the

ECEC compensation costs increased 2.3 percent, with a standard error on the difference of 0.51 percent. The ECI 12-month percent change ending in March 1996 was 2.7 percent, with a standard error on the difference of 0.27 percent

Various factors have been suggested to explain this divergent behavior of the ECI and the ECEC, including differences in the way the two measures are constructed, the sets of weights used, and the way the data are linked from quarter to quarter. A key difference between the ECEC and the ECI is the issue of matched quotes. When computing quarterly change, the ECI only uses quotes for which data were collected in two consecutive quarters. The ECEC on the other hand, estimates levels using quotes in the sample for a particular quarter only. Because about one-fifth of the sample is replaced each year, approximately 20 percent of the quotes in the sample one year are not in the sample the following year. Hence, there is not a perfect overlap in quotes used in estimating 12-month change.

Lettau, Lowenstein, and Cushner in “Explaining the Differential Growth Rates in the ECI and ECEC”, analyze the two main steps in the calculation of the ECI and ECEC. Step 1, combining all of the job quotes within a given cell to obtain a cell average, yields different estimates for ECI and ECEC, particularly due to the matched quote issue described above. This is because incoming jobs have tended to offer lower wages and benefits than outgoing jobs, and the increases in ECEC level estimates would therefore be expected to be lower than the annual ECI change. The same authors in “Sample Replacement in the ECI” conclude that about half of the difference between the wages of incoming and outgoing jobs can be explained by differences in these jobs’ observable characteristics, that is establishment size, unionization, and work schedule (part-time/full-time).

Step 2, combining cell means to obtain final estimates, involves fixed weights for the ECI, while the ECEC uses CES weights. By isolating the two steps in the process, they determined that at least one-third of the divergence of the ECI and ECEC is attributable to differences in the way the job quotes are aggregated to obtain the cell means, and at least one-third is attributable to differences in the way cell means are aggregated.

Finally, the answer to the question about which survey, the ECEC or the ECI, is appropriate for measuring the rate of change must be determined by the needs of the user. If a user prefers a measure of change, which maintains fixed employment distribution by industry and occupation group, the ECI provides an appropriate measure. Conversely, if the user wants the survey which measure rates of change accounting for changes in the employment distribution, the ECEC is more appropriate. However, if the user desires an estimate of change which both keeps the employment distribution fixed by industry and occupation group, but incorporates change arising from new jobs in the same weighting cell, then an estimator would have to be developed, which does Step 1 above using the ECEC approach and Step 2 using the ECI approach.

Any opinions expressed in this paper are those of the author and do not constitute policy of the Bureau of Labor Statistics.

References

Lettau, Michael K., Mark A. Loewenstein, and Aaron T. Cushner, "Explaining the Differential Growth Rates of the ECI and the ECEC," *Compensation and Working Conditions*, Summer 1997, pp. 15-23.

Lettau, Michael K., Mark A. Loewenstein, and Aaron T. Cushner, "Is the ECI Sensitive to the Method of Aggregation?," Compensation Research and Program Development Group Working Paper, 1996.

Lettau, Michael K. and Mark A. Loewenstein, "Sample Replacement in the ECI," Compensation Research and Program Development Group Working Paper, 1996.

Miller, Rich, "Employment Cost Index Under Scrutiny Ahead of Federal Open Market Committee," Reuters Financial Report, May 19, 1997.

Nathan, Felicia "Analyzing Employers' Costs for Wages, Salaries, and Benefits," *Monthly Labor Review*, October 1987, pp. 3-11.

O'Connor, Karen and Wong, William, "Measuring the Precision of the Employment Cost Index," *Monthly Labor Review*, March 1989, pp. 29-36.

Schwenk, Albert E., "Measuring Trends in the Structure and Levels of Employer Costs for Employee Compensation," *Compensation and Working Conditions*, Summer 1997, pp. 3-13.

Schwenk, Albert E., "Introducing new weights for the Employment Cost Index," *Monthly Labor Review*, June 1985, pp. 22-27.

Schwenk, Albert E., "Introducing 1990 Weights for the Employment Cost Index," *Compensation and Working Conditions*, June 1995, pp. 1-5.

Sheifer, Victor, "Employment Cost Index: a measure of change in the 'price of labor'." *Monthly Labor Review*, July 1975, pp. 3-12.

Wood, G. Donald, "Estimation Procedures for the Employment Cost Index," *Monthly Labor Review*, May 1982, pp. 40-42.

U.S. Department of Labor, Bureau of Labor Statistics, "Employment Cost Index," Chapter 8 in *Handbook of Methods*, Bulletin 2414, 1992.

U.S. Department of Labor, Bureau of Labor Statistics, *BLS Measures of Compensation*, Bulletin 2239, 1986.

Title: P1T1
Creator: TPL-Tables
CreationDate: Fri Jul 11 14:13:16

Title: P1T1
Creator: TPL-Tables
CreationDate: Thu Jul 31 15:05:0

Title: P2T2
Creator: TPL-Tables
CreationDate: Wed May 21 09:13:2

Title: P1T1
Creator: TPL-Tables
CreationDate: Wed May 21 09:13:3