Bureau of Labor Statistics

Local Area Unemployment Statistics

Research and Methods Branch

Report on Revision to State and Area Time-Series Models

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Executive Summary

Among the important economic data developed by the Bureau of Labor Statistics (BLS), unemployment estimates for States and local areas are viewed as key indicators of local economic conditions. These estimates are produced by State workforce agencies under the Federal-State cooperative Local Area Unemployment Statistics (LAUS) program. Currently, monthly estimates of employment, unemployment, and the unemployment rate are prepared for around 7,300 areas—regions, divisions, all States and the District of Columbia, metropolitan and small labor market areas, counties, cities of 25,000 population or more, and all cities and towns in New England regardless of population. The LAUS estimates are used by a number of agencies in the United States to allocate Federal funds to States and areas for a variety of socioeconomic programs ($90 billion in Fiscal Year 2013). State and local governments use the estimates for planning and budgetary purposes and as determinants of need for local services and programs. The LAUS estimates are one of the timeliest subnational economic measures, as the State labor force estimates are released by BLS five weeks after the reference week and just two weeks after the national estimates. In operating the LAUS program, BLS is responsible for the concepts and definitions, technical procedures, and review, analysis and publication of estimates. The State agencies are responsible for the production of the estimates and analysis and dissemination of the data to their own customers.

A key element of the Bureau's approach to subnational labor force estimation is to ensure that these estimates are comparable to the official concepts and measures of the labor force as reflected in the Current Population Survey (CPS). The CPS is the monthly

survey of households that is designed to provide reliable monthly labor force estimates for the nation. To support reliability of subnational estimates, the CPS employs a State-based sample design. The State design constraint ensures that the survey sample in a State is large enough so that there is no more than an 8 percent Coefficient of Variation (CV) on the annual average level of unemployment when the unemployment rate is 6 percent. (For comparison, the national reliability standard is a 1.9 percent CV on the monthly level.)

A hierarchy of estimation methods is used to produce the 7,000 estimates covered by the LAUS program, based in large part on the availability and quality of data from the CPS. While not reliable enough to use directly, the monthly State CPS values are integral in the production of State LAUS labor force estimates via the strongest estimating method, time-series signal-plus-noise models. The signal refers to a model of the true values of the labor force and the noise to a model of the error that arises due to sampling only a portion of the total population. This basic model takes advantage of State CPS sample information available in previous months along with auxiliary series that are correlated with the true values of the labor force but independent of the CPS sampling error. In addition the noise component accounts for changes in the magnitude of the sampling error as well as autocorrelation induced by the rotating panel design.

The current State time-series models are bivariate, where the CPS series (either employment or unemployment) is jointly modeled with an auxiliary variable (Current Employment Statistics (CES) payroll employment or claims from the State's Unemployment Insurance (UI) program, respectively). Each State's employment and unemployment models were independently fitted to their respective historical CPS and auxiliary variable series.

These bivariate models are used at the State level and for four large areas that are treated in the sample allocation and estimation process as if they were individual States: the Los Angeles-Long Beach-Glendale metropolitan division, New York City, and the respective balances of California and New York. The word "State" will include these four "state-like" areas and the District of Columbia in the subsequent discussion.

Ten additional areas use CPS-only, univariate time-series models: Miami-Miami Beach-Kendall, Chicago-Joliet-Naperville, and Seattle-Bellevue-Everett metropolitan divisions; the Detroit-Warren-Livonia and Cleveland-Elyria-Mentor metropolitan statistical areas; and the respective balances of Florida, Illinois, Washington, Michigan, and Ohio (collectively known as "modeled substate areas"). These models were also individually specified, based on the historic CPS data for the estimation area.

2005 LAUS Model Redesign

Periodically BLS undertakes a "redesign," which is a systematic review and update of many of its estimation procedures. The purpose of a redesign is to take advantage of improved estimation methodologies, new technologies, and new or changed sources of input data. The most recent LAUS redesign for State and modeled substate areas occurred in 2005 with the introduction of the third generation of LAUS models. Prior to this time, State model estimates were benchmarked at the end of the year to their respective annual CPS estimates. While an annual CPS estimate is more reliable than a single monthly CPS estimate, it still lacks sufficient reliability for over-the-year analysis and often added spurious cycles to the estimates when used as a benchmark. In addition annual benchmarking was retrospective and thus provided no real-time protection to current model estimates.

To address the shortcomings of annual benchmarking, the third generation models introduced "real-time benchmarking" in 2005, using the pro-rata method. Each month, the sum of States' not seasonally adjusted estimates is independently controlled to the national not seasonally adjusted CPS estimate for both employment and unemployment. This ensures that the sum of States' "benchmarked" not seasonally adjusted estimates exactly equals that of the national CPS.

The purpose of benchmarking is to make the model estimators more robust to national shocks. Time-series models are fitted to long data series and are therefore slow to adapt to abrupt changes. Thus, when there is a nationwide shock which tends to affect all States in the same direction, the model-dependent estimators in the various States are likely to be biased in the opposite direction to the movement in the corresponding unbiased CPS

estimators. In this case benchmarking to the national CPS will appropriately adjust the time-series estimators in the right direction.

For operational reasons, this is done via a two-step procedure. First, signal-plus-noise models of the nine U.S. Census divisions create employment and unemployment estimates. These division estimates are controlled to their respective national estimate by a pro-rata adjustment which multiplies each division's model estimate by the ratio of the national CPS to the sum of all division model estimates. The application of the pro-rata adjustment creates benchmarked division estimates. Then the States within each division have their model estimates controlled to their respective benchmarked division totals, also via a similarly constructed pro-rata adjustment. The final result is that States' estimates sum to the national total and to the appropriate benchmarked division model totals.

Since the signal component of the model being benchmarked consists of a trend and seasonal component, each of these components is benchmarked by the same pro-rata factor. Thus, for each month all States within a given division have their estimates of the signal and its subcomponents adjusted by the same pro-rata factor.

While real-time benchmarking significantly improves the responsiveness of State models to national shocks, it does so at the cost of an increase in the variance of States' benchmarked estimates. Because CPS data are used to both fit the models and also benchmark them (at a higher level of aggregation), the variance of the benchmarked estimator in a given area can be expected to be higher than the variance of the not benchmarked model estimator. This is explained by the fact that the benchmarking constraint does not add any new data and therefore makes sub-optimal use of the data when the models are correct.

As a result of the increase in the variance of the benchmarked estimator, the volatility of the month-to-month change in a State's employment and unemployment series is also increased. This volatility is especially visible in the seasonally adjusted series where month-to-month change in the pro-rata factors can be large relative to the change in the model estimates of trend. The effects of benchmarking on change are less apparent for

not seasonally adjusted estimates because they tend to be dominated by large seasonal movements.

To reduce this additional volatility in the benchmarked seasonally adjusted estimates, in 2010 the State estimation procedure was updated to include an additional step called "smooth seasonal adjustment." The model estimates are produced as described above. Then the benchmarked seasonally adjusted estimates are "smoothed" using a moving average trend filter (that uses weights from the Henderson-13 trend filter family). By applying these weights, the volatility from real-time benchmarking is removed, isolating the long-term trend of the estimates.

Proposed Improvements to the LAUS State Estimation Methodology

Currently BLS is conducting a new redesign of its estimating methodologies. In 2015, BLS proposes to update its State and modeled substate area estimation methodologies by introducing the fourth generation of LAUS models. These models incorporate a number of improvements designed to address the issues with the third generation of LAUS models described above. These improvements and changes to the LAUS employment and unemployment models are categorized into four groupings.

Improvements in the real-time benchmarking procedure

With the fourth generation, benchmarking is now a part of the estimation process. The benchmark constraints (US total in the case of divisions, Census division total in the case of States) are added to the estimation process which takes into account the errors in the benchmarks and their correlations with the model estimates. While the benchmark constraints are unchanged, the allocation of the benchmark discrepancy depends on the error variances and covariances in the system and no longer uses a single pro-rata factor for a given month.

By combining the estimation and benchmarking procedures, the models have greater flexibility for distributing benchmark adjustments. These adjustments will not be fixed for all States within a division, but rather will vary by State. It will be possible for a State to have no adjustment at all which is impossible under the pro-rata method. Currently,

every State within a division must be adjusted by the same proportion, even if a State's CPS estimate has little or no error in the given month. In addition, over-the-month changes in the estimates tend to be smoother using the updated methodology. Measures of error are also improved by incorporating benchmarking directly into the model estimation procedure. In contrast, pro-rata benchmarking does not allow the additional variability due to benchmarking to be reflected in the estimated model variances because the process is independent of the estimation step.

Improvements to State-specific outlier estimates

State-specific outliers, which are external shocks that represent departures from the normal behavior of a series, are handled with intervention models. In the third generation, intervention models were identified and estimated independently in the models for both States and divisions. In some cases, outliers were identified at the division level but not at the State level. In these instances, benchmarking would arbitrarily spread the effects of the division's outlier proportionally to all of the States in the division. With the fourth generation models, the effect of an outlier specific to a given State will not be spread to other States. This will be accomplished by estimating outliers at the State level and then aggregating these effects to the appropriate division level and the national level. The outliers are subtracted from the State, division and national CPS series. The division models are estimated from the adjusted division-level CPS data and then benchmarked to the national CPS with the same outlier effects removed. The States are estimated from the adjusted State CPS data and benchmarked in the same manner to the adjusted benchmarked division model estimates. Once benchmarking is complete, the outlier is added back to the State, division, and national totals, preserving additivity.

New model structure

The improvements to the model estimation procedure come with high resource costs in estimating the historical series. Computational resource use is substantially increased for each additional year incorporated into the historical database. Utilizing the current bivariate model structure becomes very costly during the LAUS program's annual revision process.

Fourth generation models therefore move from the bivariate structure to a regressor format. CES employment and UI claims are seasonally adjusted with their respective univariate model and then each used as the regressor variable in its respective model of employment or unemployment. This improves computational performance and adds greater flexibility for outlier treatment and for long-term model development. While this new structure will limit the correlation between the secondary input and the CPS to a single value (currently there are separate correlations for level and slope), the resulting estimates are quite close to those produced in a bivariate method. The new model structure allows for the improvements to the methodology described above, which greatly outweigh any potential negative impacts.

In addition, time-series models for the modeled substate areas will also utilize this regressor structure. These areas currently use univariate models, utilizing only CPS employment and unemployment as inputs. The new model structure allows the use of CES employment and UI claims at the modeled substate area level. This meets a request from State partners and data users outstanding for a number of years.

Improvements to smoothed seasonal-adjustment

The Henderson trend filter is used to smooth out the effects of monthly benchmarking of seasonally adjusted model estimates. Recent analysis has discovered that some of the smoothed seasonally adjusted series contain residual seasonality resulting from benchmarking to series that are seasonal (not seasonally adjusted national CPS and division model estimates). The Henderson filter, since it is designed to smooth a non-seasonal series, does not remove all of the residual seasonality in these series. The fourth generation of models utilizes a Trend-Cycle Cascade Filter, which combines the Henderson filter with a seasonal filter. This combined filter suppresses the variability due to real-time benchmarking while simultaneously removing any residual seasonality that may be present in the series.

Dual Estimation Period and Implementation Plan

The introduction of the fourth generation of LAUS models is a significant methodological change for the LAUS program. The improvements to benchmarking,

outlier treatment, and smoothed seasonal adjustment will provide data users with more responsive and less noisy State labor force estimates.

As part of implementation, a Dual Estimation Period (DEP) began in March 2014 to review the proposed methodology in a real-time environment and evaluate their impact on estimation. The DEP will continue through December 2014. A general analysis of the DEP results indicates that the estimation is consistent with the redesign objectives of addressing issues in current-year estimation. A strong statement cannot yet be made about the relationship of the redesign labor force estimates to current estimates.

Summary

With the introduction of the 2015 LAUS redesign, an improved real-time benchmarking procedure for our signal-plus-noise models will be used to produce labor force estimates for States and modeled substate areas. The current external pro-rata adjustment procedure will be replaced with a model-based procedure which is more responsive to the economic conditions and quality of survey data within individual States.

In addition, improvements to the treatment of outliers will prevent benchmarking from spreading the effects of these outliers to States where the outliers did not occur. The new structure greatly improves computational performance, which avoids costly production delays. Finally, improved trend-cycle filters remove the small but detectable residual seasonality in LAUS seasonally adjusted estimates.

LAUS program analysts believe that the changes in the State estimation methodology will greatly enhance the reliability and responsiveness of the signal-plus-noise model estimates. We look forward to comments from our partners, data customers and the general public. Through a process of discussion, consultation, dual estimation, and training, any issue that emerges in methodology, systems, documentation, or analysis will be addressed prior to formal implementation with January 2015 estimates.