

Aligning Survey Estimates of Employment in Expanding and Contracting Establishments with Population Counts: Preliminary Issues and Methods

October 2010

Kenneth W. Robertson, Mike Roosma, James R. Spletzer
U.S. Bureau of Labor Statistics, 2 Massachusetts Ave. N.E., Washington, D.C. 20212

Abstract

The Current Employment Statistics (CES) survey, conducted by the U.S. Bureau of Labor Statistics, is a large monthly survey of businesses that estimates employment, hours, and earnings by industry and geographic area. Previous research has shown that these data can also be used to produce estimates of employment change in expanding and contracting businesses, providing current information on business employment dynamics. One issue raised in the earlier research was the need to develop a method to align the survey estimates with population counts on a periodic basis. This paper describes issues associated with this periodic realignment, and one method developed to accomplish it.

Key Words: benchmarking, Bureau of Labor Statistics, business employment dynamics, establishment survey

1. Background

The U.S. Bureau of Labor Statistics' (BLS) Current Employment Statistics (CES) survey is a monthly business survey that produces timely estimates of employment, hours, and earnings, by industry, for the nation and for states and metropolitan areas. Participating businesses provide these data each month for the pay period that includes the 12th day of the month. Preliminary estimates are published about 3 weeks after the reference period, with revised estimates published the following two months. These data are among the first indicators of the health of the U.S. economy.

Another program of the BLS is the Quarterly Census of Employment and Wages (QCEW). This program collects information based upon the Unemployment Insurance program, which provides quarterly data on taxable wages, and with that a monthly employment report. These data are published quarterly about 7 to 9 months after the reference period. Among the products tabulated from these data is the Business Employment Dynamics (BED) data. These data disaggregate the total quarterly employment change into four component parts: employment change in expanding businesses; employment change in contracting businesses; employment change in units that went out of business; and employment change in new 'birth' units.

Previous research (Robertson and Roosma¹, 2009) has shown that the CES data can be used to produce timely monthly estimates of employment change in expanding and contracting businesses. However, a key issue is how to align these estimates with

population values. Our initial thoughts were that we would align these estimates with the population values produced by the QCEW-BED program. However, research by Spletzerⁱⁱ and othersⁱⁱⁱ indicated that the over-the-quarter population changes would not align with over-the-month estimates – even if we were to sum the three over-the-month changes in the quarter.

2. Alignment Issues

The CES-BED estimates originate from the equation $(\widehat{AE}_t - \widehat{AE}_{t-1}) = \widehat{E}_t + \widehat{C}_t + \widehat{NBD}_t$, where the CES published estimate of monthly net employment growth $(\widehat{AE}_t - \widehat{AE}_{t-1})$ is written as the sum of the jobs gained from expanding businesses (\widehat{E}_t) minus the jobs lost from contracting businesses (\widehat{C}_t), plus a net birth-death component (\widehat{NBD}_t). Given that the CES is a sample that annually benchmarks its employment levels to the employment levels from the QCEW universe of establishments, a key question is whether the CES-BED expansions (E_t) and contractions (C_t) estimates should be benchmarked to the expansion and contraction statistics from the QCEW-BED program. This benchmarking might seem appealing since the expansions and contractions statistics from the QCEW-BED program are computed from universe data with no sampling error.

In this section, we explain why the CES-BED estimates of expansions and contractions should not be benchmarked to the QCEW-BED data. The primary reason is that the CES-BED estimates are monthly, whereas the QCEW-BED data are quarterly, and monthly measures of jobs gained from expansions and jobs lost from contractions are conceptually different and non-comparable to quarterly measures of jobs gained from expansions and jobs lost from contractions. We also discuss several other issues of comparability that are relevant to a discussion of benchmarking the E_t and C_t estimates.

2.1 Different Timeframes

Although three monthly statistics on net employment growth can be added together to create a quarterly measure of net employment growth, monthly statistics on jobs gained from expansions and jobs lost from contractions do not possess this additive property. This can easily be seen with an example. Assume a business has 25 employees in March, loses two persons to retirement in April, hires two persons in May to fill the vacancies caused by the retirements, and then hires three summer interns in June. The monthly net employment growth for this business is -2 in April, +2 in May, and +3 in June. These three monthly net employment growth statistics can be summed to a quarterly (March to June) net employment growth statistic of +3 jobs gained. The monthly jobs gained from expansions (E_t) for this business would be 0 in April, +2 in May, and +3 in June, and the monthly jobs lost from contractions (C_t) for this business would be -2 in April, 0 in May, and 0 in June. The quarterly measure of jobs gained from expansions (E_t) for this business would be +3 (looking at the growth from 25 in March to 28 in June), and the quarterly measure of jobs lost from contractions (C_t) for this business would be 0 (since the business did not lose jobs when comparing March to June). This example illustrates that the sum of three monthly expansions is not the same as the quarterly expansion statistic, and the sum of three monthly contractions is not the quarterly contraction statistic.

The sum of three monthly expansion statistics measures a different concept than a quarterly expansion statistic. The sum of three monthly expansion statistics is the number of jobs gained by businesses *during* the quarter, whereas a quarterly expansion statistic is

the number of jobs gained by businesses *over* the quarter. The latter concept compares employment at two points in time that are three months apart, and the resulting statistic has a clear interpretation. However, the former concept – the measurement of jobs gained during a quarter – can yield different results depending upon whether the underlying measurements are taken daily, weekly, or monthly. The different results arise from the transitory nature of short-run employment changes for any given business – many expansions and contractions are temporary and reverse themselves in subsequent weeks and months. In the example above, the vacancies resulting from the two retirements in April were filled one month later.¹

For our purposes, the fact that monthly measures of jobs gained from expansions (E_t) and monthly measures of jobs lost from contractions (C_t) can not be summed to create quarterly measures demonstrates that it is not possible to benchmark the monthly CES-BED estimates of E_t and C_t to the quarterly measures of E_t and C_t from the QCEW-BED.

2.2 Other Issues of Comparability

There are four other issues of comparability that arise from differences in the CES and QCEW that are relevant to a discussion of benchmarking the CES-BED expansions and contractions estimates to the QCEW-BED data. These four issues are minor compared to the primary issue discussed above, and the effects of these four issues could be quantified by research.

The first comparability issue results from the fact that the CES survey samples and weights establishments at the Unemployment Insurance (UI) account level, whereas the QCEW-BED estimates are prepared at both the establishment level and the national firm level. Data at the UI account level is conceptually a measure of the firm within a state, which is more aggregated than data at the establishment level yet less aggregated than data at the level of a national firm. Increasing the level of aggregation will decrease the number of jobs gained by business expansions and will decrease the number of jobs lost by business contractions, since offsetting employment shifts at establishments within a multi-establishment firm will contribute to smaller net changes in growth and decline.² As an example, consider a firm with two establishments. If one establishment increases employment by 5 jobs and the other establishment decreases employment by 3 jobs, the establishment-level data will show 5 jobs gained by expansions and 3 jobs lost by contractions. The firm-level data, created by aggregating employment from all establishments, will show 2 jobs gained by expansions and 0 jobs lost by contractions. Evidence from the QCEW-BED shows that this level of aggregation substantially affects the magnitude of the expansion and contraction statistics. For the fourth quarter of 2009, the seasonally adjusted establishment level data from the QCEW-BED shows $E_t=5,322,000$ and $C_t=5,546,000$, whereas the seasonally adjusted firm level data have lower magnitudes: $E_t=4,456,000$ and $C_t=4,756,000$. The CES-BED expansions and contractions statistics created at the UI account level will be smaller in magnitude than

¹ For further discussion and empirical quantification regarding this difference in concepts, see Joshua C. Pinkston and James R. Spletzer, “Annual measures of gross job gains and gross job losses,” *Monthly Labor Review*, November 2004, pp 3-13, and Akbar Sadeghi, James R. Spletzer, and David M. Talan, “Business employment dynamics: annual tabulations,” *Monthly Labor Review*, May 2009, pp 45-56.

² This sentence ignores the effect of establishments opening and closing within a multi-establishment firm, which could either increase or decrease the jobs gained by expansions and the jobs lost by contractions as the level of aggregation increases.

comparable frequency QCEW-BED establishment-level statistics but greater in magnitude than comparable frequency QCEW-BED firm-level statistics.

The second comparability issue results from the fact that the CES sample is typically nearly two years old by the time a sample is selected, new reporters are initiated, and the data are used in estimation. On the other hand, the QCEW-BED data are computed from the full universe of businesses, including those establishments that are less than two years old. Research using the QCEW-BED data shows that establishments that are less than two years old have much higher rates of E_t and C_t than do older age groups.³

The third comparability issue results from what is called the implicit birth imputation. As discussed in Robertson and Roosma (2009),ⁱ the CES Link-Relative estimate utilizes only those respondents who report positive employment for both the current and the prior month. Because of this matched sample concept, employment for non-respondents and for business deaths is imputed at the same rate as the over the month change for the matched reporting businesses. Robertson and Roosma calculate that the implicit birth imputation induces a small overestimate on the absolute value of the CES-BED E_t and C_t estimates. This implicit birth imputation is not present in the QCEW-BED, and statistical models could be developed to remove this component.

The fourth comparability issue is that of scope. The statistic from the CES survey that gets the most attention every month is the net employment change for total nonfarm payroll. The QCEW-BED estimates are for the private sector. Ignoring the primary issue of monthly versus quarterly for the moment, benchmarking the CES-BED E_t and C_t estimates to the QCEW-BED could only be done for the private sector, and thus the decomposition of CES net employment change in to jobs gained by expansions and jobs lost by contractions could not be done (without complicated modeling) for the headline CES total nonfarm payroll statistic.

2.3 Summary of Alignment Issues

Monthly measures of jobs gained from expansions (E_t) and monthly measures of jobs lost from contractions (C_t) can not be summed to create quarterly measures of jobs gained from expansions and jobs lost from contractions. As a result, the monthly CES-BED estimates of E_t and C_t can not be benchmarked to quarterly measures of E_t and C_t from the QCEW-BED. Given this, we now turn to a discussion of how to align the CES-BED estimates with the CES All Employment estimates.

3. Benchmarking

Each year, the CES program realigns its estimates to new March population counts (benchmarks) from the QCEW program; a process known as benchmarking. The All Employee estimates between the prior year's March benchmark and the latest current year March population counts are revised using a wedge procedure. The current year's March benchmark difference (difference in estimated employment versus the new population employment counts) is wedged or spread evenly across the previous 11

³ Age data from the QCEW-BED program (http://www.bls.gov/bdm/us_age_naics_00_table2.txt) show that E_t is 19.1% for establishments that are 1 year old, relative to 6.1% for all establishments, and C_t is 13.7% for establishments that are 1 year old, relative to 10.7% for all establishments. These are annual tabulations for the March 2008 – March 2009 reference period.

months of published estimates (previous year's April through February of the current benchmark year are subject to wedge period revisions). This can be shown as follows:

$$[1] \quad \widehat{AE}_t^B = \left(\frac{Z}{12}\right) (AE_{March}^{Pop} - \widehat{AE}_{March}) + \widehat{AE}_t$$

Where:

$$Z = \begin{cases} 11 & \text{if } t = \text{February} \\ 10 & \text{if } t = \text{January} \\ \dots & \dots \\ 1 & \text{if } t = \text{April} \end{cases}$$

\widehat{AE}_t = employment estimate for month t

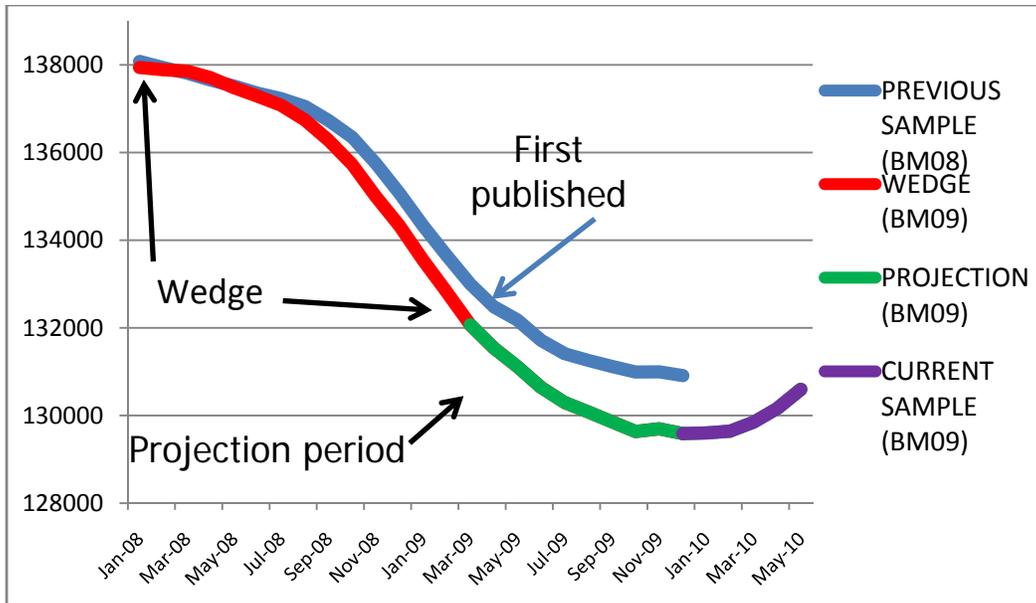
AE_{March}^{Pop} = population employment for March

\widehat{AE}_t^B = benchmarked employment for month t

In addition, the All Employee estimates for months following a new March benchmark, from April through December of the benchmark year, are projected forward using the new benchmark level, the original sample information, and updated net birth death adjustments. This April to December timeframe after a new March benchmark is the projection period.

After that point, a new sample is introduced to link off the new December projected employment levels (off of the new March benchmark). This new sample is used through December of the following year when the benchmark cycle begins anew. Thus, an estimate is subject to two benchmark revisions before it is "finalized" in the wedge period between two March benchmarks. For example, an estimate is first published using live sample in benchmark year X, is then projected (1st revision due to benchmarking) using original sample information and new net birth death adjustments in benchmark year X+1, and finally wedged (2nd revision due to benchmarking) in benchmark year X+2.

The chart below depicts the different CES estimation periods. First published estimates are illustrated by the blue line in the graph below. The linear wedge period is represented by the red line. The projection period is depicted by the green line. After the benchmarking process is complete, estimates continue to be made on a monthly basis using a new sample. This final period – current estimates published on the new benchmark – is shown by the purple line.



4.1 Benchmarking CES expansion and contraction estimates

As previously discussed, monthly CES-BED estimates cannot be directly benchmarked to the quarterly QCEW measure of expansions and contractions. However, we can maintain the alignment of the CES-BED estimates with the benchmarked CES All Employee (AE) estimates. Maintaining this alignment requires the use of two procedures: one for the wedge period and one for the projection period.

For the wedge period, we must adjust each month’s pre-benchmarked expansion and contraction CES-BED estimate to account for the benchmark error. In addition, the benchmark error for a given month should be distributed to the CES-BED components proportional to the original distribution of employment for expansions and contractions. If expansions and contractions were equal (in absolute value) for a given month, then the benchmark error for that month would be evenly distributed to the original estimates of expansions and contractions. For example, suppose that the benchmark error was a monthly downward adjustment of 1,000 AE. If the original expansions and contractions were 5,000 and -5,000 respectively, then expansions would be revised down by 500 to 4,500 (1/2 of the downward 1,000 AE benchmark revision) and contractions would be lowered by 500 as well, from -5,000 to -5,500. Note that in this example the sum of contractions and expansions has been changed by the benchmark process from 0 to -1,000, as expected.

Wedge period expansion and contraction benchmark difference adjusted estimates can be shown as:

$$[2.1] \widehat{E}_t^B = \widehat{E}_t + \left(\frac{\widehat{E}_t}{\widehat{E}_t + |\widehat{C}_t|} \right) * \left(\frac{AE_{MAR}^{BMK} - \widehat{AE}_{MAR}^{CES}}{12} \right)$$

$$[2.2] \widehat{C}_t^B = \widehat{C}_t + \left(\frac{|\widehat{C}_t|}{\widehat{E}_t + |\widehat{C}_t|} \right) * \left(\frac{AE_{MAR}^{BMK} - \widehat{AE}_{MAR}^{CES}}{12} \right)$$

Where B = benchmarked

For the projection period the monthly BED estimates could be benchmarked in the same manner the CES program uses to benchmark its women employee (WE) and production employee (PE) estimates; these estimates are also not directly obtained from the QCEW program.

CES women and production employee estimates are revised to new benchmark levels by maintaining the same proportion (or ratio) of women or production employees to their corresponding all employee estimate before and after a benchmark. For example, if April's PE estimate was 1,000 and April's pre-benchmarked or first published All Employee estimate was 10,000, then production employees represent 10% of the All Employee estimate for April. This first published 10% PE ratio is kept and used to derive PE estimates for the next two benchmarks. With the above example, if the April AE estimate was revised down from 10,000 to a benchmarked 8,000 AE, then the benchmarked PE estimate for April would be revised down from 1,000 to 800 (10% of 8,000).

For the projection period, we can use this ratio concept to align CES-BED expansions and contractions with all employee estimates projected from the new benchmark level. The new benchmark level of employment is the only new information we have available during the projection period. Thus, the only tool we have available is the ratio of expansions and contractions on pre-benchmarked levels of employment that can then be applied to the newer benchmarked and projected levels of employment. For example, if the newer benchmarked level of employment were 10% lower for a month in the projection period, then the amount of expansions and contractions would also be 10% lower (in absolute value).

For expansions and contractions this can be shown as:

$$[3.1] \hat{E}_t^P = \frac{\widehat{AE}_t^B}{\widehat{AE}_t} \hat{E}_t \quad [3.2] \hat{C}_t^P = \frac{\widehat{AE}_t^B}{\widehat{AE}_t} \hat{C}_t$$

Where P = adjusted for the Projection period

Utilizing the two procedures described here, we expect to maintain the alignment of CES-BED estimates after benchmarking; both for the wedge period estimates and for the projection period estimates.

4. Results

Simulated estimates for several years were created and benchmarked. The simulated benchmarking process included both the wedge period (benchmark difference) adjustment and the projection period (ratio) adjustment.

Simulated estimates were developed for the March benchmarks from 2004 through 2009. That is, estimates from April 2003 to March 2004 were summed to simulate the 2004 benchmark. For the wedge periods, the monthly benchmark difference adjustment, described above in equations 2.1 and 2.2, was applied to the original estimates of expansions and contractions. While in practice the ratio adjustment described above in equations 3.1 and 3.2 would be applied to the original estimates during the projection period, for simulation purposes we also applied this method to the wedge period just to compare results between the two methods.

Applying the ratio adjustment, and applying the benchmark difference adjustment to the original estimates provided two sets of benchmarked expansion and contraction estimates for each month. These monthly estimates were then compared to the original monthly level. The monthly estimates were also summed across the 11 month benchmark period to obtain an Over-The-Year (OTY) change in expansions and OTY change in contractions between first published and final benchmark for each method. These OTY expansions/contractions (first published and final benchmarked) could then be compared to the total all employee benchmark revision for each year.

The tables below show the OTY differences of expansions and contractions between pre-benchmarked and benchmarked changes using both the ratio and difference methods for the wedge period. Note that both expansion and contraction levels are similar in magnitude for both methods. Method #1 adjusts expansion and contraction estimates to fully account for the benchmark error. Note that the two columns at the right end of the table show that the benchmark error was fully distributed to the CES-BED estimates (except for some minor rounding error). Method #2, as expected, makes a minor adjustment to the estimates to account for a new all employee benchmark level.

Method #1 benchmark difference adjustment on wedge period

March to March	Benchmarked Difference			PUBLISHED and BMK			Benchmark Error
	expansions	contractions	net	expansions	contractions	net	
2004-2005	34,209	-33,139	1,070	-87	-80	-167	-167
2005-2006	36,353	-34,525	1,828	383	366	749	749
2006-2007	35,085	-34,685	400	-121	-119	-240	-240
2007-2008	34,704	-35,323	-619	-69	-69	-138	-138
2008-2009	30,591	-37,255	-6,664	-430	-504	-934	-932

Method #2 ratio adjustment (on wedge period for comparability)

March to March	Benchmarked Difference			PUBLISHED and BMK			Benchmark Error
	expansions	contractions	net	expansions	contractions	net	
2004-2005	34,303	-33,062	1,241	7	-3	4	-167
2005-2006	36,060	-34,988	1,072	90	-97	-7	749
2006-2007	35,320	-34,663	657	114	-97	17	-240
2007-2008	34,692	-35,173	-481	-81	81	0	-138
2008-2009	30,846	-36,535	-5,689	-175	216	41	-932

5. Conclusions

The tables above show the expected results. The benchmark difference adjustment described in this paper fully distributes the benchmark error during the wedge period. This method distributes that error proportional to the original distribution of expansions and contractions, resulting in estimates of expansions and contractions that reflect the original sample-based estimates and the adjustment to account for the benchmark error. Most importantly, these benchmarked CES-BED estimates are in alignment with the benchmarked CES all employee estimates.

The projection period ratio adjustment also performed as expected, expanding or contracting the originally published estimates to account for new all employee levels imposed by the new benchmark value.

6. Future Research

There are several research items remaining before we consider publishing these series. First, as mentioned earlier, the inclusion of employment from out-of-business establishments in the prior months all employee value induces a small bias in the estimates. While this error component is not large, it would be ideal to develop a model to account for it.

A second project relates specifically to the wedge period described in this paper. The wedge period estimates would benefit from an added step (not shown here) that would replace the estimated net birth/death adjustments in the all employee estimates with the actual net birth/death values that can be directly obtained from the population for the wedge period. This added step would eliminate this (usually small) non-sampling error component from the estimates. Documenting the magnitude of this error component and its elimination would be interesting.

A final interesting project would be to develop procedures to produce seasonally adjusted estimates of expansions and contractions. This would facilitate economic analysis of these estimates.

References

Previous works referenced in this paper include the following.

ⁱ Kenneth W. Robertson and Mike Roosma, "Using Current Employment Statistics survey data to estimate employment in expanding and contracting establishments: preliminary results and issues," *Proceedings of the Annual Meetings of the American Statistical Association*, 2009

ⁱⁱ Joshua C. Pinkston and James R. Spletzer, "Annual measures of gross job gains and gross job losses," *Monthly Labor Review*, November 2004, pp 3-13

ⁱⁱⁱ Akbar Sadeghi, James R. Spletzer, and David M. Talan, "Business employment dynamics: annual tabulations," *Monthly Labor Review*, May 2009, pp 45-56