Analyzing Year-to-Year Changes in Employer Costs for Employee Compensation

BLS recently completed research on the significance of differences in the year-to-year change in employer costs for employee compensation among compensation components, occupational groups, and industries. It also looked at the significance of those differences as compared to change measured by the Employment Cost Index.

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The Employer Costs for Employee Compensation (ECEC) Survey provides estimates of pay and benefits costs levels, whereas the Employment Cost Index (ECI) measures the rate of change in employee compensation. Recent studies have addressed why measured changes in ECEC estimates, published annually, frequently differ from ECI changes, published quarterly, but until now, measures of the statistical significance of year-to-year changes in ECEC estimates were unavailable.

Derived from the ECI data source, ECEC cost level estimates reflect current employment distributions. This contrasts with the ECI, a Laspeyres, fixed-weight index, that eliminates the effects of employment shifts over time among major occupational groups and industries. For the 10-year period ending in March 1996, total compensation increased by 30.3 percent as measured by change in the ECEC and 40.5 percent as measured by the ECI.

To help explain this difference, the BLS Statistical Methods Group calculated standard errors[1] on estimates of year-to-year change in the ECEC costs-per-hour-worked of the components of compensation for private industry workers, by selected industrial divisions and occupational groups. With the use of these data, it is now possible to analyze differences among published change estimates and how they compare to annual changes in the ECI.

The results, as summarized in table 1, indicate that differing levels of change among industrial and occupational groups in the ECEC from March 1995 to March 1996 usually were not statistically significant.[2] Over the long term, however, differences were significant. This pattern held for compensation components, selected industries, and occupational groups.

Methodology

The method used for computing the standard errors for the 12-month percent change in the ECI and the ECEC cost levels is called "balanced-repeated replication." This approach allows the covariance term due to the overlap in samples to be efficiently incorporated.

Table 1. Tests of significance, comparisons using year-to-year change in the ECEC

Data comparison	Level of significance			
	1995-96 change		1987-96 change	
	0.05	0.1	0.05	0.1
ECEC components of compensation Wages compared to benefits[1]	NO	YES	YES	YES
ECEC occupational groups White collar compared to blue collar[2]	NO	NO	YES	YES
ECEC industry divisions Goods producing compared to service producing[2]	NO	NO	YES	YES
ECEC compensation compared to ECI compensation[1]	NO	NO	YES	YES

[1] For this comparison, the balanced-repeated replication method was used to compute the standard error of the 1995-96 change, and the square root of the sum of two variance estimates for the 1987-96 change.

[2] For this comparison, the square root of the sum of two variance estimates was used to compute standard errors for both the 1995-96 change and the 1987-96 change.

The first step of the process is to collapse sampling strata into a number of variance strata. This is followed by dividing each industry sample in every variance stratum into half-samples.

Data from one half-sample from each stratum, instead of data from both half-samples, are then used to calculate replicate samples for each estimate. For ECEC levels data, there is replication of estimates 64 times. Each of the 64 replicates has a different combination of half samples. The standard error is then calculated by taking the square root of the average variance for the 64 replicates.

The standard error for ECEC year-to-year change is computed similarly. After calculating replicate samples for each year's estimates, the 64 prior-year replicates are subtracted from the 64 current-year replicates to yield 64 year-to-year change replicates. Then, the standard error of the year-to-year change is calculated by taking the square root of the average variance for the 64 change replicates.

The formula used for estimating the variances, VAR ($\hat{X}$), and in turn the standard error 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 ith half-sample change in level estimate for the same characteristic.

The formula used for estimating the variances, and in turn the standard error 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 ith balanced half-sample.

Trends in components of compensation

Table 2 shows ECEC year-to-year cost changes in private industry total compensation, wages and salaries, and benefits, and associated standard errors. Between March 1995 and March 1996, as summarized in table 3, total compensation increased $0.40, with a standard error of $0.09, to a level of $17.49.

Note that using table 2, the 1996 level estimate of $17.49 minus the 1995 level estimate of $17.10 yields $0.39. Due to the way each estimated replicate is subtracted, several rounding differences of $0.01 occur in the estimates.

Table 3 also summarizes the 95-percent confidence intervals which aid in determining statistical significance. These data can be used to determine if wage and salary costs increased faster than benefit costs. The 95-percent confidence interval for wages and salaries does not overlap with the 95-percent confidence interval for benefits, thus the higher increase in wage cost levels is statistically significant.

Along with the level data in table 3 is a summary of the percent change data. The percent change is calculated using the replicates by dividing the current year level estimate by the prior year estimate and then subtracting one. Table 3 shows that the percent change translates into overlapping the 95-percent confidence intervals for both wages and salaries and for benefits. Thus, the difference between the percent increases is not statistically significant with 95 percent confidence. It is necessary to determine at what confidence level the differences are statistically significant. The following calculations demonstrate that the differences are statistically significant at the 0.1 level.

To compute the 95-percent statistical significance:

Cumulative normal distribution value, d = 1.96

variance = standard deviation squared

Table 2. Trends in compensation for private industry workers, measured by changes in Employer Costs for Employee Compensation and the Employment Cost Index, March 1986-96

Survey and compensation component	Year ending March									
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
ECEC										
Total compensation:										
Cost level	$13.42	$13.79	$14.28	$14.96	$15.40	$16.14	$16.70	$17.08	$17.10	$17.49
12-month dollar change	.18	.36	.48	.69	.43	.73	.56	.38	.02	.40
Standard error	.21	.14	.08	.11	.09	.12	.09	.08	.14	.09
12-month percent change	1.3	2.7	3.5	4.8	2.9	4.8	3.5	2.3	.1	2.3
Standard error	1.6	1.1	.6	.8	.6	.8	.5	.5	.8	.5
Wages and salaries:										
Cost level	$9.83	$10.02	$10.38	$10.84	$11.14	$11.58	$11.90	$12.14	$12.25	$12.58
12-month dollar change	.16	.19	.35	.47	.29	.45	.32	.24	.11	.34
Standard error	.16	.11	.06	.08	.06	.08	.07	.06	.10	.07
12-month percent change	1.7	2.0	3.5	4.5	2.7	4.0	2.7	2.0	.9	2.8
Standard error	1.7	1.2	.6	.8	.6	.7	.6	.5	.8	.6
Benefits:										
Cost level	$3.60	$3.77	$3.90	$4.13	$4.27	$4.55	$4.80	$4.94	$4.85	$4.91
12-month dollar change	.01	.17	.13	.23	.14	.29	.25	.14	-.09	.06
Standard error	.06	.04	.03	.04	.03	.04	.03	.03	.05	.03
12-month percent change	.4	4.8	3.5	5.8	3.3	6.7	5.4	3.0	-1.9	1.3
Standard error	1.6	1.0	.7	1.0	.8	1.0	.6	.6	.9	.6
ECI										
Total compensation:										
Index level	91.0	94.5	98.8	103.9	108.5	113.1	117.1	121.0	124.5	127.9
12-month percent change	3.2	3.8	4.6	5.2	4.4	4.2	3.5	3.3	2.9	2.7
Standard error	.3	.2	.3	.2	.2	.2	.3	.2	.2	.3
Wages and salaries:										
Index level	92.0	95.0	99.0	103.2	107.3	110.9	113.9	117.2	120.6	124.4
12-month percent change	3.1	3.3	4.2	4.2	4.0	3.4	2.7	2.9	2.9	3.2
Standard error	.4	.2	.4	.3	.2	.3	.3	.2	.3	.4
Benefits:										
Index level	88.2	93.4	98.4	105.5	111.6	118.6	125.2	130.7	134.5	136.6
12-month percent change	2.8	5.9	5.4	7.2	5.8	6.3	5.6	4.4	2.9	1.6
Standard error	.3	.3	.2	.3	.4	.2	.3	.3	.4	.3

NOTE: Cost levels are in current dollars. Index levels and change unadjusted for seasonality, and reflect a base of June 1989=100. Several rounding differences of $0.01 exist among the dollar changes as a result of the estimation method used.

Table 3. ECEC changes in total compensation, wages and salaries, and benefits, private industry workers, year ending March 1996

Compensation component	Level change				Percent change			
	1995-96 change	Standard error	95-percent confidence interval		1995-96 change	Standard error	95-percent confidence interval	
			Lower	Upper			Lower	Upper
Total compensation	0.40	0.09	0.23	0.57	2.3	0.5	1.3	3.3
Wages and salaries	.34	.07	.21	.47	2.8	.6	1.6	3.9
Benefits	.06	.03	.00	.12	1.3	.6	.1	2.5

If |x-y| > 1.96*(standard deviation of x-y) then statement is valid,

x_i = 2.8; SE = 0.6; variance of x = 0.6*0.6 = 0.36

y_i = 1.3; SE = 0.6; variance of y = 0.6*0.6 = 0.36

standard deviation of x-y = 0.8485

|x-y| > 1.96*(standard deviation of x-y)

2.8–1.3 > 1.96*(0.8485)

1.5 > 1.663

Therefore, the statement that the percentage increase in wage cost levels is greater than that of benefits is *not* valid at the .05 level of significance.

However, at the 90-percent confidence level, d-value is 1.645

|x-y| > 1.645*(standard deviation of x-y)

2.8–1.3 > 1.645*(0.8485)

1.5 > 1.396

Therefore, the statement is valid at the 0.1 level of significance.

In percentage terms, from March 1995 to March 1996, total compensation grew 2.3 percent, with a standard error of 0.5 percent. During the same period, wages and salaries increased 2.8 percent and benefits 1.3 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.

These results differ from similar comparisons for the 10-year period ending in March 1996, as summarized in table 4. For comparisons which are more than 5 years apart, there is no overlap in the samples. Thus, the balanced-repeated replication method of variance estimation is not required. In other words, the covariance term in the formula for the variance of the difference of estimates, at least 5 years 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.[3]

The 10-year change, for the period ending in March 1996, in total compensation was $4.07 with a standard error of $0.23. For benefits, the 10-year change was $1.31, with a standard error of $0.08; for wages and salaries, the change was $2.75, with a standard error of $0.16. 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 5 shows ECEC year-to-year percentage change among specific benefit categories and corresponding standard error. Year-to-year change in health insurance was significantly higher than life insurance from 1991 to 1994. There was no significant difference, however, between life and health insurance for the years ending March 1995 and 1996.

Trends among industry divisions and occupational groups

Table 6 shows ECEC year-to-year changes in employer costs-per-hour-worked for employee compensation and corresponding standard error by major industrial division and major occupational group. Table 7 shows that the March 1995-96 change in total compensation costs for the individual goods-producing divisions ranged numerically from $0.21 to $0.89. The corresponding changes in the service-producing divisions ranged numerically from $0.22 to $1.20.

The 95-percent confidence interval for each estimate is calculated as follows:

$$x_i \pm d_k \sqrt{\sigma^2_{x_i}}$$

where, i = 1, ..., k

$\sigma^2_{x_i}$ = variance of x_i

d_k = 1.96 when comparing two estimates, i.e., k = 2

d_k = multiplication factor which is provided in the table below for values of k from 3 to 20.[4]

k	d_k
3	2.39
4	2.50
5	2.58
6	2.64
7	2.69
8	2.73
9	2.77
10	2.81
11	2.84
12	2.87
13	2.89
14	2.91
15	2.94
16	2.96
17	2.97
18	2.99
19	3.01
20	3.02

Although there is a large numeric range among the individual industrial divisions, no meaningful statistical conclusions about these differences can be drawn, even at the 0.1 level of significance. Likewise, white-collar, blue-collar, and service occupational groups show cost level changes for

Table 4. ECEC changes in total compensation, wages and salaries, and benefits, private industry, 10 years ending March 1996

Compensation component	Level change				Percent change			
	1987-96 change	Standard error	95-percent confidence interval		1987-96 change	Standard error	95-percent confidence interval	
			Lower	Upper			Lower	Upper
Total compensation	4.07	0.23	3.62	4.52	30.3	1.9	26.5	34.0
Wages and salaries	2.75	.16	2.43	3.07	28.0	1.9	24.2	31.7
Benefits	1.31	.08	1.16	1.46	36.5	2.4	31.9	41.1

Table 5. Estimates of year-to-year percent change in employer costs-per-hour-worked for employee benefits, private industry, and corresponding standard errors, 1986-96

Paid benefit	1986-87		1987-88		1988-89		1989-90		1990-91	
	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error
Leave	0.5	2.8	4.4	1.3	3.2	0.9	2.4	1.2	2.3	1.2
Vacation	1.4	3.3	4.0	1.2	3.1	1.1	2.3	1.3	2.0	1.3
Holiday	-1.9	2.7	4.1	1.3	3.0	1.0	2.0	1.2	2.6	1.2
Sick leave	2.3	3.8	5.1	2.0	2.8	1.6	1.8	2.2	2.7	1.6
Other leave	6.7	5.7	10.7	3.5	5.9	4.3	8.8	3.0	3.3	3.2
Supplemental pay	5.7	2.0	3.7	2.5	2.9	2.0	9.6	4.0	-3.5	3.1
Premium pay	-1.0	2.2	5.8	1.9	2.1	2.0	-3.6	2.6	4.2	1.7
Shift pay	-3.8	5.8	10.1	4.2	14.3	4.5	-3.5	3.4	7.3	2.2
Nonproduction bonuses	20.7	5.9	-1.3	5.8	-.1	4.2	34.8	10.8	-15.0	6.3
Insurance[1]	-1.6	1.9	7.9	1.3	9.4	1.2	8.0	1.4	9.3	1.3
Life	–	–	–	–	–	–	–	–	–	–
Health	–	–	–	–	–	–	–	–	–	–
Sickness and accident[2]	–	–	–	–	–	–	–	–	–	–
Retirement and savings	-4.1	2.9	-6.1	2.2	-6.3	1.5	7.0	2.5	-2.1	1.9
Pensions[3]	-4.7	2.9	-8.9	2.4	-10.6	1.6	5.6	3.1	-3.8	2.0
Savings and thrift[3]	.2	9.4	12.8	3.9	17.7	3.0	12.4	5.4	4.4	3.6
Legally required benefits[4]	2.2	1.1	7.7	.8	4.0	.6	6.1	.7	3.7	.5
Social Security	1.4	1.3	7.8	.8	3.9	.5	6.4	.7	3.4	.5
Federal unemployment insurance	5.0	1.2	7.1	1.2	-6.3	.9	.8	.6	-.2	.9

Paid benefit	1991-92		1992-93		1993-94		1994-95		1995-96	
	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error
Leave	4.2	1.4	1.0	0.8	0.4	0.9	-1.6	1.4	2.2	0.7
Vacation	3.0	1.9	.6	.9	.6	.8	-1.2	1.7	3.0	1.1
Holiday	4.5	1.2	2.3	.8	.6	1.0	-1.4	1.3	1.3	.6
Sick leave	6.4	1.9	1.1	1.8	-1.6	1.3	-2.3	1.9	.7	1.3
Other leave	8.8	4.6	-2.9	2.0	1.0	2.9	-6.4	2.7	6.2	3.0
Supplemental pay	8.8	2.6	9.6	1.7	4.2	2.1	6.4	3.6	4.8	2.6
Premium pay	4.7	2.0	1.9	1.3	1.2	1.4	.4	2.8	5.0	1.7
Shift pay	3.3	2.4	2.1	4.4	6.3	3.6	-1.4	3.7	1.9	2.8
Nonproduction bonuses	16.3	6.4	21.2	4.2	6.7	5.0	14.1	7.8	5.3	4.9
Insurance[1]	10.9	1.5	7.1	1.0	3.1	1.0	-6.6	1.2	-1.2	.8
Life	2.4	2.1	.8	1.6	-3.0	1.3	-4.4	1.7	.1	1.6
Health	11.4	1.5	7.4	1.0	3.7	1.0	-6.6	1.3	-2.3	.9
Sickness and accident[2]	9.0	3.3	6.9	1.8	-3.0	2.9	-7.6	2.5	–	–
Retirement and savings	4.6	3.4	5.0	2.0	6.8	1.8	-.4	2.1	5.9	1.9
Pensions[3]	5.4	4.1	4.5	2.7	7.4	2.0	–	–	–	–
Savings and thrift[3]	1.4	5.2	7.0	2.7	4.5	2.4	–	–	–	–
Legally required benefits[4]	5.4	.7	5.1	.5	3.3	.6	-.5	.7	.0	.6
Social Security	4.1	.6	2.9	.5	2.6	.5	1.0	.6	-17.9	.3
Federal unemployment insurance	3.9	1.2	-3.0	1.2	.2	.6	1.2	.6	-5.0	.6

See footnotes at end of table.

Table 5. Estimates of year-to-year percent change in employer costs-per-hour-worked for employee benefits, private industry, and corresponding standard errors, 1986-96 — Continued

Paid benefit	1986-87		1987-88		1988-89		1989-90		1990-91	
	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error
Legally required benefits[4]										
State unemployment insurance	-4.2	1.8	-2.9	1.5	-5.5	1.6	-13.8	1.8	-2.7	1.8
Workers' compensation	9.6	2.5	13.7	2.2	11.6	2.0	14.7	2.1	6.6	1.7
Other benefits[5]	-4.8	6.6	19.8	6.2	-15.0	5.4	-25.7	8.3	4.2	5.5
	1991-92		1992-93		1993-94		1994-95		1995-96	
	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error	Percent change	Standard error
Legally required benefits[4]										
State unemployment insurance	8.6	2.0	15.5	1.4	9.5	1.4	-3.1	1.7	-3.4	1.4
Workers' compensation	9.2	2.5	9.3	1.7	4.0	2.0	-3.3	1.8	.7	1.6
Other benefits[5]	40.1	8.7	103.8	36.0	-3.2	8.5	-26.4	15.6	-7.9	6.5

1 Individual insurance benefit cost estimates were first published for 1991 data.
2 Until 1996, long-term disability insurance was included in the category of sickness and accident insurance.
3 Discontinued in 1994. The pension and savings and thrift categories were replaced by defined benefit and defined contribution plans categories beginning in 1995. Although these old and new categories are not comparable with each other, the overall category of retirement and savings is comparable.
4 Prior to 1996, railroad retirement and unemployment insurance benefits were included with the legally required benefits category. Since then, railroad benefit costs have been reclassified into the benefits that match their intended purpose (Social Security, retirement and savings, sickness and accident insurance, and state unemployment insurance).
5 Includes severance pay and supplemental unemployment benefits.
NOTE: Cost levels change and standard error are percentages. Dashes indicate data unavailable.

total compensation that ranged numerically from -$0.01 to $1.00. (See table 8.) Again, there are no significant differences among the individual occupational groups.

Furthermore, for March 1995-96, broader comparisons[5] of the overall goods-producing sector with the service-producing sector yielded similar results, as did comparisons of white-collar, blue-collar, and service occupational groups.

For the year ending March 1996, total compensation costs in the goods-producing sector increased $0.52 with a standard error of $0.57, while the service-producing sector cost levels increased $0.40 with a standard error of $0.25. The aggregate white-collar, blue-collar, and service occupational groups increased $0.60, $0.35 and $0.21, respectively, with standard errors of $0.40, $0.32, and $0.09, respectively. None of these differences between aggregate industries or aggregate occupational groups were statistically significant, even at the 0.1 level of significance.

However, over a 10-year period, as shown in tables 9 and 10, such comparisons do yield differences that are statistically significant. Total compensation costs for the goods-producing sector grew $5.41 for the 10-year period ending in March 1996, while the service-producing sector cost levels increased $3.87, with standard errors of $0.49 and $0.25, respectively. For the same period, total compensation costs for white-collar workers increased $5.54, while that of blue-collar workers increased $3.61 and that of service workers increased $2.18, with standard errors of, $0.39, $0.28 and $0.14, respectively. At the .05 level of significance, the increase in compensation for goods-producing industrial divisions was significantly larger than for the service-producing divisions. As ascertained by a multiple comparisons test, the increase for white-collar workers was larger than the increase for blue-collar workers, which in turn was larger than the increase for service workers.

ECEC trends compared to the ECI

Table 11 shows that, over the period March 1987-96, private industry

Table 6. Estimates of year-to-year change in employer costs-per-hour-worked for employee compensation by industry division and occupational group, private industry, and corresponding standard errors, 1986-96

Industry division and occupational group	1986-87		1987-88		1988-89		1989-90		1990-91	
	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error
All private industry	$0.18	$0.21	$0.36	$0.14	$0.48	$0.08	$0.69	$0.11	$0.43	$0.09
Goods-producing industries										
Construction	.86	.19	-.15	1.10	.48	.23	.74	.26	.90	.30
Manufacturing										
Durables	.20	.08	.70	.11	.98	.30	.13	.46	1.04	.13
Nondurables	.25	.16	.83	.08	.78	.05	.50	.70	.76	.12
Service-producing industries										
Transportation and public utilities	.37	.20	.26	.38	-.30	.61	1.28	.20	.61	.31
Wholesale trade	-.25	.76	.58	.16	.78	.21	.99	.29	-.41	.85
Retail trade	.03	.11	.16	.17	.10	.16	.42	.06	.28	.05
Finance, insurance, and real estate	1.16	.62	-.49	1.26	1.12	.15	.91	.16	1.00	.26
Services	.10	.67	.62	.12	.46	.11	.98	.19	.26	.22
White-collar occupations										
Professional and technical	.11	.73	1.04	.24	.94	.25	1.47	.35	.52	.34
Executive, administrative, and managerial	1.60	.70	-.09	.68	1.49	.33	1.39	.58	1.53	.52
Sales	-.59	.47	-.20	.36	.52	.22	.75	.26	.75	.31
Administrative support	.64	.26	.58	.08	.50	.10	.60	.10	.54	.12

Industry division and occupational group	1991-92		1992-93		1993-94		1994-95		1995-96	
	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error
All private industry	$0.73	$0.12	$0.56	$0.09	$0.38	$0.08	$0.02	$0.14	$0.40	$0.09
Goods-producing industries										
Construction	.57	1.00	.80	.21	.88	.22	.44	.29	.56	.26
Manufacturing										
Durables	1.18	.12	1.11	.18	.59	.11	-.18	.63	.21	.22
Nondurables	.75	.14	.65	.14	.67	.14	-.43	.86	.89	.34
Service-producing industries										
Transportation and public utilities	.83	.36	1.16	.20	.51	.21	-1.33	.58	.98	.30
Wholesale trade	.59	.18	.45	.21	.30	.16	.19	.85	.44	.22
Retail trade	.26	.08	.21	.09	-.10	.17	.14	.13	.22	.09
Finance, insurance, and real estate	.92	.26	.31	.76	.76	.51	.37	.27	1.20	.20
Services	.89	.32	.75	.18	.45	.15	.13	.16	.27	.21
White-collar occupations										
Professional and technical	1.41	.68	1.93	.42	.53	.20	.53	.42	1.00	.49
Executive, administrative, and managerial	1.27	.85	1.02	.49	.69	.62	1.30	.72	.70	.48
Sales	.37	.17	.05	.16	.50	.24	-.19	.31	.71	.17
Administrative support	.52	.24	.45	.10	.51	.14	-.01	.14	.28	.12

See footnotes at end of table.

Table 6. Estimates of year-to-year change in employer costs-per-hour-worked for employee compensation by industry division and occupational group, private industry, and corresponding standard errors, 1986-96 — Continued

Industry division and occupational group	1986-87		1987-88		1988-89		1989-90		1990-91	
	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error
Blue-collar occupations										
Precision production, craft, and repair	$0.19	$0.30	$0.48	$0.40	$0.37	$0.18	$0.65	$0.23	$0.90	$0.20
Machine operators, assemblers, and inspectors	.72	.15	.51	.08	.63	.18	-.09	.31	.75	.17
Transportation and material movement	.15	.38	.57	.20	.66	.42	.35	.35	.15	.39
Handlers, equipment cleaners, helpers, and laborers	-.88	.21	.33	.24	.37	.19	.10	.20	.33	.15
Service occupations	-.16	.21	.33	.07	.40	.11	.49	.10	.16	.10

Industry division and occupational group	1991-92		1992-93		1993-94		1994-95		1995-96	
	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error	Change	Standard error
Blue-collar occupations										
Precision production, craft, and repair	$1.05	$0.38	$0.75	$0.18	$0.69	$0.21	$-0.04	$0.29	$0.42	$0.21
Machine operators, assemblers, and inspectors	.74	.18	.52	.13	.54	.16	-.82	.38	.26	.25
Transportation and material movement	.58	.33	.25	.17	.68	.37	-.11	.48	-.01	.28
Handlers, equipment cleaners, helpers, and laborers	.46	.24	.38	.11	.18	.16	-.34	.30	.45	.15
Service occupations	.62	.12	.11	.09	-.16	.14	.01	.07	.21	.08

NOTE: Cost change and standard error are in current dollars.

Table 7. ECEC changes in total compensation, by private industry division, year ending March 1996 - multiple comparison (k=8, d=2.73)

Division	Current dollars			
	1995-96 change	Standard error	95-percent confidence interval	
			Lower	Upper
Goods producing	0.52	0.57	-0.59	1.63
Construction	.56	.26	- .16	1.28
Durable manufacturing	.21	.22	- .40	.82
Nondurable manufacturing	.89	.34	- .03	1.81
Service producing	.40	.25	- .09	.89
Transportation and public utilities	.98	.30	.16	1.80
Wholesale trade	.44	.22	- .17	1.05
Retail trade	.22	.09	- .04	.48
Finance, insurance, and real estate	1.20	.20	.65	1.75
Services	.27	.21	- .30	.84

Table 8. ECEC changes in total compensation, by private industry occupational group, year ending March 1996 - multiple comparison (k=9, d=2.77)

Occupational group	Current dollars: 1995-96 change	Standard error	95-percent confidence interval: Lower	Upper
White collar	0.60	0.40	-0.18	1.38
Professional and technical	1.00	.49	- .37	2.37
Executive, administrative and managerial	.70	.48	- .64	2.04
Sales	.71	.17	.25	1.17
Administrative support	.28	.12	- .05	.61
Blue collar	.35	.32	- .28	.98
Precision production, craft, and repair	.42	.21	- .16	1.00
Machine operators, assemblers, and inspectors	.26	.25	- .44	.96
Transportation and material movement	- .01	.28	- .77	.75
Handlers, equipment cleaners, helpers, and laborers	.45	.15	.03	.87
Service occupations	.21	.09	- .03	.45

employer compensation costs rose 40.5 percent as measured by the ECI and 30.3 percent as measured by the change in ECEC 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 the ECEC, 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 percent for wages and salaries, and 4.5 for 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. As table 11 shows, the differences in percent change for the 10-year period between the ECI and the ECEC for compensation, wages and salaries, and benefits were all significant at the .05 level of significance.

Table 2 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 the corresponding standard errors. Although differences between the ECI and ECEC are significant over the long term, they are not significant over the 12-month period, March 1995-96. (See table 12.) For example, ECEC compensation costs increased 2.3 percent over the period with a standard error on the difference of 0.5 percent. The ECI 12-month percent change for the same period was 2.7 percent with a standard error on the difference of 0.3 percent.

Various factors have been suggested to explain the 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 two 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 20 percent of the sample is replaced each year, a number 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[6] analyzed differences in the two main steps involved 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 (mean), yields different estimates for ECI and ECEC, mostly 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. In another paper, Lettau and Lowenstein[7] concluded 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 Current Employment Statistics Survey weights. By isolating the two steps in the process, Lettau, Lowenstein, and Cushner 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 measure, the ECEC or the ECI, is appropriate for determining the rate of change must be determined by the needs of the user. If a user prefers a measure of change that maintains fixed employment distribution by industry and occupation group, the ECI provides an appropriate measure. Conversely, if the user wants the survey that measures 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 applies the ECEC approach for step 1 and the ECI approach for step 2.

Table 9. ECEC changes in total compensation, by private industry division, 10 years ending March 1996 - multiple comparison (k=8, d=2.73)

Division	Current dollars			
	1987-96 change	Standard error	95-percent confidence interval	
			Lower	Upper
Goods producing	5.41	0.49	4.45	6.37
Construction	5.22	1.11	2.20	8.24
Durable manufacturing	5.75	.66	3.95	7.57
Nondurable manufacturing	5.16	.98	2.45	7.83
Service producing	3.87	.25	3.38	4.36
Transportation and public utilities	3.98	.70	2.07	5.89
Wholesale trade	3.89	.82	1.65	6.13
Retail trade	1.69	.24	1.03	2.35
Finance, insurance, and real estate	6.10	.56	4.56	7.64
Services	4.84	.38	3.80	5.88

Table 10. ECEC changes in total compensation, by private industry occupational group, 10 years ending March 1996 - multiple comparison (k=9, d=2.77)

Occupational group	Current dollars			
	1987-96 change	Standard error	95-percent confidence interval	
			Lower	Upper
White collar	5.54	0.39	4.78	6.30
Professional and technical	9.38	.78	7.23	11.53
Executive, administrative and managerial	9.31	1.08	6.33	12.29
Sales	3.27	.34	2.32	4.22
Administrative support	3.99	.25	3.29	4.69
Blue collar	3.61	.28	3.06	4.16
Precision production, craft, and repair	5.27	.48	3.93	6.61
Machine operators, assemblers, and inspectors	3.04	.42	1.87	4.21
Transportation and material movement	3.13	.64	1.37	4.89
Handlers, equipment cleaners, helpers, and laborers	2.26	.43	1.07	3.45
Service occupations	2.18	.14	1.79	2.57

Table 11. ECEC/ECI changes in total compensation, wages and salaries, and benefits, private industry, 10 years ending March 1996

Compensation component	Percent change					
	ECI		ECEC		ECI-ECEC	
	Change 1987-96	Standard error	Change 1987-96	Standard error	Change 1987-96	Standard error
Total compensation	40.5	2.2	30.3	1.9	10.2	2.9
Wages and salaries	35.2	2.9	28.0	1.9	7.2	3.5
Benefits	54.9	2.2	36.5	2.4	18.5	3.2

Table 12. ECEC/ECI changes in total compensation, wages and salaries, and benefits, private industry, year ending March 1996

Compensation component	Percent change					
	ECI		ECEC		ECI-ECEC	
	Change 1995-96	Standard error	Change 1995-96	Standard error	Change 1995-96	Standard error
Total compensation	2.7	0.3	2.3	0.5	0.4	0.6
Wages and salaries	3.2	.4	2.8	.6	.5	.7
Benefits	1.6	.3	1.3	.6	.3	.7

Trends in the ECEC and the ECI

This article supplements two articles from the Summer 1997 issue of *Compensation and Working Conditions* which focused on trends in the ECI and ECEC. "Measuring Trends in the Structure and Levels for Employer Costs for Employee Compensation," by Albert E. Schwenk, discussed trends in the distribution of employer costs among compensation components at different points in time. "Explaining the Differential Growth Rates of the ECI and the ECEC," by Michael K. Lettau, Mark A. Loewenstein, and Aaron T. Cushner, examined how differences in the construction of these measures contribute to differing trends. This article adds another dimension to the discussion, by explaining how to use newly-published standard error data to analyze differences in year-to-year changes.

For a more complete discussion of the scope of and the methods used in the ECI and ECEC series, see *BLS Handbook of Methods*, Bulletin 2490, Bureau of Labor Statistics, April 1997, pp. 57-65; G. Donald Wood, Jr., "Estimation Procedures for the Employment Cost Index," *Monthly Labor Review*, May 1982, pp. 40-42; and Karen O'Conor and William Wong, "Measuring the Precision of the Employment Cost Index," *Monthly Labor Review*, March 1989, pp. 29-36.

—ENDNOTES—

[1] The standard error is a measure of the precision of the estimate. A 95-percent confidence interval is centered around a sample estimate and includes all values within 2 times the estimate's standard error. If all possible samples were selected to estimate the population value, the confidence interval from each sample would include the true population value approximately 95 percent of the time. See Albert E. Schwenk, "Measuring Trends in the Structure and Levels of Employer Costs for Employee Compensation," Appendix, "Measuring the Precision of Cost Level Changes," *Compensation and Working Conditions*, Summer 1997, p. 14.

[2] Statistical statements may be evaluated using different significance levels, otherwise known as alpha levels. The .05 alpha level corresponds to the 95-percent confidence interval, the level usually used to measure the precision of an estimate.

[3] To compute standard errors using this approach, relative errors, published in the bulletin *Employment Cost Indexes and Levels, 1975-1995*, were used. Relative error is the standard error expressed as a percent of a cost level estimate.

[4] These multiplication factors are used to compare, for example, an occupational group (or industry) to an occupational group comprised of two or more other occupational groups. Such multiple comparisons involve using a higher cumulative normal distribution d-value to determine the confidence interval. For a more complete discussion of testing various types of statistical statements, see Lawrence R. Ernst and Chester H. Ponikowski, "Statistical Review of Press Releases and Bulletins," Internal Memorandum, Statistical Methods Group, Bureau of Labor Statistics, December 1996.

[5] For these aggregate categories, it was necessary to compute the standard error as the square root of the sum of the variance estimates of the cost levels. This approach, which tends to overestimate the standard error because it does not subtract the effect of the covariance term, had to be used because of resource limitations.

[6] See Michael K. Lettau, 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.

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