Technical Note

Estimation procedures for the Employment Cost Index

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The quarterly Employment Cost Index (ECI),[1] which includes measures of change in wages and salaries and in compensation (wages and salaries plus the employer cost of employee benefits), is estimated using the standard Laspeyres index formula. The general survey sample was specially designed to permit the construction of these standard indexes.

Indexes of wages and salaries are also available for union status and location categories. It is not possible to estimate standard Laspeyres indexes for these categories, because union status and location were not included in the basic sample design. However, information on these characteristics is collected from the sample establishments, and may be combined with data on wages and salaries to estimate quarter-to-quarter changes. The quarterly changes can then be used to derive special indexes by union status and location.

These special indexes have many of the properties of Laspeyres chain indexes. For example, each quarter the fixed-base-period-employment weight for each occupation by industry defined in the ECI sample design is apportioned between union and nonunion sectors. The current distribution of the work force in that occupation and industry, as reflected in the current sample, is the basis for the appropriation. The weights are used to compute quarterly changes in wages and salaries for the union and nonunion series. These changes are then multiplied together (chained) to estimate an index. Indexes derived in this fashion—special indexes—will be discussed in more detail after derivation of the standard indexes is described.

The ECI index of wages

The standard formula for the wage index is:

$$(1) \qquad I_t = \frac{\sum_i W_{it} E_{ib}}{\sum_i W_{i0} E_{ib}} \times 100$$

W_{i0} is the wage rate for the ith type labor in the reference period *0*—June 1981. (Labor of type i is defined in terms of an occupation within an industry.) W_{it} is the wage rate for the ith type labor in the current period t, and E_{ib} is employment of the ith type labor in the base period b, 1970.

In actual practice, the formula becomes:

$$(2) \qquad I_t = \frac{\sum_i CW_{it}}{\sum_i CW_{i0}} \times 100$$

where:

$CW_{i0} = \overline{W}_{i0} E_{ib}$ = The cost weight of the ith type labor at time *0*;

$CW_{it} = \overline{W}_{it} E_{ib}$ = The cost weight of the ith type labor at time t;

$\overline{W}_{i0}$ = The average wage at time *0*, estimated from the sample observations;

$\overline{W}_{it} = r_{it}(W_{i(t-1)})$ = The average wage at time t;

r_{it} = The estimated relative change in wages between time t-*1* and time t. It is the estimate of the ratio of the wage rate at time t to the wage rate at time t-*1*. The estimate is based on matched wages—that is, wages for specific occupations and establishments that provide data for both periods.

The compensation index

The calculation of the ECI index of compensation is similar to that described above for wages. For the reference period *0*, a cost weight for wages (CW_{i0}) is calculated as described above. In addition, a cost weight for benefits (CB_{i0}) is calculated by multiplying the average cost of benefits per hour worked times employment in 1970:

$CB_{i0} = \overline{B}_{i0}(E_{ib})$ = The cost weight for benefits in the reference period *0*.

where $\overline{B}_{i0}$ is the average cost of benefits per hour worked for the ith type labor in period *0*.

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The benefit cost weight in period $t-1$ is multiplied by the estimated change in benefit cost ($r^{B}_{i(t)}$) between times $t-1$ and t to get the next quarter's cost weight (CB_{it}):

$$(3) \qquad CB_{it} = r^{B}_{i(t)}\, CB_{i(t-1)}$$

The compensation index at time t is formed by summing the wage and the benefit cost weights at time t, dividing by the sum of the wage and benefit cost weights for the reference period 0, and multiplying by 100.

Calculation of component indexes

As noted, the ECI is a system of indexes. In addition to the indexes of wages and compensation for the private civilian economy, there are indexes for State and local governments, and for the private nonfarm economy. For each of the chief economic sectors, there are subindexes for both wages and compensation by industry and occupation. At this time, more industry and occupation indexes of wages than of compensation meet publication standards.

The standard subindexes of the ECI are estimated using the formulas given above. All that is necessary is to limit the summation to the groups of labor included in the component series. This is possible because a Laspeyres index can always be expressed as a weighted sum of any set of component indexes. Thus, the overall index I at time t may be expressed as:

$$(4) \qquad I_t = \sum_k I^k_t\, (RI)^k_0$$

where its subindexes (I^k) are defined by:

$$(5) \qquad I^k_t = \frac{\sum_{i \epsilon k} \overline{W}_{it}\, E_{ib}}{\sum_{i \epsilon k} \overline{W}_{i0}\, E_{ib}}$$

and the weights used to aggregate them to the total are called relative importances $(RI)^k_0$, defined by:

$$(6) \qquad (RI)^k_0 = \frac{\sum_{i \epsilon k} W_{i0}\, E_{ib}}{\sum_k \sum_{i \epsilon k} W_{i0}\, E_{ib}}, \text{ and } \sum_k (RI)^k_0 = 1$$

Special wage indexes

The indexes by union, metropolitan area, and region use a different estimation formula. The reason for the difference deserves attention.

The national ECI measures the change in the cost of fixed labor inputs where units of labor input are defined by an occupation in an industry, for example, operatives except transport in the textile mill products industry. For the aggregate index, no distinction is made between union and nonunion labor. For instance, if weavers performing a specific job in a textile mill were selected to represent operatives in the textile industry, the change in their wage rate between quarters would be used in calculating the quarterly relative for all series that included this type of labor. No change in the computation procedure would be made if the workers in the mill became union members. Both before and after the workers were organized, the change in the wage rate would represent operatives in the textile industry.

But for the union and nonunion series, it is desirable to take account of changes in the union status of workers. Using the example above, before the weavers are organized, they are included as nonunion textile operatives in the wage index for nonunion workers. After they are organized, they should be included in the union index for textile operatives.

Because such categorical shifts cannot be accommodated with a fixed-weight index, the union-status and other special indexes are derived in such a way that they are like chain indexes. The relative importance of the union and nonunion components of the ith type of labor (that is, an occupation within an industry) is allowed to vary over time as the sample changes. The union and other special indexes are derived by compounding successive quarter-to-quarter relatives (that is, percentage changes expressed as ratios) and multiplying by 100, rather than by comparing a current-quarter cost weight to some base-period cost weight. This procedure is followed because any base-period cost weight might, for example, reflect a different employment distribution between union and nonunion than prevails currently. These special indexes differ from the usual chain index, however, in that total employment, union plus nonunion, for each type of labor is held fixed at the 1970 level. The union relative, R^u, has the form:

$$(7) \qquad R^u_t = \frac{\sum_i \overline{W}^u_{it}\, \frac{E^u_{i(t-1)}}{E_{i(t-1)}}\, E_{ib}}{\sum_i \overline{W}^u_{i(t-1)}\, \frac{E^u_{i(t-1)}}{E_{i(t-1)}}\, E_{ib}}$$

where:

$\overline{W}^u_{it}$ = Wage of union labor of type i in time t;

$E^u_{i(t-1)}$ = Employment of union labor of type i in time $t-1$;

$E_{i(t-1)}$ = Employment of union and nonunion labor of type i in time $t-1$.

The index, I^u, is the product of the relatives times 100:

$$I^u_t = R^u_t \times R^u_{(t-1)} \ldots R^u_1 \times 100$$

The proportion of total employment represented by union labor at time t for the comparison between times

t-1 and *t* is based on the sample of matched quotes used in the estimation of the aggregate index. But note that the union wage in time *t-1* is not estimated directly from the sample observations. Rather, the matched sample is used to estimate the union wage rate for the *i*th type of labor relative to the wage of all labor of the *i*th type. This estimated relative is multiplied by the estimated average wage for all types of labor used in the aggregate index, as indicated by:[2]

$$(8) \qquad \overline{W}^{u}_{i\,(t-1)} = \overline{W}_{i(t-1)} \left(\frac{W^{u}_{i\,(t-1)}}{W_{i\,(t-1)}} \right)_{av}$$

The union wage rate at time *t* is estimated as:

$$(9) \qquad \overline{W}^{u}_{it} = r^{u}_{it}\, \overline{W}^{u}_{i(t-1)}$$

where r^{u}_{it} is the wage relative of union labor of type *i* based on matched quotes between time *t-1* and *t*.

Indexes before June 1981

All standard and special index values since June 1981 have been estimated using the equations described above. But before June 1981, only quarterly relatives for each series were calculated. Because index numbers were not being constructed at that time, there was no need to compare the current quarter cost weights to the reference period cost weights. Instead, the wages or compensation based on matched quotes were directly multiplied by 1970 employment.

For this reason, the indexes for periods before June 1981 have been estimated by dividing the index (*I*) for June 1981 by the product of previously derived quarterly change relatives (*R*). That is:

$$(10a) \qquad I_{\text{March 1981}} = I_{\text{June 1981}} / R_{\text{June 1981}}$$

$$(10b) \qquad I_{\text{December 1980}} = I_{\text{June 1981}} / (R_{\text{June 1981}})\,(R_{\text{March 1981}})$$

and so forth. □

FOOTNOTES

[1] See Beth Levin, "The Employment Cost Index: recent trends and expansion," elsewhere in this issue for additional information on the ECI program.

[2] In fact, the system does not explicitly compute all of the estimates described, but uses a simplified computational procedure which yields the same final estimates.