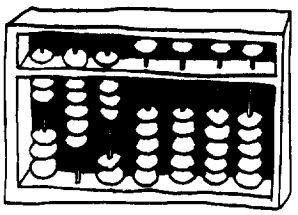

Technical notes

Measuring the precision of the Employment Cost Index

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The Employment Cost Index (ECI) is a quarterly measure of the rate of change in employer costs for employee compensation per hour worked. Since 1986, measures of the reliability (standard errors) of the ECI have been calculated to assist users in evaluating the precision of estimates and to improve the efficiency of the sample design. Beginning with the 1988 annual bulletin on the ECI, standard errors will be published yearly for measures of the annual change in the ECI and its subseries.

This report presents examples of the standard error tabulations that will be published. The tables provide estimates of the percent changes and corresponding standard errors for 12-month periods ending September 1987, December 1987, March 1988, and June 1988.

For the June 1988 tabulations, more than nine-tenths of the standard errors are less than 0.7 percent. Only nine of the measures are over 1 percent. These are in the series for sales occupations, wholesale trade, and finance, insurance, and real estate. The data for sales occupations reflect the volatility of commission earnings, which account for a large percentage of the standard error for those industries in which salesworkers on commission are concentrated.

An overview of the ECI. The Employment Cost Index measures the rate of change in employers' cost for employee compensation, free from the influence of employment shifts among occupations and industries. The cost of compensation has two components: wages and salaries, and employee benefits.

Wages and salaries are defined as the straight-time hourly wage rate or, for workers not paid on an hourly basis, straight-time earnings or salaries divided by the corresponding number of scheduled hours. Straight-time wages and salaries (or earnings) are the total before payroll deductions, and include production bonuses, incentive earnings, commission payments, and cost-of-living adjustments. Excluded from wages and salaries, but included in benefit costs, are premium pay for overtime and for work on weekends, holidays, and late shifts.

Benefits covered by the ECI are: *paid leave* (vacations, holidays, sick leave, and other leave); *supplemental pay* (premium pay for overtime, shift differentials, nonproduction bonuses, and lump-sum payments provided in lieu of wage increases); *insurance benefits* (life, health, and sickness and accident coverage); *retirement and savings benefits* (employer contributions to pension and other retirement plans and savings and thrift plans); *legally required benefits* (employer contributions for Social Security, railroad retirement and supplemental retirement, railroad unemployment insurance, Federal and State unemployment insurance, workers' compensation, and other legally required benefits such as State temporary disability programs); and *other benefits* (severance pay and contributions to supplemental unemployment plans).

The ECI provides data for the civilian economy, excluding farms, households, and the Federal Government. Within the civilian economy, separate index series are provided for private industry and for State and local governments. Each quarter, the Bureau collects straight-time average hourly wage and salary rates and benefit cost data (cents-per-hour-worked) from a probability sample of about 18,000 occupations within approximately 3,600 establishments in private industry and about 3,300 occupations within approximately 700 establishments in State and local governments. The data are collected initially through personal interview and are updated every quarter by mail questionnaire or by telephone interview of an establishment representative.

Reliability of the estimates. Because the ECI compensation change measures are estimates for a probability sample, they are likely to differ from results that would be obtained from a complete census of the employees within

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Table 1. Twelve-month percent changes in the Employment Cost Index and associated standard errors, by occupation and industry group, September 1987 to June 1988

[Not seasonally adjusted]

Series	September 1987		December 1987		March 1988		June 1988	
	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error
Compensation								
Civilian workers	3.4	0.2	3.6	0.2	4.1	0.2	4.6	0.2
Workers, by occupational group:								
White-collar occupations	3.8	.2	3.9	.3	4.1	.2	4.6	.3
Blue-collar occupations	2.7	.2	3.2	.2	4.3	.2	4.7	.2
Service occupations	3.3	.4	3.1	.4	3.6	.3	4.2	.3
Workers, by industry division:								
Goods-producing[1]	2.6	.2	3.1	.2	4.3	.2	4.7	.2
Manufacturing	2.6	.2	3.1	.2	4.7	.2	5.0	.3
Service-producing[2]	3.8	.2	3.8	.2	4.0	.3	4.5	.3
Services	4.8	.3	4.9	.3	5.2	.4	5.5	.3
Health services	4.3	.6	4.4	.4	4.3	.4	5.1	.5
Hospitals	4.6	.4	4.8	.3	5.1	.3	5.7	.4
Public administration	4.1	.4	4.6	.4	4.3	.4	4.5	.6
Nonmanufacturing	3.7	.2	3.8	.2	3.9	.2	4.4	.3
Private industry workers	3.3	2	3.3	.2	3.9	.2	4.5	.2
Workers, by occupational group:								
White-collar occupations	3.7	.3	3.7	.3	3.7	.3	4.4	.4
Blue-collar occupations	2.7	.2	3.1	.2	4.4	.2	4.7	.2
Service occupations	2.7	.6	2.4	.5	2.9	.4	3.6	.3
Workers, by industry division:								
Goods-producing[1]	2.6	.2	3.1	.2	4.4	.2	4.8	.2
Service-producing[2]	3.8	.3	3.7	.4	3.6	.3	4.3	4
State and local government workers	4.2	.3	4.4	.3	4.9	.3	5.0	.3
Workers, by occupational group:								
White-collar occupations	4.3	.4	4.6	.4	5.2	.4	5.2	.3
Blue-collar occupations	3.5	.4	3.4	.4	3.6	.5	3.3	.6
Workers, by industry division:								
Services	4.3	.4	4.4	.4	5.4	.4	5.4	.4
Excluding schools[3]	4.1	.6	3.7	.4	5.5	.6	5.0	.4
Health services	4.4	.5	4.7	.5	5.0	.5	4.8	.6
Schools	4.4	.6	4.8	.5	5.3	.5	5.5	.5
Elementary and secondary	4.8	.6	5.0	.6	5.6	.6	5.8	.6
Public administration	4.1	.4	4.6	.4	4.3	.4	4.5	.6
Wages and salaries								
Civilian workers	3.4	.2	3.5	.2	3.5	.2	3.9	2
Workers, by occupational group:								
White-collar occupations	4.0	.3	3.9	.3	3.6	.3	4.2	3
Blue-collar occupations	2.6	.2	3.0	.3	3.3	.2	3.5	.2
Service occupations	3.3	.4	2.9	.4	2.8	.3	3.4	.3
Workers, by industry division:								
Goods-producing[1]	2.8	.2	3.1	.2	3.4	.2	3.8	.2
Manufacturing	2.8	.2	3.4	.2	3.6	.2	3.8	.3
Service-producing[2]	3.8	.3	3.7	.3	3.5	.2	4.0	.3
Services	4.9	.3	5.0	.3	4.8	.4	4.9	.3
Health services	4.7	.4	4.6	.3	4.0	.4	4.9	.6
Hospitals	4.9	.2	5.0	.2	4.8	.3	5.6	.5
Public administration	3.7	.4	4.1	.4	3.6	.4	3.8	.5
Nonmanufacturing	3.7	.2	3.6	.3	3.3	.3	3.9	.3
Private industry workers	3.3	.2	3.3	.3	3.3	.2	3.7	.3
Workers, by occupational group:								
White-collar occupations	3.8	.3	3.7	.4	3.3	.3	4.0	.4
Blue-collar occupations	2.6	.2	3.0	.3	3.4	.3	3.6	.2
Service occupations	2.9	.6	2.4	.6	2.4	.5	3.0	.3
Workers, by industry division:								
Goods-producing[1]	2.8	.2	3.2	.2	3.5	.2	3.8	.2
Service-producing[2]	3.7	.3	3.5	.4	3.1	.3	3.7	.4
State and local government workers	4.1	.3	4.2	.3	4.4	.3	4.4	.3
Workers, by occupational group:								
White-collar occupations	4.2	.4	4.6	.4	4.6	.4	4.6	.4
Blue-collar occupations	3.3	.4	3.3	.4	3.5	.3	3.1	.5
Workers, by industry division:								
Services	4.3	.4	4.3	.5	4.7	.4	4.8	.4
Excluding schools[3]	4.0	.8	3.6	.5	4.3	.4	3.8	.4
Health services	3.8	.6	4.4	.6	4.3	.5	4.3	.5
Schools	4.3	.5	4.6	.5	4.9	.5	5.1	.5
Elementary and secondary	4.3	.6	4.8	.6	5.1	.6	5.3	.6
Public administration	3.7	.4	4.1	.4	3.6	.4	3.8	.5

[1]Includes mining, construction, and manufacturing.

[2]Includes transportation; public utilities; trade, finance, insurance, and real estate; services; and, where applicable, public administration in State and local governments.

[3]Includes, for example, library, social, and health services, formerly called hospitals and other services.

the scope of the survey (the survey population). The difference between an estimate calculated from a specific sample and an average for all samples that could be drawn from the survey population using the same methodology for the same statistic is the sampling error.

When probability techniques are used to select a sample, as in the ECI, statistical measures of precision called "estimated standard errors" can be calculated. In turn, the estimates' standard errors can be used to construct "confidence intervals," which provide an indication of the reliability of the estimates. The lower bound of a confidence interval is constructed by subtracting a multiple of the standard error from the published estimate. The upper bound of a confidence interval is constructed by adding the same multiple of the standard error to the published estimate.

Confidence intervals have the following properties: Suppose that samples are repeatedly drawn from the same population. The data from each sample are used to compute a percentage change (the survey estimate) and its estimated standard error. The confidence intervals from one standard error below each sample's estimate to one standard error above would include the value being estimated for approximately 68 percent of the samples. That is, we could say with 68-percent confidence that the "true" value of a measurement, which could be obtained only from a complete census of the population, falls within ± one standard error of the sample estimate. Confidence rises to 95 percent if the intervals surrounding sample estimate are widened to ± two standard errors.

In table 1, the 12-month percentage change for total compensation for all civilian workers was 4.6 percent for the period ending June 1988. The estimated standard error for this change was 0.2 percent. Thus the 95-percent confidence interval for the true population change is 4.2 [= 4.6 − (2 x 0.2)] percent to 5.0 [= 4.6 + (2 x 0.2)] percent. Intervals for the other table entries can be calculated in a similar manner.

Total error, the difference between the survey estimate and the true value, is composed of two parts: sampling error and nonsampling error. Nonsampling errors can be traced to sources such as: inability to obtain information about all establishments in the sample; incomplete definitions of survey data elements; differences in the interpretation of questions among survey interviewers and survey respondents; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the

Table 2. Twelve-month percent changes in the Employment Cost Index and associated standard errors, private industry workers by occupation group, September 1987 to June 1988
[Not seasonally adjusted]

Series	September 1987		December 1987		March 1988		June 1988	
	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error
	Compensation							
Private industry workers	3.3	0.2	3.3	0.2	3.9	0.2	4.5	0.2
Excluding sales	3.4	.2	3.6	.2	4.2	.2	4.5	.2
Workers, by occupational group:								
White-collar occupations	3.7	.3	3.7	.3	3.7	.3	4.4	.4
Excluding sales	4.2	.2	4.2	.3	4.2	.3	4.6	.3
Professional specialty and technical	3.9	.4	4.1	.4	4.4	.5	5.0	.5
Executive, administrative, and managerial	4.8	.4	4.4	.5	3.5	.5	3.9	.6
Sales	1.5	1.0	1.2	1.2	1.5	.9	3.4	1.5
Administrative support, including clerical	3.9	.2	4.1	.3	4.9	.3	4.9	.3
Blue-collar occupations	2.7	.2	3.1	.2	4.4	.2	4.7	.2
Precision production, craft, and repair	2.8	.3	3.1	.4	4.1	.4	4.3	.3
Machine operators, assemblers, and inspectors	2.7	.3	3.4	.4	5.0	.4	5.2	.4
Transportation and material moving	2.6	.5	2.9	.5	4.0	.4	4.7	.6
Handlers, equipment cleaners, helpers, and laborers	2.2	.4	2.8	.4	4.6	.4	4.9	.4
Service occupations	2.7	.6	2.4	.5	2.9	.4	3.6	.3
	Wages and salaries							
Private industry workers	3.3	.2	3.3	.3	3.3	.2	3.7	.3
Excluding sales	3.5	.2	3.7	.2	3.6	.2	3.9	.2
Workers, by occupational group:								
White-collar occupations	3.8	.3	3.7	.4	3.3	.3	4.0	.4
Excluding sales	4.4	.3	4.3	.3	3.9	.3	4.2	.3
Professional specialty and technical	4.3	.5	4.5	.4	4.0	.5	4.8	.5
Executive, administrative, and managerial	4.7	.4	4.3	.6	3.2	.6	3.6	.7
Sales	1.4	1.3	1.0	1.5	.6	1.0	2.9	1.7
Administrative support, including clerical	4.1	.3	4.1	.3	4.4	.3	4.2	.2
Blue-collar occupations	2.6	.2	3.0	.3	3.4	.3	3.6	.2
Precision production, craft, and repair	2.8	.4	2.9	.4	3.3	.5	3.6	.3
Machine operators, assemblers, and inspectors	2.7	.4	3.4	.5	3.5	.4	3.6	.4
Transportation and material moving	2.1	.5	2.3	.5	2.7	.5	3.2	.6
Handlers, equipment cleaners, helpers, and laborers	2.3	.4	3.0	.5	3.9	.5	4.0	.3
Service occupations	2.9	.6	2.4	.6	2.4	.5	3.0	.3

data; and other errors of collection, response, processing, coverage, and estimation (for missing data). Unlike the calculation of sampling errors, the estimation of nonsampling errors requires either the reinterview of some of the survey respondents or the availability of independent corroborative data. Thus, nonsampling errors are difficult and costly to measure and are rarely calculated.

Through the use of a quality management program, computer checks of the data for omissions, inconsistencies, and questionable values, and professional review of both individual and summarized data, efforts are made to reduce the nonsampling errors in collecting, recording, coding, and processing the data. However, nonsampling errors are introduced into the survey estimates depending on the extent to which quality management programs are imperfect, and characteristics of sample units that do not

Table 3. Twelve-month percent changes in the Employment Cost Index and associated standard errors, private industry workers by industry group, September 1987 to June 1988

[Not seasonally adjusted]

Series	September 1987		December 1987		March 1988		June 1988	
	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error
	Compensation							
Workers, by industry division:								
Goods-producing[1]	2.6	0.2	3.1	0.2	4.4	0.2	4.8	0.2
Excluding sales occupations	2.6	2	3.1	.2	4.2	.2	4.8	.2
Construction	3.1	5	3.7	.5	4.0	.4	4.1	.5
Manufacturing	2.6	2	3.1	.2	4.7	.2	5.0	.3
Durables	2.3	3	2.7	.2	4.7	.2	5.0	.3
Nondurables	3.3	4	3.8	.3	4.5	.5	4.9	.5
Service-producing[2]	3.8	3	3.7	.4	3.6	.3	4.3	.4
Excluding sales occupations	4.2	3	4.0	.3	4.1	.3	4.4	.3
Transportation and public utilities	2.7	4	3.0	.3	3.2	.4	3.1	.3
Transportation	2.2	6	2.7	.5	3.2	.6	3.4	.5
Public utilities	3.4	3	3.3	.4	3.1	.3	2.6	.3
Wholesale and retail trade	3.3	5	3.0	.5	3.6	.4	4.0	.3
Excluding sales occupations	3.8	5	3.3	.4	3.7	.4	3.9	.4
Wholesale trade	4.3	8	4.0	1.0	3.6	.7	4.0	.8
Excluding sales occupations	3.9	6	3.7	.5	3.8	.5	4.3	.6
Retail trade	2.8	5	2.5	.5	3.5	.4	4.0	.3
Finance, insurance, and real estate	2.7	1.2	2.0	1.5	.6	1.5	3.1	2.5
Excluding sales occupations	4.5	7	4.1	1.2	3.3	1.3	3.8	1.6
Insurance	—	—	—	—	—	—	6.0	1.0
Services	5.2	.5	5.2	.5	5.2	.5	5.5	.4
Health services	4.3	7	4.3	.4	4.2	.5	5.3	.5
Hospitals	4.7	5	4.9	.3	5.1	.4	5.9	.6
Nonmanufacturing	3.6	.3	3.5	.3	3.6	.3	4.2	.3
	Wages and salaries							
Workers, by industry division:								
Goods-producing[1]	2.8	2	3.2	.2	3.5	.2	3.8	.2
Excluding sales occupations	2.7	2	3.2	.2	3.3	.2	3.8	.2
Construction	2.7	.6	3.2	.5	3.5	.4	4.0	.5
Manufacturing	2.8	.2	3.4	.2	3.6	.2	3.8	.3
Durables	2.6	.3	3.1	.3	3.4	.2	3.4	.2
Nondurables	3.3	.4	3.7	.4	3.9	.6	4.4	.6
Service-producing[2]	3.7	.3	3.5	.4	3.1	.3	3.7	.4
Excluding sales occupations	4.2	.3	4.0	.3	3.7	.3	3.9	.3
Transportation and public utilities	2.1	.3	2.1	.3	2.5	.3	2.5	.3
Transportation	1.6	.6	1.7	.5	2.3	.7	2.1	.5
Public utilities	2.8	.3	2.6	.3	2.7	.2	2.7	.2
Wholesale and retail trade	3.2	.4	3.0	.5	3.1	.4	3.6	.4
Excluding sales occupations	3.8	.5	3.4	.4	3.3	.4	3.6	.4
Wholesale trade	4.6	.9	4.1	1.2	3.1	.7	3.3	.9
Excluding sales occupations	3.8	.7	3.7	.5	3.3	.5	3.7	.6
Retail trade	2.7	.5	2.6	.4	3.2	.4	3.6	.4
Finance, insurance, and real estate	2.2	1.4	1.2	1.8	-.4	1.7	2.6	2.8
Excluding sales occupations	4.3	.8	3.8	1.5	2.7	1.5	3.3	1.8
Insurance	—	—	—	—	—	—	6.0	1.1
Services	5.6	.5	5.4	.5	4.8	.6	4.9	.5
Health services	5.0	.5	4.6	.3	3.9	.5	5.2	.7
Hospitals	5.3	.3	5.1	.1	4.9	.3	5.8	.7
Nonmanufacturing	3.5	.3	3.4	.4	3.1	.3	3.8	.4

[1]Includes mining, construction, and manufacturing.

[2]Includes transportation; public utilities; trade; finance, insurance, and real estate; services; and, where applicable, public administration in State and local governments.

NOTE: Dash indicates data not available.

Table 4. Twelve-month percent changes in the Employment Cost Index for benefits and associated standard errors, private industry workers by occupation and industry group, September 1987 to June 1988

[Not seasonally adjusted]

Series	September 1987		December 1987		March 1988		June 1988	
	Benefit change	Standard error	Benefit change	Standard error	Benefit change	Standard error	Benefit change	Standard error
Private industry workers	3.1	0.3	3.5	0.3	5.8	0.3	6.4	0.2
Workers, by occupational group:								
White-collar occupations	3.5	.4	3.6	.4	5.1	.4	5.7	.4
Blue-collar occupations	2.8	.3	3.4	.3	6.8	.4	7.3	.3
Service occupations	2.4	.8	2.4	.8	4.4	.8	5.6	.7
Workers, by industry division:								
Goods-producing[1]	2.4	.3	2.9	.3	6.4	.4	7.0	.4
Service-producing[2]	3.8	.4	4.0	.4	5.3	.4	5.8	.4
Manufacturing	2.0	.3	2.6	.3	7.0	.4	7.6	.4
Nonmanufacturing	3.9	.4	4.0	.4	5.1	.4	5.6	.3

[1]Includes mining, construction, and manufacturing.
[2]Includes transportation; public utilities; trade; finance, insurance, and real estate; services; and, where applicable, public administration in State and local governments.

respond to the survey are different from those that do respond. As is the case in most surveys, the impact of these limitations on the ECI estimates is unknown.

Estimation of standard errors. As indicated earlier, a standard error is a measure of the variation among the estimates that could be calculated from different samples with the same sample design. Because the ECI estimator, like most index estimators, is a complex product of ratios, its standard error is estimated by a replication method.

Replication methods involve taking a subset of the sample selected under the original sample design, and estimating the statistic of interest using data only from the subset. This subset estimate is called a replicate. Other replicates are then computed by using different, possibly overlapping subsets of the whole sample. In the ECI program, 64 replicates are generally computed for each published estimate.

The standard error of an estimate is calculated by summing the squared differences between the replicate estimates and the estimate for the entire sample. In the ECI program, this procedure is performed for the 12-month percent change in compensation costs for a group of workers. The formula used for calculating the standard error for the 12-month percent change is:

$$\text{ST ERR } (\mathbf{P}_{s,t}) = \left[\sum_{i=1}^{64} \frac{(\mathbf{P}_{s,t,i} - \mathbf{P}_{s,t})^2}{64} \right]^{1/2}$$

where $P_{s,t}$ is the published 12-month percent change for a group of workers from time s to time t, calculated using the whole sample; and $P_{s,t,i}$ is the 12-month percent change for the same group of workers from time s to time t, calculated using the ith replicate.

Use of variances in sample allocation. The variance (that is, the square of the standard error) is used to allocate the ECI sample of establishments among industries. Originally, the sample design allocated the number of establishments to be surveyed in proportion to the number of employees in each industry (2-digit Standard Industrial Classification, or SIC, basis), using the 1970 census as a source of estimated employment. For example, 70 establishments were selected for study in the Food and Kindred Products Industry (SIC 20) and 7 establishments in Metal Mining (SIC 10), because the employment in metal mining was approximately 10 percent of the employment in food and kindred products.

Beginning in 1981, a systematic sample replacement scheme was introduced into the ECI program. This resulted in the resampling of about one-fourth of the private-sector establishments each year. The industries that had retained smaller proportions of their original sample and that had the largest apparent volatility in their estimates were resampled first. The size of the total sample was enlarged in subsequent years in line with ECI budget increases, reflecting the Bureau's desire to publish additional series and a concern for better data quality.

With an establishment replacement schedule in place and an expanding sample to allocate, the Bureau had a growing need for reliable estimates of the standard error. Because the variance of an estimate decreases as the sample size for that estimate increases, the ECI sample could be allocated among industries in proportion to the variance of the industry estimate. Segments of the survey population such as finance, insurance, and real estate have variances that are approximately 20 times larger than those for the rest of the population and should have larger sample sizes. Because the ECI program makes estimates for many different industries and occupations, the sample size for wholesale trade and for finance, insurance, and real estate could not, in practice, be increased proportionally to the variance of estimates for those industries. However, even if the sample size could be increased, the

variance for wholesale trade and for finance, insurance, and real estate would remain large because of the large fluctuations in commission earnings for salesworkers in the survey population.

By March of 1986, the entire private-sector sample had been replaced, so that estimates of the variance could be calculated. The sample was split into 60 contiguous pieces, or strata, and each piece was divided into two samples, so that a replication method could be used. Preliminary estimates indicated that the reliability of the ECI estimates could be improved by as much as 20 percent, for a given ECI sample size, if the allocation were appropriately done using variances.

In 1986, the sample was allocated among industries using a model based on variances. In 1987, the sample was reallocated based on a revised model using current variance estimates. The allocations from the two models differed significantly. More research and data are needed to stabilize the model and its allocations.

The year-to-year fluctuation in the model results may be caused by two factors. First, the 1986 model was based on only two quarters of data in the manufacturing industries, three quarters in the mining industries, and two quarters in the retail industries. Second, the model needed to be adjusted to reflect the change in the survey population from 1970 to 1980 census totals. The source of the ECI estimates of total occupational employment by industry was changed from the 1970 census to the 1980 census, starting with the quarter ended June 1987. While work is continuing on the variance model, the model is being used to identify industries that are proportionately undersampled and to increase their sample size.

Improvements to the model also are expected because the ECI'S variances are being reduced by increasing sample sizes and by sampling occupations in proportion to their representation within establishments. Beginning April 1987, the selection of occupations was made proportional to the representation of the occupation (number of employees in the occupation) in the selected establishments. This change is expected to reduce the range of the weights assigned to data from sample establishments and help stabilize the variances. Also, the effect of the shift from the 1970 to the 1980 census will diminish over time. However, it will take 5 years for the full effect of these changes to be seen in the estimates of annual compensation change. This is because the ECI sample is replaced industry by industry over a 4-year cycle, and the new sample must be in place for 1 year to permit calculation of estimates of annual change using only new sample data.

In general, standard errors are determined by the size of the estimate, the size of the sample, the sample design, and the variability of the estimate across subsets of the total survey sample. For the ECI, the standard errors of the estimated standard errors are comparatively low. They range from 6 percent to 14 percent of the standard errors. Thus, the estimates of standard errors are reasonably precise.

As one would expect, standard errors for aggregates, such as the overall civilian estimate, are generally smaller than those for individual industries or occupations because the samples underlying the aggregates are larger. For example, the June 1988 12-month percent change in compensation costs for blue-collar workers in private industry has an estimated standard error of 0.2 percent, compared with a range of from 0.3 percent to 0.6 percent for the four occupational groups within the blue-collar category. (See table 2.) Similarly, the standard errors for government-sector estimates are larger than those for the private sector because the sample size for the government sector is smaller.

Table 2 also shows that estimated standard errors associated with wage and salary changes for white-collar workers are larger than those for blue-collar workers, primarily because of the large standard errors for salesworkers. With salesworkers excluded, the estimated standard error is virtually the same for blue- and white-collar workers.

Table 3 shows that standard errors for service-producing industries are larger than those for goods-producing industries, again because of the greater representation of salesworkers in service-producing industries, which include finance, insurance, and real estate. Table 2 shows the estimated standard errors for groups of occupations. As among industries, the highest estimated standard errors of the published occupational series are found in sales and in finance, insurance, and real estate. The estimated standard errors associated with these series from September 1987 through June 1988 were between 0.7 and 2.8 percent. The series for finance, insurance, and real estate excluding sales occupations is more reliable than the same series with salesworkers.

This relatively small component of the work force makes a disproportionate contribution to the standard error of the ECI estimate for private industry. Salesworkers accounted for 37 percent of the variance in the December 1987 12-month percent change and 53 percent of the variance in the June 1988 12-month percent change for private industry, even though they represented only 10 percent of the compensation costs in the private sector for either period. The following tabulation presents the percent of total compensation in the private sector by selected subgroups of workers in both periods, and the associated percent of variance of annual change for each period:

	Percent of—		
	Total compensation (December and June)	Variance of annual change	
		December	June
Total private industry	100	100	100
Private industry, except salesworkers	90	63	47
Salesworkers in finance, insurance, and real estate	2	24	48
Other salesworkers	8	13	5

The original sample allocations for the finance, insurance, and real estate portion of the ECI were proportional to the census employment of that industry. Once the variance of the industry estimates, particularly in sales occupations, was obtained, efforts were made to control it. The largest components of the variance are due to the sales occupations in the establishments of security and commodity brokers, dealers, exchanges, and services (that is, stockbrokers). In 1987, the sample for the industry was increased from 36 to 130 establishments, and an additional 140 establishments were selected for the collection of data for salesworkers only.

Table 5. Twelve-month percent changes in the Employment Cost Index and associated standard errors, private industry workers by bargaining status, region, and area size, September 1987 to June 1988

[Not seasonally adjusted]

Series	September 1987		December 1987		March 1988		June 1988	
	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error	12-month change	Standard error
	Compensation							
Workers, by bargaining status:								
Union	2.0	0.2	2.8	0.2	3.9	0.3	4.3	0.2
Goods-producing[1]	1.7	.3	3.0	.3	4.8	.4	5.1	.3
Service-producing[2]	2.3	.3	2.5	.3	2.7	.4	3.1	.4
Manufacturing	1.6	.3	2.8	.3	5.5	.4	5.8	.4
Nonmanufacturing	2.4	.3	2.7	.3	2.7	.3	3.0	.3
Nonunion	3.7	.2	3.6	.3	4.0	.3	4.5	.3
Goods-producing[1]	3.1	.3	3.2	.3	4.1	.2	4.6	.3
Service-producing[2]	4.1	.4	3.9	.4	3.8	.4	4.5	.5
Manufacturing	3.2	.3	3.2	.3	4.2	.3	4.5	.3
Nonmanufacturing	4.0	.3	3.8	.4	3.8	.4	4.6	.5
Workers, by region:								
Northeast	4.5	.5	5.0	.5	4.6	.4	5.3	.5
South	2.7	.3	3.0	.3	3.8	.4	4.6	.4
Midwest (formerly North Central)	3.1	.3	2.8	.3	4.1	.4	4.1	.4
West	2.8	.5	2.6	.5	3.1	.5	3.9	.3
Workers, by area size:								
Metropolitan areas	3.3	.2	3.4	.2	4.0	.2	4.5	.2
Other areas	3.2	.4	3.2	.5	3.6	.4	4.1	1.0
	Wages and salaries							
Workers, by bargaining status:								
Union	1.7	.2	2.6	.2	2.6	.2	2.9	.2
Goods-producing[1]	1.6	.4	3.0	.4	3.0	.2	3.1	.2
Service-producing[2]	1.8	.4	2.1	.4	2.1	.4	2.4	.4
Manufacturing	1.6	.3	3.0	.4	3.2	.2	3.3	.3
Nonmanufacturing	1.8	.3	2.2	.3	2.0	.3	2.5	.3
Nonunion	3.8	.3	3.6	.3	3.5	.3	4.0	.3
Goods-producing[1]	3.2	.2	3.4	.2	3.7	.3	4.2	.3
Service-producing[2]	4.1	.4	3.8	.5	3.3	.4	4.0	.5
Manufacturing	3.5	.3	3.4	.3	3.8	.3	4.0	.3
Nonmanufacturing	3.9	.4	3.7	.4	3.3	.3	4.0	.5
Workers, by region:								
Northeast	4.5	.5	5.0	.6	4.1	.4	4.6	.5
South	2.6	.3	2.8	.3	3.0	.4	3.8	.5
Midwest (formerly North Central)	3.4	.3	2.9	.4	3.1	.5	2.8	.5
West	2.9	.6	2.6	.7	2.8	.6	3.7	.4
Workers, by area size:								
Metropolitan areas	3.3	.2	3.4	.2	3.2	.2	3.7	.3
Other areas	3.3	.5	3.3	.6	3.4	.5	4.1	1.2

[1] Includes mining, construction, and manufacturing.

[2] Includes transportation; public utilities; trade; finance, insurance, and real estate; services; and, where applicable, public administration in State and local governments.

The most recent ECI sample has been in place for too short a time to judge its effect on the standard error. The estimate of annual relative change is a product of four quarterly relative estimates, the first of which was calculated from the old sample and the last from the new sample. (The relative is the ratio of current-quarter employment cost divided by the prior-quarter cost). An estimate of change based on two estimates from different samples will usually have a higher standard error than one based on two estimates from the same sample. This problem will continue to affect the ECI estimates until the current sample has been active for a full year. It is possible that the combination of the new sample and the fluctuations in the stockbrokers' commissions have overwhelmed any reduction in the standard error that could have been expected from the increase in sample size.

The ECI methodology cannot control for the distribution of changes in wages and benefits among establishments. This distribution has a large impact on the standard errors. Changes in economic conditions can create large variations in the change in wages and benefits offered in an industry. Planned increases in sample size may not result in smaller standard errors if economic developments cause more variability in the wage and benefit change. Conversely, standard errors may fall in the absence of any increase in sample size if wage and benefit changes become more homogeneous.

As industry samples are replaced in the ECI, new sample size allocations will be developed based on the most recent variance data available and a determination of additional industry or occupational series to be published. Recent budget increases allowed the Bureau to enlarge the sample size for the service sector beginning in 1986. Concern about the large variances for the finance industries has led to sample increases for those industries since 1987.

STANDARD ERRORS for the published ECI annual percent changes will appear in the BLS annual bulletin on the survey, enabling data users to assess the reliability of the estimates by constructing confidence intervals. Improved sampling methods, increased ECI sample sizes, and the use of variances in sample allocation are expected to reduce the magnitude of the standard errors, assuming relatively stable economic conditions. □

Erratum

Because of an editorial oversight, reference to the State of Maine was omitted from the article, "State workers' compensation: enactments in 1988," by LaVerne C. Tinsley, *Monthly Labor Review*, January 1989. The name "Maine" should appear in the second column on p. 68, just before the paragraph beginning "New coverage enacted for prisoners . . . . "