Chapter 4. Measurement of Unemployment in States and Local Areas

Estimates of unemployment in states and local areas are key indicators of local economic conditions. These estimates are produced by the Local Area Unemployment Statistics (LAUS) program and used by state and local governments for planning and budgetary purposes and as determinants of the need for local employment and training services and programs. They also are used by economic forecasters, researchers, and bond and mortgage underwriters. In addition, local area unemployment estimates are used to determine the eligibility of an area for benefits in various federal assistance programs.

The LAUS program is a Federal-State cooperative program. The Bureau of Labor Statistics (BLS) develops concepts, definitions, and technical procedures and then works with state workforce agencies, who prepare labor force and unemployment estimates. Monthly and annual average estimates of employment and unemployment are prepared in state agencies for more than 7,300 unique geographic areas: states, the District of Columbia, and Puerto Rico; labor market areas (LMAs), such as metropolitan and micropolitan areas; counties and equivalents; cities with a population of 25,000 or more; and all cities and towns in New England, regardless of population.

IN THIS CHAPTER

Background and History

Unemployment estimates have been developed for subnational areas for nearly 70 years. The program began during World War II under the War Manpower Commission, with the aim of identifying areas where a labor market imbalance had been created due to inadequate labor supply, material shortages, or transportation difficulties. After the war, emphasis was placed on identifying areas of labor surplus, and a program of classifying areas in accordance with severity of unemployment was established.

In 1950, the Department of Labor's Bureau of Employment Security (now Employment and Training Administration) published a handbook, *Techniques for Estimating Unemployment*, so that comparable estimates of the unemployment rate could be produced for all states. This led to the formulation of the "handbook method" in the late 1950s. The handbook method is a series of computational steps designed to produce local employment and unemployment estimates, using available data at a much lower cost than a direct survey. The handbook method relies heavily on data derived from the unemployment insurance (UI) system. (See section "Estimates for Substate Areas—The handbook method.")

In 1972, BLS assumed technical responsibility for the program and began to refine the concepts and methods used to estimate the labor force, employment, and unemployment at the subnational level. In 1973, a new system for developing labor force estimates was introduced, combining the handbook method with the concepts, definitions, and estimation controls from the Current Population Survey (CPS). The CPS, a monthly BLS survey conducted by the Census Bureau, is used to measure the labor force status of individuals for the nation as a whole. (See chapter 1.) CPS estimates are based on data from a sample of households that is designed to provide reliable monthly unemployment estimates for the nation and reliable annual average estimates for the 50 states and the District of Columbia. A major advantage of the CPS is that it applies uniformly across states, whereas UI data are affected by individual states' UI laws.

Since 1973, the CPS sample size has been increased (and reduced to a lesser degree) several times in selected states, and the design has been modified to improve the quality of state labor force estimates. As a criterion for using the monthly CPS data directly for official publication of labor force estimates, a maximum expected coefficient of variation (CV) of

10 percent for unemployment—assuming an unemployment rate of 6 percent—was established by BLS. (The coefficient of variation of an estimate is defined as the standard error of the estimate divided by the estimate itself.) On the basis of this criterion, beginning in 1978 the monthly CPS data were used for official statewide labor force estimates for 10 large states—California, Florida, Illinois, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, and Texas—and for 2 substate areas—the Los Angeles–Long Beach metropolitan area and New York City. These states and areas were referred to as "direct-use" areas, because they used the CPS data without any mathematical or statistical adjustments. Official monthly estimates for the remaining "non-direct-use" states were based on the handbook method adjusted to CPS controls, using a historical 6-month moving-average ratio adjustment.

In 1985, a state-based design for the CPS was fully implemented for the first time, to incorporate 1980 Census information and to improve reliability for each of the 50 states and the District of Columbia. North Carolina was added as another direct-use state, and the CV requirement for monthly unemployment was reduced to 8 percent for these 11 large states. For each of the other 39 (non-direct-use) states and the District of Columbia, the reliability requirement was established at an 8-percent CV for annual average unemployment, assuming a 6-percent unemployment rate.

Beginning in 1989, handbook estimation for the 39 non-direct-use states and the District of Columbia was discontinued in favor of time-series statistical modeling. The models were developed by BLS and tested by state workforce agencies. (Estimates for most substate areas continue to be based on the handbook method.)

Estimates for the large, direct-use states had been seasonally adjusted since 1978. In 1992, seasonal adjustment was extended to the model-based estimates for the non-direct-use states. In 1994, in conjunction with a major redesign of the CPS, a second generation of time-series models was introduced, based on a "signal-plus-noise" approach.

In 1996, in response to budget reductions, the number of households in the CPS sample was temporarily reduced, resulting in the elimination of direct use of the CPS for monthly estimation in the 11 large states, the Los Angeles-Long Beach metropolitan area, and New York City. Beginning with January 1996, labor force estimates for these subnational areas have been based on the time-series modeling approach used in the other 39 states and the District of Columbia.

In 2005, improved third-generation time-series estimates for modeled areas were introduced, along with real-time benchmarking of state estimates to the national CPS estimates. (See the section "Estimates for States—Real-time Benchmarking.") Also introduced were new time-series models for five metropolitan areas and the respective balances of their states, as well as improved substate estimation in the handbook method.

In 2010, a process for smoothing the seasonally adjusted estimates was introduced for all model-based areas. In 2011, seasonal adjustment, including the smoothing process, was introduced for metropolitan areas and metropolitan divisions.

Estimation Methodology

Estimates for states

Monthly labor force data for all states and the District of Columbia are based on the time-series approach to sample survey data (Scott, Smith, and Jones, 1974; Bell and Hillmer, 1990). This approach reduces the high variability in monthly CPS estimates that results from these areas' small CPS sample sizes. Actual monthly CPS sample estimates are represented in signal-plus-noise form as the sum of a stochastic true labor force series (signal) and error (noise) generated by sampling only a portion of the total population, where:

$$y_t = Y_t + e_t,$$

y_t = CPS estimate,

Y_t = true labor force value (signal), and

e_t = sampling error (noise).

The signal is represented by a time-series model that incorporates historical relationships in the monthly CPS estimates, along with auxiliary data from the UI and Current Employment Statistics (CES) programs. (See chapter 2.) This time-series model is combined with a noise model that reflects key characteristics of the sampling error (SE), to produce estimates of the true labor force values (Tiller, 2006). This estimator is optimal under the model assumptions and has been shown by Bell and Hillmer (1990) to be design consistent under general conditions.

Two models—one for the unemployment level and a second for the employment level—were developed for each state, on the basis of data from 1976 forward. The labor force level and unemployment rate are derived from the employment and unemployment measures produced by the two respective models. The signals for both models are based on a basic structural model that decomposes a series into stochastic trend-cycle (T_t), seasonal (S_t), and irregular (I_t) components (Harvey, 1989). The model is of the form:

$$Y_t = T_t + S_t + I_t.$$

The trend-cycle and seasonal components have mutually independent normal disturbance terms that cause them to drift slowly over time. The variances of these disturbances constitute the hyperparameters of the signal and determine the properties of the individual components. A positive variance for a component implies that it is stochastic (not perfectly predictable from past history), while a zero variance implies deterministic behavior (a fixed pattern over time). The irregular is treated as an uncorrelated zero-mean disturbance with fixed variance.

The model uses information from state CPS time series. A natural extension of the structural model is to allow one

or more of the unobserved components of the signal to be related to corresponding components in another series. A common core of state-specific monthly covariates have been developed from auxiliary data sources: UI claims from the Federal-State UI system are used for the unemployment model, and nonagricultural payroll employment estimates from the CES program are used for the employment model. The model for the covariate, X_t, follows the same basic structural form as for Y_t, with stochastic trend, seasonal, and irregular components. The two series, Y_t and X_t, are treated as related in a bivariate time-series model with contemporaneous correlations between their respective trend disturbances (a special case of the seemingly unrelated time-series equations model; see Harvey, 1989). Correlations between irregular and seasonal components could be allowed, but because they are very weak, adding further complexity would result in little gain.

The bivariate model just described can accommodate a wide variety of evolving CPS time-series patterns and covariate relationships. The degree to which the time-series components vary over time is determined empirically for each state. In some cases, the seasonal component is estimated to have a fixed pattern from year to year. For most models, the irregular component is zero. Also, the degree of correlation between the trends in the CPS and the covariates is determined empirically. The strongest relationship occurs when there is a linear relationship between the trend levels and/or growth rates (cointegration). For most of the CPS series, empirical correlations are not strong enough to imply the presence of cointegration with the covariates. For some series, the trend correlations are effectively zero.

Occasionally, there are sudden changes, either temporary or permanent, in the CPS that are not predictable from past history. These aberrant observations, or outliers, are modeled with exogenous regression variables that introduce independent outlier components into the model's components. The most common types of outliers are permanent shifts and transitory changes in the level of the series. For example, a level shift was introduced into the Louisiana models to account for Hurricane Katrina.

The second major component of the signal-plus-noise model deals with CPS sampling errors (Tiller, 1992). Because of this survey's complex design, the behavior of the observed sample estimates differs in important ways from that of the true values. Sampled households are rotated in and out of the CPS over a period of 16 months, such that 75 percent of the sample from month to month consists of the same households and 50 percent from year to year. (See chapter 1.) Also, sample redesigns and large fluctuations in the size of the labor force cause changes in the variance of the estimates. These two features of the CPS—an overlapping sample design and changes in reliability—induce strong positive autocorrelation and heteroskedasticity in the standard errors. These characteristics can seriously contaminate estimates of the true labor force if the sampling error is ignored in the estimation process. For this reason, it is important to specify a model of the standard error process and combine it with the model of the signal, to estimate the unobserved components of the CPS. The standard error model is specified as:

$$e_t = \gamma_t e^*_t,$$

with e^*_t reflecting the autocovariance structure, assumed to follow an autoregressive moving average (ARMA) process, and γ_t representing a changing variance over time. The parameters of the ARMA model are derived from sampling error autocorrelations developed independently of the time-series model from design-based information. The CPS error variances are estimated using the method of generalized variance functions (Zimmerman and Robison, 1996).

The unknown hyperparameters of the signal are estimated by maximum likelihood, using the Kalman filter algorithm. Given these estimated hyperparameters, the Kalman filter is used to decompose the observed CPS into its signal and noise components. This algorithm efficiently updates the model estimates as new data become available each month. For the latest month, the Kalman filter calculates estimates on the basis of all available data but does not revise estimates for the previous months with the latest data. Previous estimates are updated by a Kalman filter "smoother," which revises a given period's estimate by using all data available, both prior and subsequent to the month. This smoothing procedure is performed only at the end of each year.

Real-time Benchmarking. LAUS model estimates are adjusted by means of a process of real-time benchmarking, whereby each month state model estimates are "ratio adjusted" to the CPS national estimates of employment and unemployment, such that the not seasonally adjusted estimates for all states and the District of Columbia sum to the national levels. By forcing state model estimates to add to current monthly national CPS estimates, real-time protection is provided for the models, because the benchmarked estimators will reflect this change as it occurs, whereas the original model estimators would be slower to adapt. Another benefit of benchmarking is to ensure comparability between estimates at different levels of geography.

Real-time benchmarking occurs in a two-step process. First, employment and unemployment estimates for Census divisions are created from CPS-only univariate signal-plus-noise models that are controlled to the national CPS estimates. Then, state model estimates are controlled to the appropriate division estimates.

Smoothed Seasonal Adjustment Process. In 2010, a smoothed seasonal adjustment (SSA) process was introduced to reduce the number of spurious fluctuations in the seasonally adjusted estimates due primarily to noise introduced in real-time benchmarking. State labor force estimates are smoothed with the use of the Henderson trend filter, which uses weighted moving averages to suppress irregular fluctuations in the seasonally adjusted series, leaving the trend more visible. Two-sided, symmetric moving averages (up to 13 months in

length) are used to smooth the historical series, while a one-sided, asymmetric (7-month) average is used in real time.

Estimates for substate areas

Modeled substate areas

Labor force estimates for the Los Angeles-Long Beach-Glendale, CA, Metropolitan Division (formerly the Los Angeles-Long Beach metropolitan area) and New York City have been developed since 1978, first as direct-use areas and then using bivariate signal-plus-noise models. In 2005, signal-plus-noise models for five additional substate areas and their respective state balances were introduced. The areas are the Chicago-Joliet-Naperville, IL, Metropolitan Division; the Cleveland-Elyria-Mentor, OH, Metropolitan Statistical Area; the Detroit-Warren-Livonia, MI, Metropolitan Statistical Area; the Miami-Miami Beach-Kendall, FL, Metropolitan Division; and the Seattle-Bellevue-Everett, WA, Metropolitan Division. (Model-based estimation also was initiated for the New Orleans-Metairie-Kenner, LA, Metropolitan Statistical Area but was discontinued following Hurricane Katrina, due to the storm's impact on the CPS sample and data collection.) These area models are based on the classical decomposition of a time series into trend, seasonal, and irregular components. A component to identify and remove the CPS sampling error also is included. Area models, like the Census division models, are univariate in design in that only the historical relationship of the CPS inputs is considered—UI claims counts and CES estimates are not used in the estimation process. Area and balance-of-state models are controlled directly to the state benchmarked model totals, which are themselves controlled to the national CPS via the Census division models, as described above.

The handbook method

Until 1973, the handbook method was the only means used to develop state and local area labor force and unemployment estimates. With the exception of the seven substate area models discussed, the handbook method continues to be used for substate estimation. This method is an effort to use available information to create employment and unemployment estimates for an LMA that are comparable to what would be produced by a representative sample of households in that area, without the expense of conducting a large labor force survey like the CPS. The method presents a series of estimating building blocks, for which categories of employed and unemployed workers are estimated and then summed.

Employment. The total employment estimate for a particular area is based on data from several sources. The main sources are the CES survey, the state-designed monthly survey of establishments, and the Quarterly Census of Employment and Wages (QCEW), a universe count of employment covered by the UI system. (See chapter 5.) These sources are designed to produce estimates of the total number of employees on payrolls in nonfarm industries for a particular area.

Because employment estimates from these sources are based on the location of the establishment, these "place-of-work" estimates must be adjusted to reflect the place-of-residence concept used in the CPS survey of households. Resident employment includes workers living and working in the same area and also those who work in other areas within commuting distance. Estimates of resident employment should, therefore, reflect employment changes in those related commutation areas as well. In 2005, LAUS introduced dynamic residency ratios (DRRs) to provide this adjustment. Multiple residency adjustment ratios were produced, using Census 2000 county-to-county worker commuting data and March/April 2000 total nonfarm job estimates. Separate residency adjustment ratios were developed for each estimating area and up to four additional labor market areas into which at least 100 residents commuted to work. Ratios for each of the commuting areas are multiplied by their respective monthly nonfarm jobs estimates to produce estimates of estimating area residents who work in each of the commuting areas. Separate commuting area estimates are summed to create a total of the resident nonfarm wage-and-salary employed for the estimating area. This adjustment also accounts for multiple jobholding and unpaid absences in the payroll employment estimates.

Estimates for employment not represented in the establishment series—agricultural workers and nonfarm self-employed, unpaid family, and private household workers—are derived by extrapolation from the decennial census. These components, plus the wage and salary component, represent total handbook employment. To develop estimates for employment not covered by the establishment series, census counts are used as base-period estimates to which change factors are then applied. Estimates of nonfarm self-employed, unpaid family, and private household workers are developed from change factors based on monthly CES and CPS data. Agricultural employment estimates are developed from change factors based on monthly and annual CPS data.

Unemployment. The estimate of unemployment is an aggregate of the estimates for each of the two building-block categories: those covered by the UI system and those outside its scope ("noncovered"). The covered category consists of (a) those who are currently receiving UI benefits and (b) those who have exhausted their benefits. The noncovered category consists of those who are ineligible to receive UI benefits.

A count of the covered unemployed who collected UI benefits during the reference week (the week of the 12th) and also had no earnings due to employment is obtained directly from state, federal, and railroad unemployment programs. Estimates of unemployed persons who have exhausted their benefits ("exhaustees") are based upon the number of claimants who received their final payments in the week before the reference week, plus an estimate of exhaustees from previous periods who are still unemployed. This calculation involves estimating the percentage of long-term unemployed who continue to remain unemployed each week and applying that percentage to the exhaustee pool.

Noncovered unemployed are those persons who are not in the scope of the UI system. Many of the unemployed were not employed immediately before their current spell of unemployment and, thus, did not meet the wage and employment experience requirements to qualify for UI compensation. Because UI compensation is not a criterion for determining unemployment status in the CPS, these individuals, known as entrants to the labor force, are counted as unemployed and included in LAUS estimates.

Unemployed entrants are divided into two groups: new entrants and reentrants. New entrants are individuals who have entered the labor force for the first time. Reentrants are individuals who have reentered the labor force after a period of neither employment nor unemployment. Both new entrants and reentrants are estimated from state-level CPS data on a 5-year weighted-average for each month. Then, the averages for each state are controlled to the corresponding national total for the current month. Next, these adjusted statewide entrant totals are distributed to each LMA, using population shares based on the latest annual July 1 population estimates from the Census Bureau. An LMA new entrant estimate is calculated as its share of the state population ages 16–19, multiplied by the total statewide new entrant estimate. Reentrants are estimated by a similar procedure, using each LMA's share of the state population ages 20 years and older and the statewide reentrant total.

Substate adjustment for consistency and additivity. Each month, handbook estimates are prepared for LMAs that exhaust each state geographically. To obtain an estimate for a given area, a "handbook share" is computed for that area; this is defined as the ratio of the area's handbook estimate to the sum of the handbook estimates for all LMAs in the state. The area's handbook share is then multiplied by the current statewide modeled estimate to produce the final adjusted LMA estimate of employment:

$$E_{a(t)} = E_{s(t)} * HB_{a(t)} / \Sigma HB_{a(t)},$$

where:

E = total employment,

HB = handbook employment,

a = area,

s = state, and

t = time.

A comparable adjustment is performed for unemployment.

Estimates for parts of LMAs

Current labor force estimates at the sub-LMA level are required by several federal allocation programs. However, the handbook method was not designed for these small areas, because the data required to compute independent handbook estimates generally are not available. Based on data availability, two alternative methods are used to disaggregate the LMA estimates to the subarea level.

The population-claims method is the standard technique for unemployment. If residence-based UI claims data are available for the subareas within the labor market area, the ratio of the subarea to the total number of claims within the LMA is used to disaggregate the estimate of covered unemployed to the subarea level. The estimate of unemployed entrants is allocated on the basis of the latest annual distribution of adult and teenage population groups. When the population-claims method is used for unemployment, employment is disaggregated with the use of current population distributions prepared by the Census Bureau and weighted by each area's decennial census relative share of employment to population. This preferred combination of techniques is used to derive estimates for all counties in multicounty LMAs and for cities in nearly all states.

If the necessary UI claims data are not available at the subarea level, the census-share method is used. This method uses each subarea's decennial census share of county employment and unemployment, respectively, to disaggregate the monthly subarea (that is, city) estimates of employment and unemployment.

Smoothed seasonal adjustment of metropolitan areas

Employment and unemployment estimates for metropolitan areas and metropolitan divisions are seasonally adjusted and smoothed each month, using one of two methods. One option is a non-model-based X-11 Auto-Regressive Integrated Moving Average (ARIMA) method. The preferred option is a model-based approach known as Signal Extraction in ARIMA Time Series (SEATS). The approach that yields the best fit is used for each employment and unemployment time series. Once labor force estimates are seasonally adjusted, they are smoothed, using the same Henderson trend filter (H13) used in state estimation. These data were made available on the BLS website in mid-2011 and will be integrated into news releases and the time-series database at a later date.

Annual Processing

At the end of each year, LAUS conducts a review of model performance. States provide information about their economies. Month-to-month movements and observations are examined to determine if they are reflective of economic events or if any should be considered outliers.

At the beginning of each year, LAUS receives new population controls from the Census Bureau. CPS estimates for states, Census divisions, and the United States are revised, using these new estimates of the civilian noninstitutional population ages 16 and older. Revisions to state model inputs—specifically, CES and UI—also are received. State and substate models then are reestimated to incorporate changes in inputs and population controls, using all data in the series. Revised statewide estimates are controlled to updated Census

division models that sum to national totals, all reflecting the new population controls. (The official U.S. totals generally are not updated to reflect new population estimates.) Revised seasonally adjusted estimates are smoothed with the Henderson-13 symmetric filter, incorporating the current month and 6 prior and subsequent months. Toward the end of the series, where there are fewer than 6 subsequent months of data, an asymmetric filter is used.

Substate estimates are revised to incorporate any changes in the inputs, such as revisions in the place-of-work-based employment estimates, revisions to claims data, and updated historical relationships. Area handbook estimates then are revised and readjusted to sum to the revised state estimates of employment and unemployment. Areas for which the estimates are disaggregated are revised, using updated population estimates.

Uses and Limitations

Estimates of unemployment and the unemployment rate are used by federal agencies to determine the eligibility of an area for benefits under various federal programs. These include: the Workforce Investment Act (WIA), the Temporary Assistance for Needy Families (TANF) program, the Emergency Food and Shelter Program (EFSP), The Emergency Food Assistance Program (TEFAP), the Historically Underutilized Business Zones (HUBZone) program, and Labor Surplus Area (LSA) designations. Under most programs, unemployment data are used to determine the distribution of funds to be allocated to each eligible area. In the case of the HUBZone and LSA designations, data are used in the determination of area eligibility for benefits.

In 2005, improved time series models introduced reliability measures for the seasonally adjusted and not seasonally adjusted series and for over-the-month changes. In 2008, reliability measures were implemented for over-the-year changes. In early 2007, model-based error measures became available for annual average estimates. Model-based error measures are available for regions, divisions, and states. (See Information on Model-Based Error Measures for Regions, Divisions, and States on the BLS website.) Analysis in the monthly *Regional and State Employment and Unemployment* news release reflects the use of these error measures.

Estimates not directly derived from sample surveys or statistical modeling are subject to errors resulting from the estimation processes used, as well as the limitations of the data sources used. The error structure associated with these estimates is complex, and information on the magnitude of the overall errors is not available.

Data products. Data from the LAUS program are made available to users in a variety of ways. Labor force and unemployment data are published monthly for Census regions and divisions, states, and the model-based substate areas in a news release entitled *Regional and State Employment and Unemployment*. Estimates for metropolitan areas and divisions are published monthly in a news release entitled *Metropolitan Area Employment and Unemployment.*

Annual average data are published each year in a news release entitled *Regional and State Unemployment*, which typically is issued in late February. This release presents data on the population, civilian labor force, employed, unemployed, and unemployment rate for regions, divisions, and states. Annual average information for states and metropolitan areas also is published each spring in *Employment and Earnings Online*.

Current and historical data from the LAUS program for all 7,300 areas also are available online in the Bureau's public database. Users may access the data via the BLS website (www.bls.gov/data/) or by anonymous FTP (ftp://ftp.bls.gov/pub/time.series/la/). Additional information about the LAUS program, including frequently asked questions, contacts, and technical references, are online at the LAUS homepage (www.bls.gov/lau/).

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