Proposed Improvement in Estimating and Benchmarking State Labor Force Estimates[*]

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 7,000 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.[1] The LAUS estimates are used by a number of agencies in the United States to allocate more than $40 billion in Federal funds to States and areas for a variety of socioeconomic programs. 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. The strongest estimating method—signal-plus-noise models for current estimation and annual average CPS benchmarks—is employed at the State level and for four large areas—New York City, the Los Angeles metropolitan area, balance of New York State, and balance of California. While not reliable enough to use directly, the monthly CPS values are integral to the signal-plus-noise estimation. In order to ensure comparability across States, the annual average employment and unemployment levels from the CPS are used as the benchmarks for the modeled LAUS estimates. (In subsequent discussion, the term "State" will be used to refer to all modeled areas.)

In general, the current method of model estimation results in an overestimate of employment and an underestimate of unemployment and the unemployment rate in States as compared to the national CPS estimates. This is shown in the following charts which depict the differences in the LAUS sum of State and independent national CPS estimates from January 2000 to June 2004.

Chart 1: LAUS Sum-of-State minus CPS Employment,
Not seasonally adjusted, January 2000 - June 2004

Chart 2: LAUS Sum-of-State minus CPS Unemployment Level,
Not seasonally adjusted, January 2000 - June 2004

Chart 3: LAUS Sum-of-State minus CPS Unemployment Rate,
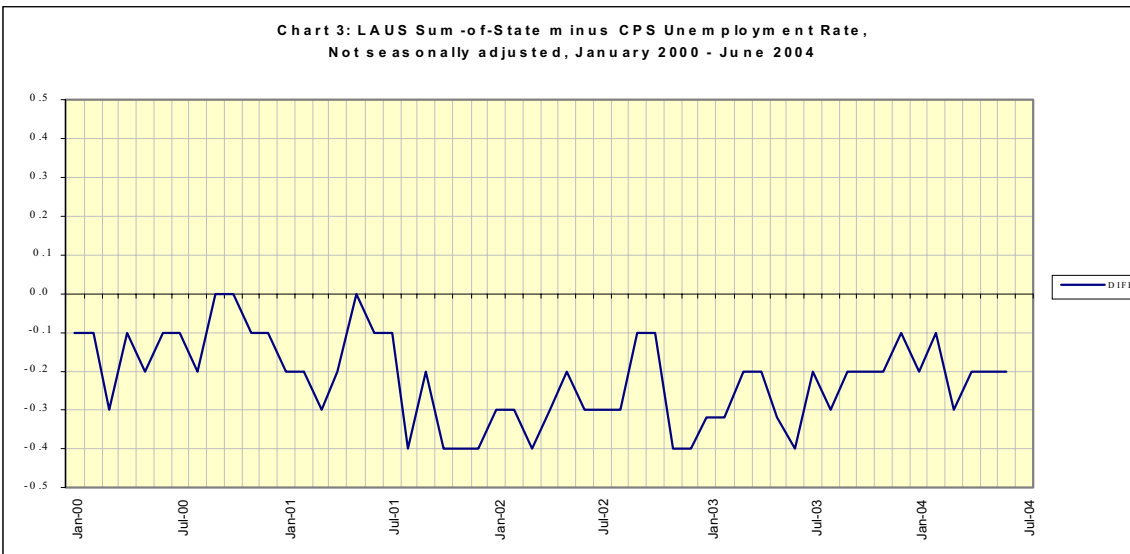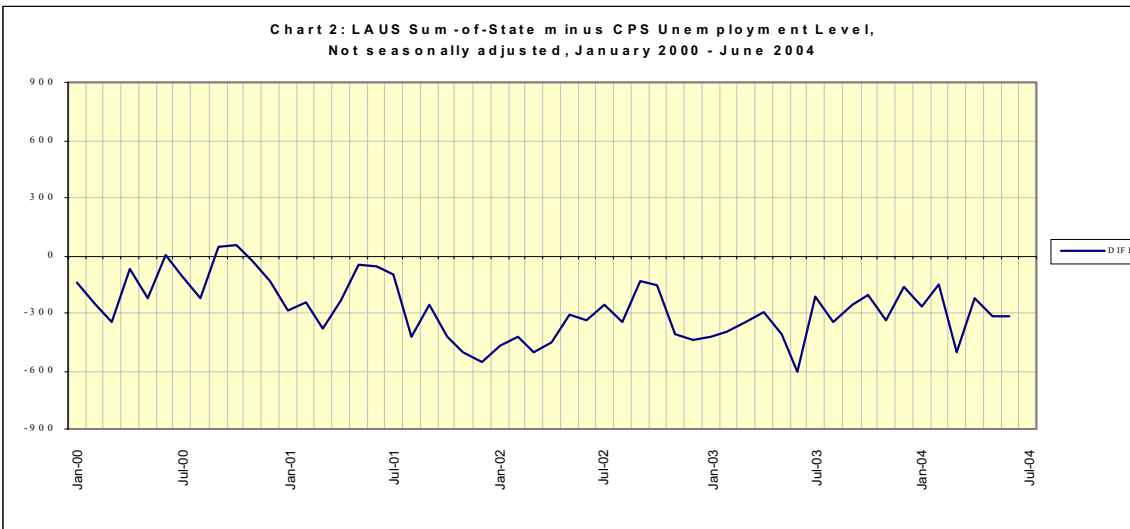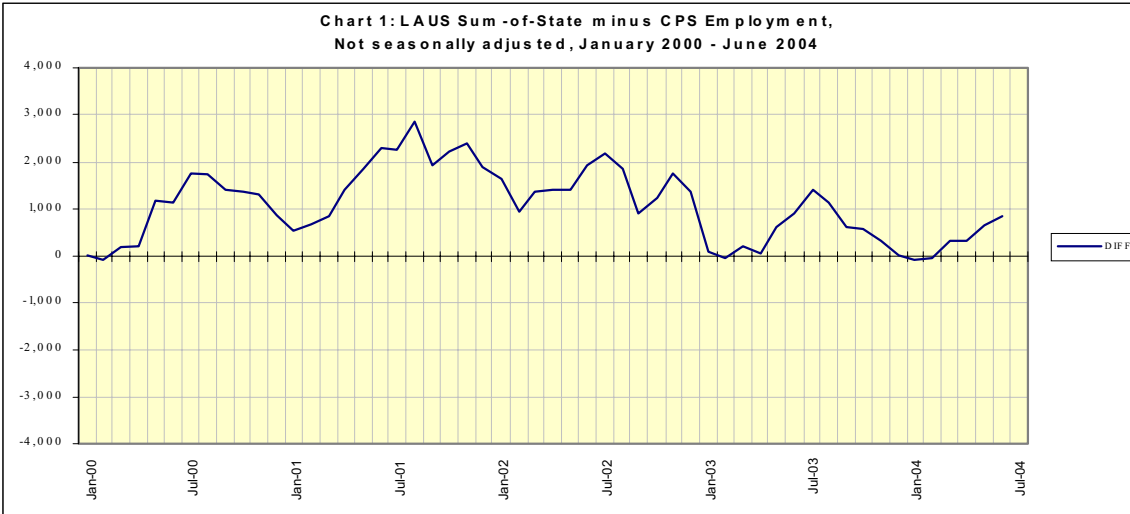**Not seasonally adjusted, January 2000 - June 2004**

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Chart 1 describes the relationship between the sum of State model-based estimates and the independent CPS-based estimate of employment for the nation. With the exception of four months, the LAUS model-based sum-of-State estimate has been higher than the CPS national estimate. The overestimation reached its highest levels in 2001. During that year, the nation went into a recession starting in March, and experienced the terrorist attacks of September. The State LAUS employment overestimation reached a peak of nearly 2.9 million in August 2001.

Chart 2 depicts the relationship between the sum of State model-based estimates of unemployment and the national estimate of unemployment. For this labor force measure, the model has, with the exception of three months, consistently underestimated unemployment relative to the national CPS measure. Consistent, large monthly underestimates of unemployment began in 2001. The average monthly difference was greatest in 2002 (-352,600), while the largest monthly difference (-602,000) occurred in June of 2003.

Chart 3 describes the relationship between the unemployment rate developed using the sum of State LAUS estimates and the CPS national measure. For nearly the entire period, the sum of State estimate falls below the independent national jobless rate. (In two months, the rates were identical.) While for many months, the difference is -0.2 percentage point or less, it is important to note that the direction of the difference is consistent. Starting in 2001, sum-of-States differences of -0.3 point and greater were reported with increasing frequency. In 2001, differences of -0.3 percentage point or more were recorded for five months, in 2002, for nine months, and in 2003, for five months.

To address the over- and underestimation associated with current model-based estimates, the model-based estimates of employment and unemployment are benchmarked to the respective annual average estimates from the CPS. However, the use of annual average State CPS benchmarks creates other problems. It reintroduces sampling error into the series and results in significant end-of-year revisions in a large number of States, causes economic anomalies that are an artifact of the benchmarking approach, distorts seasonality in the previous year so that analysis is impaired, and often misses shocks to the economy. (A detailed discussion of these issues follows.)

A Fiscal Year 2001 budget initiative provided BLS with resources to improve the methods used to develop State and area LAUS estimates, including upgrading and enhancing the modeling approach, extending it to more areas, and incorporating decennial updates to procedures, data inputs, and geography. As part of this major LAUS Program Redesign, BLS is proposing an innovative alternative to model benchmarking that will be part of improved monthly model-based estimation. This alternative will address longstanding issues related to accuracy and end-of-year revision, and also will enhance the analytical capability of the estimates.

The Redesign method of estimation will ensure that State estimates add to the national estimates of employment and unemployment each month (real-time benchmarking). In doing so, the benchmark will change from annual average State-level estimates of employment and unemployment to monthly national estimates of these measures, and will be part of current monthly estimation. In this way, economic changes will be reflected in the State estimates on a real-time basis, and end-of-year revisions will be significantly smaller.

The BLS and States are now in a one-year Dual Estimation Period (DEP), which allows for the evaluation of the proposed methods and systems, and the impact on estimation. With the successful completion of the DEP, and after Federal Register notification and comments, the LAUS Redesign estimation will be implemented with labor force and unemployment estimates for January 2005.

Current Modeling and Benchmarking Procedure

In 1989, time series models were first implemented in 39 small States and the District of Columbia for developing labor force estimates. In 1996, the time series approach to sample survey data was also extended to large States; thus, all States and the District of Columbia employed the time series methodology. The purpose of the approach is to reduce the high variability in monthly CPS estimates due to small sample sizes.

A signal-plus-noise form of the model is currently used, with the monthly CPS sample estimate described as the sum of the true labor force value (signal) and sampling error (noise). Two models—one for the employment/population ratio and one for the unemployment rate—are developed for each State. In estimating the signal, the employment-population ratio model uses the statewide monthly estimate of workers on nonfarm payrolls and intercensal population data, while the unemployment rate model uses counts of unemployment insurance claimants who file for the CPS reference week and nonfarm payroll data. Each model has a trend, seasonal, and irregular component, as well as the regression component. An important feature of the model is the use of the Kalman filter to update regression coefficients and trend and seasonal terms when gradual structural changes occur. The signal term allows the extraction of noise from the CPS time series data, thus providing a better estimate of the true value. The error term of the model reflects unique sampling error characteristics of the CPS, outliers, and irregular movements in the underlying true series. Seasonal adjustment is performed externally, with the application of X-11 ARIMA software to the unadjusted estimates.

Because of the potential for bias in the models and to ensure comparability in the estimates across all States, each year the monthly estimates of employment and unemployment are benchmarked to the respective CPS annual averages. (Also as part of annual benchmarking, the model inputs are revised as necessary, and the models are reestimated and smoothed in an iterative process that allows each observation to benefit from all observations in the series.) The primary external impetus for benchmarking to the CPS annual averages is to address the use of the estimates in distributing Federal funds. Beyond addressing this legislative use, benchmarking to the CPS is viewed as appropriate given the role of the CPS in providing the conceptual standard for the program.

The goal assigned to the statistical benchmarking procedure is twofold: (1) to ensure that the annual average of the final benchmarked series equals the CPS annual average and (2) to preserve the monthly pattern of the model series as much as possible. In practice, the two goals are conflicting, and some changes to the monthly pattern are necessary to meet the first goal. The particular approach used is the Denton method.

The Denton method combines a constraint feature (relating to goal 1) and a feature that maintains the monthly pattern of the original series (goal 2). The specific routine seeks to minimize the percent differences (squared) in the model/benchmarked series estimates from month-to-month. The method is used because of the overall modeling goal of accuracy of the month-to-month changes. The method is applied to three years in pairs of years, to minimize discontinuities within the benchmark period.

Issues with a Retrospective Benchmark to Annual Averages

An annual average CPS benchmark has been employed in the LAUS program since 1974, and the Denton method of benchmarking since 1989. The Denton method is a mechanical procedure that does not take into account the properties of the time series models and ignores the survey error. As a result, no reliability measures are available for the benchmarked estimates.

While achieving the specific goals of ensuring comparability of estimates across States and addressing potential bias in the models, a number of methodological and analytical issues have surfaced in the current estimation/benchmark procedures. These include reintroduction of sampling error to monthly estimates, discontinuities between December benchmarked and January model estimates, impaired comparability of data over the year, and inability to address, on a timely basis, "shocks" to the model such as the September 11 terrorist attacks and the onset of the economic recession.

Reintroducing sampling error

Despite the State-based sample design of the CPS, the State samples are fairly small (averaging about 950 households in small States and 2,200 in large States) and the resultant annual averages contain a significant degree of sampling error. On the other hand, the model does a very good job of removing error from the current CPS estimates. The noise component of the current signal-plus-noise model is a sophisticated measure of the error in the CPS related to the unique aspects of the CPS sample design, as well as outliers and variance. Thus, the current model estimate of the signal is viewed as a good estimate of the true labor force value.

- Because the variance of the model is less than the sampling error of the annual average CPS, by using the CPS annual average employment and unemployment levels as the point benchmarks, the current method puts variability back into the monthly estimates.

The reliability criterion for the State CPS sample is an 8 percent or less Coefficient of Variation on the annual average level of unemployment when the unemployment rate is 6 percent. This relates to a 90 percent confidence interval of ± 0.8 percentage point on the annual average unemployment rate in a typical State. Each year, some number of States will experience significant benchmark revisions that are related to the random nature of sampling error. In 2003, the benchmark revision for 10 States was 0.5 percentage point or more, with the maximum at 0.8 percentage point. Six of the States with large unemployment rate revisions to the 2003 CPS annual averages did not have significant revisions in the prior year, reflective of the random nature of the CPS variance. Model deterioration is assumed to be occurring for the Kansas and New Mexico estimation.

Comparison of State Unemployment Rate Benchmark Revisions in Selected States, 2000-2004

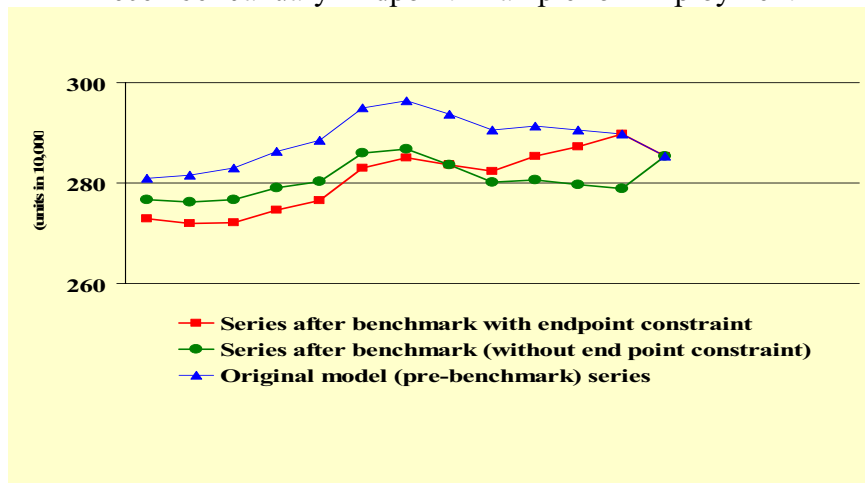| State | Total Unemployment Rate (TUR) Benchmark Revision | | | 2003 | | | |
| | | | | TUR | | Benchmark Revision | CPS Error Range on TUR* |
	2000	2001	2002	Model	CPS		
Arkansas	0.2	**0.5**	0.3	5.4	6.2	**0.8**	+/-0.7
Kansas	0.3	**0.5**	**0.6**	4.8	5.4	**0.6**	+/-0.5
Tennessee	0.2	0.2	0.2	5.2	5.8	**0.6**	+/-0.6
Alaska	**0.6**	0.4	**1.1**	7.5	8.0	**0.5**	+/-0.7
North Dakota	0.2	0.4	**0.7**	3.5	4.0	**0.5**	+/-0.5
New Mexico	**-0.6**	**-0.9**	**-0.6**	5.9	6.4	**0.5**	+/-0.7
Connecticut	0.0	**0.5**	0.4	5.0	5.5	**0.5**	+/-0.5
Kentucky	0.2	**0.8**	0.3	5.7	6.2	**0.5**	+/-0.6
Minnesota	**0.6**	0.1	0.3	4.5	5.0	**0.5**	+/-0.5
Vermont	0.2	**0.5**	-0.2	4.1	4.6	**0.5**	+/-0.4

*Error ranges are shown at the 90-percent confidence level and reflect the actual CVs.

- As long as the LAUS estimates are benchmarked to the CPS annual average, each year a small group of States will experience large noneconomic revisions in the series.

Discontinuity between December benchmarked and January model estimates: the Endpoint Effect

Under the current methodology, the previous year's December level—the endpoint of the benchmarking—reflects the adjustment to the CPS annual average and the sampling error that it contains, while the January estimate is model-based. December-January is a very seasonal period with predictable changes in employment in many States. Depending upon the size and direction of the employment benchmark revision in the State, the December-January employment change may not reflect economic reality. Rather, it will be an artifact of the benchmarking method. In the past, procedures were instituted that maintained the December-January model relationship for employment (the November endpoint), but they created serious distortion in the historical series.

December-January Endpoint Example for Employment

- ■ Series after benchmark with endpoint constraint
- ● Series after benchmark (without end point constraint)
- ▲ Original model (pre-benchmark) series

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- Here, too, as long as an annual average benchmarking approach is used, the December-January employment change in a small group of States will be at variance with expected seasonal movement

Impaired analysis over the year

Regardless of whether the endpoint was moved to November (to preserve the December-January change) or kept at December, the ability to analyze over-the-year change in labor force series is compromised in a number of States each year. With a November endpoint, the difference between the annual average of the model series and the CPS was forced into eleven months, causing the series to rotate around August. This distortion in the series affected analysis of the labor force data over time. Even with the December endpoint, comparisons of modeled to benchmarked estimates can provide spurious results, depending on the size of the benchmark revision in the State.

Distortion in Historical Series Due to Benchmarking
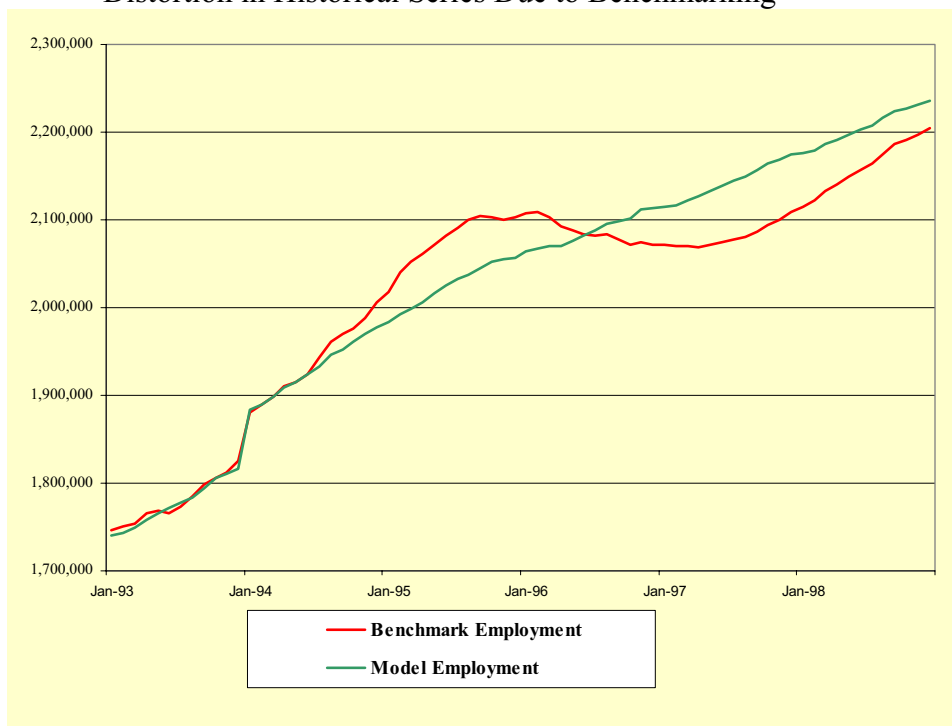
- Each year, the ability to analyze over-the-year change in labor force estimates is compromised in a number of States.

Addressing "shocks" to the series: Sum of States versus National Estimates

In the current methodology, the State model estimates are developed independent of the national CPS. Although the monthly State CPS input data sum to the national measures, the sum of the

State model estimates generally do not equal the national CPS estimates. To evaluate model performance, each month the sum of the State model estimates is compared to the national CPS estimates. Until 2001, the difference between the sum of State model estimates and the national CPS was well within sampling error of the national estimates. In 2001, significant deviations occurred in the sum of States versus national CPS measures in a number of months, specifically March, August, and October-December. Economic shocks to the national economy related to the onset of the recession and to the September 11 terrorist attacks occurred in these months. These economic shocks were not reflected in the State model estimates because the model viewed the increase in the State CPS unemployment in these periods as related to sampling error. Most evident is the post-September 11 period, exacerbating the economic recession, and continuing into 2002. The inability of the current methodology to provide protection for economic shocks negatively impacts the use of the estimates in federal fund allocation and in labor market analysis.

Difference between LAUS sum-of-States and CPS national unemployment rates,
1996-2004 to date

Month	1996	1997	1998	1999	2000	2001	2002	2003	2004
Not seasonally adjusted									
January	-0.2	-0.2	-0.1	0.0	-0.1	-0.2	-0.4	-0.3	-0.2
February	-0.1	-0.2	-0.1	-0.1	-0.1	-0.2	-0.3	-0.3	-0.1
March	-0.2	-0.3	-0.3	0.0	-0.3	-0.3	-0.4	-0.2	-0.3
April	-0.2	0.0	0.1	-0.1	-0.1	-0.2	-0.3	0.2	-0.2
May	-0.2	-0.1	0.0	0.0	-0.2	0.0	-0.2	-0.3	-0.2
June	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.3	-0.4	-0.2
July	-0.1	0.0	-0.1	-0.2	-0.1	-0.1	-0.3	-0.2	
August	0.0	-0.1	-0.2	-0.2	-0.2	-0.4	-0.3	-0.3	
September	0.0	0.0	-0.1	-0.1	0.0	-0.2	-0.1	-0.2	
October	-0.1	0.1	-0.1	0.0	0.0	-0.3	-0.1	-0.2	
November	-0.1	0.1	0.0	0.0	-0.1	-0.3	-0.4	-0.2	
December	-0.1	-0.1	0.0	0.0	-0.1	-0.4	-0.4	-0.1	
Seasonally adjusted									
January	-0.1	-0.2	-0.2	-0.1	-0.1	-0.2	-0.2	-0.1	-0.1
February	-0.1	-0.3	-0.1	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1
March	-0.1	-0.2	-0.1	0.0	-0.1	-0.2	-0.1	0.0	-0.2
April	-0.2	-0.2	0.0	-0.2	-0.1	-0.2	-0.4	0.2	-0.3
May	-0.2	0.0	0.0	0.0	-0.2	-0.1	-0.3	-0.3	-0.3
June	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.5	-0.3
July	-0.2	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3	-0.3	
August	0.1	0.0	-0.1	-0.1	-0.1	-0.3	-0.2	-0.2	
September	0.0	0.0	0.0	-0.1	0.0	-0.3	-0.2	-0.3	
October	-0.1	0.0	-0.1	0.0	0.0	-0.4	-0.2	-0.3	
November	-0.3	0.1	0.0	-0.1	-0.1	-0.4	-0.5	-0.3	
December	-0.2	-0.1	-0.1	-0.1	-0.1	-0.5	-0.4	-0.1	

- The current methodology provides no real-time protection to the State estimates, since benchmarking is held to the end of the year.

Proposed Method: Models with Real-time Benchmarking

As part of the LAUS Redesign, the signal-plus-noise univariate models of the unemployment rate and the employment-population ratio will be replaced. The Redesign models are also signal-plus-noise models, where the signal is a bivariate model of the unemployment or employment levels. The unemployment insurance claims and nonfarm payroll employment inputs themselves are modeled, as well as their interaction with the appropriate CPS series. Seasonal, trend, and irregular components are developed for each modeled estimate. Seasonal adjustment occurs within the model structure through the removal of the seasonal component. The models produce reliability measures for the seasonally adjusted and not seasonally adjusted series, and on over-the-month and over-the-year change.

The Redesign bivariate models incorporate a major change in the approach to benchmarking and the benchmarking process. Rather than continue with an <u>annual</u> <u>average State</u> benchmark <u>applied</u> <u>retrospectively</u> that reintroduces sampling error to the historical monthly estimates, the proposed approach uses a reliable <u>real-time</u> <u>monthly</u> <u>national</u> benchmark for controlling current State model estimates of employment and unemployment. In this process, benchmarking is part of the monthly State model estimation process, rather than a once-a-year retrospective adjustment.

The model-based approach to estimation and benchmarking will produce reliability measures that take into account survey error in the monthly State estimates, as well as error in the benchmark series (including any correlations between the State and national survey errors) and estimation error in the models. Through historical benchmarking to the national CPS estimates, the resultant series will not be distorted, so that historical analysis of the estimates will be improved.

<u>General methodological approach</u>

Under real-time benchmarking, a tiered approach to estimation is used. Model-based estimates are developed for the nine Census divisions that geographically exhaust the nation using univariate signal-plus-noise models. (Census division groupings are currently used to analyze and publish LAUS estimates.) The division models are similar to the State models, but do not use unemployment insurance claims or nonfarm payroll employment as variables. This allows division models to be developed without sacrificing reliability, in a very timely manner. The division estimates are benchmarked to the national levels of employment and unemployment on a monthly basis. The benchmarked division model estimate is then used as the benchmark for the States within the division. That is, State model-based estimates are controlled to add to the division employment and unemployment. The distribution of the monthly benchmark adjustment to the States will be based on each State's monthly model estimate.

In this manner, the monthly State employment and unemployment estimates will add to the national levels, precluding differences between the sum of States and the national estimates, and national shocks related to the business cycle or to an event such as the terrorist attacks of September 11 will be addressed.[2]

Annual historical benchmarking would still continue for State estimates but would be greatly altered. The updating of model inputs, model reestimation, and incorporation of updated population controls would be performed each year, as well as adjustment of the revised State model estimates to the national CPS employment and unemployment levels each month. However, the impact on the historical series of these benchmark activities is considered to be fairly small, especially in comparison with annual revisions using the current methodology.

Dual Estimation Period and Implementation Plan

The introduction of bivariate models with real-time benchmarking is viewed as one of the most significant methodological changes to be introduced in the LAUS program. The new estimation approach will ensure additivity of the State estimates to national estimates on a monthly basis, thus addressing the timely reflection of economic events and reducing the expected size of the annual revision to the series. For the first time, estimated standard errors for seasonally adjusted estimates will be provided, in addition to reliability measures for the not seasonally adjusted series and on over-the-month and over-the-year change.

As part of implementation, a Dual Estimation Period (DEP) began in February 2004 so that proposed methodology and operational systems can be reviewed in a real-time environment and the impact on estimation can be evaluated. The DEP will continue through December 2004. A general analysis of the DEP results indicates that the estimation is consistent with the Redesign objectives of addressing issues in current estimation. In brief, the new models with real-time benchmarking result in higher Redesign estimates of unemployment and the rate and lower estimates of employment, and address the consistent under- and over-estimation described in Charts 1-3. Thus, the new estimates of both employment and unemployment at the State level are expected to be more accurate using the new methodology than with the current procedures.

In the first six months of Dual Estimation, monthly estimates of unemployment and the unemployment rate (not seasonally adjusted) developed using the Redesign method are somewhat higher than the measures based on the current official method. In nearly six out of ten comparisons of the Redesign estimates and current estimates, the monthly Redesign unemployment rate not seasonally adjusted has differed from the current measure by no more than ±0.2 percentage point. In about one out of seven instances, the difference for a month's unemployment rate estimate was 0.5 percentage point or higher. A similar pattern was recorded for seasonally adjusted unemployment rates in the January-June period. Month-to-month changes in not seasonally adjusted Redesign unemployment estimates were slightly more volatile than the current series.

A strong statement cannot yet be made about the relationship of the Redesign employment estimates (not seasonally adjusted) to current employment estimates. In January and February, the Redesign estimates were higher than the current estimates in more than half of the States, while in March through June, more States had Redesign estimates that were below their current measures. In previous years, significant divergences in the sum of States and the national employment estimates were not evident until the latter part of the year. Considering the seasonally adjusted series, in general, the Redesign employment estimates were below current estimates from January through June. Month-to-month changes in the not seasonally adjusted

and seasonally adjusted Redesign employment estimates appear to be of the same magnitude as the current series.

A Federal Register Notice announcing the proposed LAUS Program Redesign and requesting comments is targeted for November 8. Through a process of discussion, consultation, dual estimation, and training, any issue that emerges in methodology, systems, documentation, or analysis will be able to be addressed prior to formal implementation with January 2005 estimates.

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[1] Information on the technical procedures used in the Local Area Unemployment Statistics program can be obtained from the BLS Handbook of Methods, Bulletin 2490, August 1997, and from the BLS Internet at http://www.bls.gov/lau/.
[2] For a description of the proposed statistical approach, see *State-Space Modeling with Correlated Measurements with Application to Small Area Estimation Under Benchmark Constraints*, D. Pfeffermann and R. Tiller; State Space and Unobserved Components Models in Honour of Professor J. Durbin, Amsterdam, 2002.