Revisions to Payroll Employment Data: Are They Predictable?

Andrew C. Krikelas

Nonfarm payroll employment data provide one of the most important sources of current information on economic activity at the national, state, and local levels. Collected and published monthly by the Bureau of Labor Statistics (BLS), these data provide not only a timely picture of overall employment conditions but also detailed information on trends at the industry level. In addition, these data focus on an economic variable that is of interest to the general public as well as to fiscal and monetary policymakers. The monthly release of nonfarm payroll employment statistics therefore affects both the public's perception of current economic conditions and the decisions of national, state, and local policy authorities who seek to influence economic activity at all levels.

Unfortunately, while the survey methodologies used to produce preliminary estimates of total and industry nonfarm payroll employment identify current employment trends reasonably well, they do not do this job perfectly. Payroll employment statistics are revised on an annual basis, and sometimes these revisions can be quite large. For example, substantial downward revisions to preliminary employment estimates for both 1990 and 1991 revealed that the 1990-91 recession was more severe than survey data originally indicated (see Table 1). However, these revised statistics were not available for analytical purposes until after the nation already was out of that recessionary period, far too late to have value for fiscal or monetary policy action.

The author is an economist in the regional section of the Atlanta Fed's research department. *He would like to thank Stacy Kottman for his contribution to the research and Aimee Foreman for assistance in data collection.*

The importance of monthly payroll employment statistics to both business decisions and economic policymaking—and the fact of their revision on an annual basis—raises the following question: Is there any way to predict the direction and magnitude of industry payroll employment revisions? Research by David Neumark and William L. Wascher (1991) indicates that, at the national level, the answer to this question is yes. Recent research conducted by this author confirms Neumark and Wascher's results and further suggests that, in most cases, revisions to preliminary state payroll employment estimates may also be predictable. In presenting the new research, this article discusses the process by which revised data replace preliminary survey data at both the state and national levels, confirms Neumark and Wascher's (1991) results, and extends these results to demonstrate that it may also be possible to predict annual revisions to preliminary state employment statistics.

Table 1
Preliminary and Final BLS Estimates of Total U.S. Nonfarm Employment: 1976-93
(Annual March employment, in thousands)

Year	Preliminary Estimate	Final Benchmark	Size of Revision
1976	77,906	78,092	186
1977	80,547	80,493	–54
1978	83,734	84,607	873
1979	87,346	88,654	1,308
1980	89,960	90,253	293
1981	90,720	90,371	–349
1982	89,679	89,566	–113
1983	88,172	88,232	60
1984	92,234	92,587	353
1985	96,045	96,042	–3
1986	98,617	97,987	–630
1987	100,462	100,202	–260
1988	104,161	103,535	–626
1989	107,017	106,624	–393
1990	109,581	108,606	–975
1991	108,147	107,507	–640
1992	107,359	107,300	–59
1993	108,672	108,935	263

Source: Calculated by the Federal Reserve Bank of Atlanta using data from the Bureau of Labor Statistics, U.S. Department of Labor.

*P*ayroll Employment Data: The Establishment Survey

Each month, the BLS releases detailed industry information on employment, hours, and earnings in its publication *Employment and Earnings*. Although most of the statistics focus on national industry variables, state industry data also are reported.[1] As will be discussed, the preliminary estimates of current state and national employment, hours, and earnings reported in this publication are based on information derived from a survey of approximately 370,000 business establishments. The survey is designed to provide an accurate measure of state and national industry trends, but these preliminary estimates always are subject to revision, and such revisions are made only with a substantial lag. These realities pose difficulties for timely and effective decision making.

A second complication with respect to these data is the fact that state and national industry statistics are not directly comparable. National data, both pre- and postrevision, are derived primarily from survey information. By contrast, although survey information is used to produce preliminary state payroll employment estimates, final revised state industry data are derived from a nearly complete census of local employers.[2] Therefore, in order to be clear about the relationships that exist between the preliminary and revised versions of state and national industry statistics, it is necessary to consider the sources of this information in some detail.

As mentioned earlier, at the national level preliminary monthly estimates of industry employment levels, hours worked, and wages earnings are derived from a survey, known as the establishment survey, of approximately 370,000 U.S. business establishments. The sample of firms surveyed each month ranges from goods-producing mining and construction companies, to service-producing wholesale and retail sales establishments, to local, state, and federal government agencies. The collection and analysis of these survey results is a collaborative effort between the BLS in Washington and state administrators of federally mandated unemployment insurance (UI) programs, most of whom are employed by their respective state's department of labor.

In accordance with the mandates of this program, all firms paying social security taxes on their employees must file a detailed quarterly statement, an ES-202 report, with state UI program administrators. The report requires firms to provide a monthly summary of their

average employment levels, the total number of hours worked, and the dollar value of wages paid to employees. Approximately 98 percent of total nonfarm employees in the United States are covered by the provisions of these UI programs so that when the states compile the monthly information contained in these quarterly reports, they obtain a virtual census of state nonfarm employment. However, the fact that the reporting procedure is quarterly causes delays, as does the need to clean up the data before they can be published. The result is a substantial lag in availability of data.[3]

To produce more timely preliminary estimates of state and national employment, the BLS created the establishment survey. Unlike the quarterly ES-202 reports required of all employers, monthly surveys, known as the BLS-790 reporting form, are collected from a small sample of state firms. The sample is stratified according to firm size and industry type and usually includes a nearly complete accounting of the largest employers in the state. Each month, state UI administrators must collect the completed BLS-790 surveys, compile their results, forward a copy of the data to the BLS for its use in deriving national industry statistics, and retain a copy for deriving state industry estimates.

Of concern to users who wish to analyze national employment trends is the fact that the national and state preliminary estimates differ in the quality of the survey information used to depict current economic activity and in the methodology used to analyze the results of monthly surveys. First, state-level survey sample sizes are too small, in general, to produce reliable industry estimates below the two-digit SIC level of disaggregation. By contrast, for the nation the complete sample is large enough to produce industry estimates at the more disaggregated three- and four-digit SIC code level. As a result, the national survey produces a more finely tuned picture of current economic activity.

Second, substantial methodological differences characterize analysis of the monthly survey results at the state and national levels. The BLS produces preliminary national industry statistics using information from the entire sample, which is stratified according to industry type and firm size and designed to provide reliable estimates of nearly 1,700 categories of firms, classified according to approximately 250 industry types and nine size classes.[4] The BLS uses BLS-790 survey results to produce estimates for each of the categories and then sums the appropriate elements of the resulting matrix to produce monthly estimates of total, sectoral, and industry employment levels, hours, and earnings for the nation.

Before releasing the data to the public, however, the BLS adjusts these industry statistics to account for cyclical variations in industry employment trends. During the course of the business cycle, firm births and deaths generally occur at varying rates. During periods of economic recovery and expansion, new firms tend to develop in relatively large numbers, thereby boosting employment totals; in contrast, during periods of economic contraction, existing firms tend to go out of business in relatively large numbers, resulting in job losses. Because delays in reporting firm births and deaths can skew the representativeness of the sample at any given time, the BLS has developed a procedure known as bias adjustment to account for such cyclical variations. The BLS began calculating bias adjustment factors in the early 1980s, and BLS estimates of employment at cyclical turning points have subsequently more closely matched revised data.

At the state level, the relatively small size of the survey samples makes it impossible for UI program administrators to adopt the BLS methodology in its entirety. In particular, the states do not attempt to replicate the BLS matrix nor its four-digit level of detail but instead produce estimates at the more disaggregated two-digit level. In addition, although the states do calculate bias adjustment factors in order to account for cyclical variations in industry employment, the small size of the state samples introduces greater variability in these factors than occurs at the national level. The statistical properties of each of the state samples are different enough that it is inadvisable to add up preliminary state industry estimates for purposes of analyzing national employment trends. The BLS warns its readers not to do so, and none of its published reports include sum-of-states variables, preliminary or revised.

Within six weeks of the initial data collection, BLS officials and state UI program administrators are able to release to the public a wide range of current national and state industry statistics. Preliminary national industry statistics for any given month are released on the first Friday of the month subsequent to the collection of survey data, and preliminary state data are released during the last week of that same month. These survey-based preliminary estimates are generally reliable indicators of state and national industry trends. Because all preliminary estimates are revised at least twice, however, the result may be substantial changes that are significant for the perception and analysis of economic trends, as mentioned above. The first of these data revisions occurs in the month immediately subsequent to their initial release. At this time, additional information

obtained from late or corrected survey responses is added to the original sample, and estimates are recalculated. Like the data that they replace, therefore, these revised preliminary estimates are based solely upon information contained in BLS-790 surveys.

By contrast, the second and theoretically final set of revisions also incorporates information from quarterly ES-202 reports.[5] In general, the states collect, clean up, and compile the results of quarterly ES-202 reports within a one-year period. As previously indicated, the quarterly ES-202 reports provide a virtual census of local nonfarm payroll employment. Approximately 2 percent of total state nonfarm employment, however, is not covered by the mandates of the unemployment compensation program, and instead state administrators tap alternative data sources in order to obtain estimates of this employment. Nevertheless, at the state level, final revised monthly industry statistics are derived from something that is very close to being a complete census of local nonfarm business establishments.

The BLS has developed a hybrid approach that combines information from both ES-202 reports and BLS-790 surveys to produce final revised national statistics. The BLS collects complete ES-202 data from each state only for the month of March. These state data are summed to create national totals for each of the 1,700 series previously estimated using BLS-790 survey data alone. The appropriate cells in this matrix are again aggregated to produce national statistics for total, sectoral, and industry variables. However, this time the national totals derived by summing state ES-202 data produce March population benchmarks for each of these series.

Once established, March population benchmarks are compared with revised preliminary March estimates for each of the firm types tracked. This comparison determines both the direction and the magnitude of the revisions required to bring each pair of series—preliminary and final—into line. As illustrated by the sectoral data presented in Table 2, some preliminary estimates may be adjusted upward and others downward. In the aggregate, of course, total U.S. nonfarm payroll employment revisions will be either positive or negative. The upward revision of 263,000 to total employment in the most recent rebenchmarking of data for March 1993 was the first such upward adjustment since March 1984 (see Table 1).

In the final step of this process, the BLS uses a "wedge-back" procedure to distribute industry revisions back through the preliminary data to April of the previous year.[6] Accordingly, one-twelfth of the benchmark revision is added to the revised preliminary estimate for April of the preceding year; this fraction then increases monthly until eleven-twelfths of the revision is added in February of the benchmark year.

In contrast, then, to state final revised estimates, which are derived primarily from the information contained in ES-202 reports, final revised national industry statistics are derived from a hybrid of census and survey information. On the one hand, census information is used to derive March benchmarks for all industry variables and to adjust the levels of these series for the period between March benchmark observations. On the other hand, in this intervening period BLS-790 survey information still largely determines the month-to-month changes in industry variables. Therefore, even in their final revised form, national industry statistics incorporate a great deal of information obtained from monthly surveys.

Table 2
Benchmark Revisions to Sectoral Employment: March 1993
(Employment in thousands)

Sector	Preliminary Estimate	Final Benchmark	Size of Revision
Mining	590	603	13
Construction	4,109	4,177	68
Manufacturing	17,768	17,974	206
Transportation, Communication, and Public Utilities	5,662	5,720	58
Trade	25,228	25,036	–192
Finance, Insurance, and Real Estate	6,533	6,633	100
Services	29,612	29,647	35
Government	19,170	19,145	–25
Total	108,672	108,935	263

Source: Calculated by the Federal Reserve Bank of Atlanta using data from the Bureau of Labor Statistics, U.S. Department of Labor.

Characteristics of National and State Payroll Employment Revisions

The key to more accurately predicting payroll employment revisions lies in understanding some important characteristics of these revisions. These characteristics

and their interrelatedness can be illustrated best by comparing the two sets of preliminary and revised March data for the 1976-93 period reported in Table 3, as well as two other variables that can be derived from these data. The two primary series reported in this table include total U.S. nonfarm payroll employment as published by the BLS along with the alternative national total that can be derived by summing state-level data. The two additional variables that can be calculated from these data include the revisions made to each of the preliminary totals and the gap between the two national series, preliminary and revised.

The preliminary totals reported in Table 3 are identical to the revised preliminary statistics originally reported by the BLS in their publication *Employment and Earnings*.[7] By contrast, the "final" revised data reported in the table represent the latest revisions made to official payroll employment statistics. Several significant revisions have been made to these series over the years, and only the latest version of these data were examined in this research.[8] Therefore, the revised values reported in Table 3 generally are not the same as those originally published by the BLS.[9]

An examination of the two sets of data presented in Table 3 reveals several interesting relationships. First and foremost, perhaps, is the fact that the stories told by each of the revised national total employment series are quite similar. Since 1976 the U.S. economy has been through two complete oscillations of the business cycle, both of which are reflected in these series. In particular, each of these national totals captures a period of expansion (1976-81) and recession (1981-82) followed by a second period of expansion (1983-90) and recession (1990-91). In fact, as the year-over-year growth rates reported in Table 4 indicate, the two final revised series provide nearly identical pictures of annual employment trends. Although this result might be expected given that the March values of the series are so closely related, it is important to note that the annual averages calculated from all of the available monthly data reveal a similarly close correspondence between year-over-year growth rates.[10]

In contrast to the relatively tight relationship that exists between the year-over-year growth rates implicit in the revised data, growth rates calculated from preliminary estimates of both of these series often differ, sometimes quite substantially. In some cases, in fact, these different estimates can lead to very different assessments of the overall health of the national economy. For example, while preliminary national data for March 1992 seemed to indicate a deceleration of employment losses associated with the 1991 recession, the preliminary sum-of-states total appeared to indicate a deepening of the recession. The release of final data revisions demonstrated that the recovery already was underway, however, and that it was much stronger than originally suggested by the preliminary data in both cases. In general, preliminary national data offer a more precise picture of current economic activity than the sum-of-states alternative. The BLS's decision not to provide sum-of-states totals in their publications therefore appears reasonable.

Given the way in which preliminary national and state estimates are derived, it is not surprising that the average size of the sum-of-states revision is significantly larger than its national counterpart. Measured in relative terms, the average size of the national revision during the period studied was 0.53 percent of the contemporaneous national total. The average size of a similar measure of revisions to the sum-of-states total was a much higher 0.88 percent, reflecting revisions for individual states that ranged from a low of 0.72 percent for Minnesota to a high of 2.88 percent for Wyoming. As these percentages show, revisions to preliminary national totals are substantially smaller than those for either the sum-of-states variable or for any of the states individually.

In addition to being large relative to their national counterpart, the revisions to the sum-of-states variable also appear to have a cyclical pattern. Although the states do calculate bias adjustment factors to account for cyclical differences in the rate of firm births and deaths, the relatively small size of the state survey samples introduces greater variability in these bias adjustment factors than is the case at the national level. As a result, preliminary estimates of the sum-of-states total still tend to be revised upward during periods of recovery and expansion (as was the case in 1976, 1978, and 1984) and revised downward during recessionary periods (as in 1982, 1990, and 1991).

The final variable presented in Table 3 is the gap variable, which measures the difference between the national and sum-of-states employment totals. One of the most interesting features of the data in the table is the fact that the gap between the two revised national totals is consistently negative throughout the seventeen-year period under examination. On the one hand, this relationship highlights the fact that there is a fundamental difference between the way in which the states and the BLS define total nonfarm employment, with the gap apparently identifying approximately 300,000 federal employees counted by the states but not recognized by the federal government. On the other hand, the relatively tight relationship that is apparent in the

Table 3
Total Nonfarm Payroll Employment
Preliminary and Revised National and Sum-of-States Totals, 1976-93
(Annual March observations, in thousands)

Year	BLS National Total		Size of Revision	Sum-of-States Total		Size of Revision	Gap between Two Totals	
	Preliminary	Revised		Preliminary	Revised		Preliminary	Revised
1976	77,906	78,092	186	77,083	78,352	1,268	823	–260
1977	80,547	80,493	–54	80,061	80,850	789	486	–357
1978	83,734	84,607	873	83,359	85,033	1,674	375	–426
1979	87,346	88,654	1,308	88,111	89,045	933	–765	–391
1980	89,960	90,253	293	90,483	90,572	89	–523	–319
1981	90,720	90,371	–349	90,737	90,761	24	–17	–390
1982	89,679	89,566	–113	90,286	89,860	–426	–607	–294
1983	88,172	88,232	60	88,499	88,617	118	–327	–385
1984	92,234	92,587	353	91,688	92,967	1,279	546	–380
1985	96,045	96,042	–3	96,081	96,182	102	–36	–140
1986	98,617	97,987	–630	98,594	98,198	–396	23	–211
1987	100,462	100,202	–260	100,523	100,426	–97	–61	–224
1988	104,161	103,535	–626	103,502	103,802	300	659	–267
1989	107,017	106,624	–393	106,401	106,765	364	616	–141
1990	109,581	108,606	–975	109,031	108,850	–181	550	–244
1991	108,147	107,507	–640	109,097	107,607	–1,490	–950	–100
1992	107,359	107,300	–59	107,357	107,633	276	2	–333
1993	108,672	108,935	263	108,682	109,217	589	–10	–336

Source: Calculated by the Federal Reserve Bank of Atlanta using data from the Bureau of Labor Statistics, U.S. Department of Labor.

two revised national employment totals provides an indication that these two variables might be cointegrated, a statistical relationship that by definition would imply a stable, long-run correlation between these two series. In an important article in the econometrics literature, Robert Engle and Clive W.J. Granger (1987) prove that if such a cointegration relationship can be demonstrated to exist between two or more variables, this information can be used to improve forecasts of each variable. In particular, their research suggests that the long-run restriction implied by such a relationship can be incorporated within the context of an error-correction model, which can then be specified and estimated to generate improved forecasts of the cointegrated variables.

In terms of its overall structure, an error-correction model is quite similar to a vector autoregression: lagged values of each of the dependent variables in a system of equations enter each equation as explanatory variables. In an error-correction model, however, an additional variable, an error-correction term, is added to each equation in order to impose the restriction that there exists a long-run relationship between these cointegrated variables. Given that statistical tests performed on the revised national and sum-of-states data series indicate that these variables likely are cointegrated, econometric theory suggests that an error-correction model might be useful for predicting each of these revised employment totals.[11] Indeed, recent research conducted for the present study indicates that such models can be used successfully to predict both the sign and the magnitude of revisions to national, sum-of-states, and the majority of individual state employment totals. Because this approach appears to outperform an alternative model developed and tested by Neumark and Wascher (1991), the final section of this article will compare these two forecasting methodologies.

Predicting Revisions to National and State Employment Totals

Although the precise question addressed by Neumark and Wascher (1991) differs somewhat from the one explored in this article, their results are reported in

Table 4
Year-over-Year Growth Rates Implicit in Preliminary and Revised National and Sum-of-States March Employment Totals
(Percent change)

	Preliminary Data		Revised Data	
March of	National	Sum-of-States	National	Sum-of-States
1977	3.39	3.86	3.07	3.19
1978	3.96	4.12	5.11	5.17
1979	4.31	5.70	4.78	4.72
1980	2.99	2.69	1.80	1.73
1981	0.95	0.28	0.13	0.21
1982	–1.25	–0.50	–0.91	–0.99
1983	–1.68	–1.98	–1.52	–1.38
1984	4.61	3.61	4.90	4.91
1985	4.13	4.79	3.68	3.46
1986	2.68	2.61	2.15	2.10
1987	1.87	1.96	2.26	2.27
1988	3.68	2.96	3.33	3.36
1989	2.74	2.80	2.98	2.85
1990	2.40	2.47	1.86	1.95
1991	–1.31	0.06	–1.01	–1.14
1992	–0.73	–1.60	–0.19	0.02
1993	1.22	1.23	1.52	1.52

Source: Calculated by the Federal Reserve Bank of Atlanta using data from the Bureau of Labor Statistics, U.S. Department of Labor.

such a way that comparisons can be made between the two research efforts. Neumark and Wascher asked the following question: Can the BLS improve on its preliminary estimates of month-to-month changes in nonfarm payroll employment by using additional information available at the time of initial release of the estimates? Their statistical tests answered this question positively. In particular, Neumark and Wascher found that three pieces of labor market information—changes in household employment as measured by the Current Population Survey (CPS), changes in the number of persons receiving unemployment insurance benefits, and changes in the number of initial claims filed for such benefits—appeared to contain information that could improve the accuracy of BLS preliminary employment estimates.

Neumark and Wascher then conducted an out-of-sample forecasting competition in which they used their statistical model to produce forecasts of the BLS final data revisions. In their single-equation model, the authors regressed observed revisions to total employment against a set of explanatory variables that included, in addition to the three labor market series described above, the BLS preliminary employment growth estimate and a constant. They used this model to forecast BLS data revisions, one to twelve months into the future, and compared these forecasts with actual revisions reported by the BLS. Neumark and Wascher found that they were able to improve upon the accuracy of the preliminary growth estimates by 22 percent (that is, on average their forecasts were 22 percent closer to the final revised growth rates than the preliminary estimate) as well as correctly to predict the direction of these final revisions (upward or downward) relative to preliminary figures 77 percent of the time.

Whereas Neumark and Wascher focused on predicting revised BLS employment growth estimates (month-to-month changes in the levels of total employment), the focus of the present research has been on the prediction of revised national and state employment totals—total employment levels, not growth rates. Another significant difference in the two studies is that while the data Neumark and Wascher analyzed in their study were seasonally adjusted, the data examined in the present study were unadjusted.[12] In addition, whereas Neumark and Wascher adopted a single-equation modeling strategy for producing employment growth forecasts, the error-correction models estimated in the present study represent a system of equations: one two-equation system for predicting revised national and sum-of-states employment totals and fifty-one separate three-equation systems for predicting revisions to individual state employment totals.[13] Despite these differences, the results of out-of-sample forecasts produced by these error-correction models can be reported in such a way that the forecasting methodologies can be compared.

Design of the Research Models. Prior to conducting the out-of-sample forecasting competition that forms the basis of the present research, two questions had to be resolved concerning the exact specification of these models. First, given the fact that each equation in an error-correction model contains lagged values of each variable in the system as explanatory variables, the appropriate number of lags to include had to be specified. And second, because Neumark and Wascher's (1991) research demonstrated that models that inclued additional labor market information could produce significantly better forecasts of BLS data revisions, it seemed reasonable to investigate whether such variables ought to be included in the error-correction models as well. In order to resolve these two issues, preliminary in-sample tests were conducted on seven alternative model specifications. Of these, three represented pure error-correction models, differing only in terms of the lag structure of the right-hand variables (*ECM*), and four represented augmented error-correction models, which in addition to exploring different lag structures also included CPS measures of household employment and unemployment as explanatory variables (*ECM + LF*).

According to the specification search employed in this research, seven alternative models were estimated to produce in-sample forecasts of revised total employment for the nation, the sum-of-states variable, and each of the states. Four sets of one- to twelve-month forecasts were calculated for the forty-eight month period between April 1984 and March 1988. The results of each of the alternative forecasting models were compared with final revised BLS data, and the models were ranked according to their accuracy in predicting the final revised employment totals and the direction of these revisions relative to the preliminary BLS estimate. Using this dual set of selection criteria, fifty-two models, one for both the national and sum-of-states data and fifty-one individual models for each of the states, were chosen for a second, out-of-sample forecasting competition. Of the fifty-two models, twelve were pure error-correction models, and forty were augmented error-correction models.

Results of the Forecasting Competition. A second forecasting competition was performed for the sixty-month period between April 1988 and March 1993. Five sets of one- to twelve-month forecasts were calculated for each employment total. Once again, two

measures of success were calculated to assess the relative accuracy of these models. The results are reported in Table 5. The first two columns identify the models. The fourth column reports the mean absolute percent difference between the model forecast and the actual revised BLS total, which can be compared with the size of the actual data revisions reported in the third column.[14] The fifth column reports the results of this comparison, indicating the percentage of improvement, if any, relative to the preliminary estimates. The final column reports the percentage of the sixty months under examination in which the models' forecasts correctly predicted the direction of the final revision relative to the preliminary estimates.

Evaluation of the Results. An examination of the results presented in Table 5 yields the following observations. First, as indicated above, the augmented error-correction model specified for the national and sum-of-states variable produces results that are superior to the single-equation model specified by Neumark and Wascher (1991): their forecast errors were 22 percent smaller than the actual BLS revisions, and this alternative specification generated forecast errors nearly 40 percent smaller. Similarly, the Neumark and Wascher model predicted the direction of the BLS final revision 77 percent of the time; this alternative methodology does so more than 83 percent of the time for both variables. It is also important to note that the period over which Neumark and Wascher ran their forecasting experiment, March 1985 to March 1989, contained no cyclical turning points. The period covered in the present forecasting experiment included such a turning point, the 1990-91 recession. In many respects, therefore, the superior results of the current experiment were gained over a forecast period that provided a much greater challenge to the competing models.

At the state level, thirty-four of the fifty-one models examined produced forecast errors that were smaller, often substantially so, than the BLS revisions. Of the thirty-four, twenty-seven recorded reductions in forecast errors of over 20 percent, twenty-one recorded reductions of more than 30 percent, fourteen recorded reductions greater than 40 percent, and seven recorded reductions in excess of 50 percent. In addition, twenty-nine of these models were able to predict the direction of final BLS revisions correctly at least 75 percent of the time, twenty-two did so at least 80 percent of the time, and six were able to do so at least 90 percent of the time.

Examining the results for the seventeen states for which the specified models failed to improve on the preliminary BLS estimates leads to several observations. First, when all states are ranked according to the size of their actual revisions over this five-year period, eight states (DE, DC, IN, MN, NY, ND, UT, and WV) rank among the nine having the smallest actual revisions. Kansas was the only state for which the model did better than state estimates. For these states with small revisions, preliminary BLS employment estimates already were relatively good, and the models, which were designed to improve upon these estimates, clearly were unable to do so. Second, of the remaining nine states that showed no improvement over the preliminary BLS estimates, four were specified as pure error-correction models (ID, NJ, NC, and VA). Because augmented error-correction models generally performed better than pure ECM models, it is possible that an augmented error-correction model specification for these states might have produced better results than those that were reported.

The monthly release of nonfarm payroll employment statistics affects both the public's perception of current economic conditions and the decisions of policymakers at all levels.

Finally, the uniquely poor performance of the models specified for Alaska and West Virginia provide a clue to an alternative modeling strategy. In each of these states, resource extraction industries play an unusually large role in determining the performance of the state economy. Disaggregation of total employment into its sectoral or industrial components, therefore, likely would help improve the estimation of total state employment. The modeling strategy discussed above can be modified to produce forecasts at the industry level, and previous research (Andrew C. Krikelas 1991) indicates that such a strategy probably would help improve forecasts of total state employment.[15]

Predicting Final Revisions for 1993-94. Despite the fact that models specified for seventeen states did not perform well in this particular competition, the

Table 5
Results of Out-of-Sample Forecasting Competition: Actual and Forecast Revisions, April 1988-March 1993

State	Model	Actual Revision (Percent)	Forecast Error (Percent)	Improvement (Percent)	Correct Sign (Percent)
US	ECM+LF	0.66	0.41	38.19	86.67
USS	ECM+LF	0.67	0.42	37.63	83.33
		States Showing Improvement			
AL	ECM+LF	1.43	0.68	52.39	90.00
AZ	ECM+LF	1.23	0.74	40.08	86.67
AR	ECM+LF	0.92	0.86	6.74	80.00
CA	ECM+LF	1.95	0.42	78.70	95.00
CO	ECM+LF	1.72	1.24	27.82	81.67
CT	ECM+LF	1.68	0.92	44.97	81.67
FL	ECM+LF	1.14	1.07	6.43	73.33
GA	ECM+LF	1.08	0.83	22.92	80.00
HI	ECM+LF	1.49	0.84	43.86	93.33
IL	ECM+LF	1.12	0.70	37.18	88.33
IA	ECM+LF	0.81	0.53	34.85	83.33
KS	ECM+LF	0.77	0.59	22.51	71.67
KY	ECM	1.39	1.35	2.83	75.00
LA	ECM+LF	1.54	1.06	30.80	68.33
MD	ECM	2.02	1.13	43.93	76.67
MI	ECM+LF	1.37	0.84	38.75	83.33
MS	ECM	0.85	0.63	26.04	85.00
MO	ECM+LF	1.45	0.96	33.81	76.67
MT	ECM	2.07	1.30	37.10	80.00
NE	ECM+LF	1.81	1.08	40.17	86.67
NV	ECM+LF	1.23	1.01	17.66	75.00
NM	ECM+LF	1.54	0.62	59.47	90.00
OH	ECM	0.98	0.91	7.35	71.67
OK	ECM+LF	2.09	0.83	60.26	93.33
PA	ECM+LF	0.80	0.44	44.57	83.33
RI	ECM+LF	1.67	1.53	8.71	70.00
SC	ECM+LF	1.25	1.00	19.78	78.33
SD	ECM+LF	2.10	1.14	45.93	80.00
TN	ECM+LF	2.00	0.68	66.09	78.33
TX	ECM+LF	1.10	0.52	52.59	81.67
VT	ECM+LF	1.45	1.02	29.64	80.00
WA	ECM+LF	0.84	0.42	50.67	90.00
WI	ECM+LF	1.09	0.66	39.33	81.67
WY	ECM+LF	2.00	1.49	25.57	76.67

Continued on next page

Table 5 continued

State	Model	Actual Revision (Percent)	Forecast Error (Percent)	Improvement (Percent)	Correct Sign (Percent)
		States Not Showing Improvement			
AK	ECM+LF	1.73	2.14	–23.17	75.00
DE	ECM+LF	0.78	1.54	–97.07	63.33
DC	ECM	0.56	1.17	–108.05	68.33
ID	ECM	0.98	1.20	–22.33	70.00
IN	ECM+LF	0.56	1.02	–81.59	65.00
ME	ECM+LF	1.24	1.82	–47.10	61.67
MA	ECM+LF	1.00	1.40	–40.15	56.67
MN	ECM+LF	0.42	0.58	–39.67	58.33
NH	ECM+LF	1.22	2.16	–76.27	65.00
NJ	ECM	1.44	1.72	–19.61	68.33
NY	ECM	0.58	0.98	–71.22	48.33
NC	ECM	1.11	1.26	–13.54	90.00
ND	ECM+LF	0.38	0.57	–50.19	68.33
OR	ECM+LF	0.93	1.34	–43.71	81.67
UT	ECM+LF	0.42	0.69	–65.85	63.33
VA	ECM	1.02	1.32	–28.97	68.33
WV	ECM	0.50	2.02	–302.49	48.33

Source: Actual revisions calculated by the Federal Reserve Bank of Atlanta using data from the Bureau of Labor Statistics, U.S. Department of Labor. Forecast errors derived by the author from the models described in the text.

modeling strategy outlined appears to have potential for predicting annual revisions to payroll employment data. If so, one important question remains: What do these forecasting models have to say about employment revisions for the period between April 1993 and March 1994? Although it would be unreasonable to supply point estimates because such forecasts obviously are subject to forecast error, the following more general observations concerning the forecasts derived from this research can be made: (1) monthly employment totals for the nation likely will be revised upward, and by an amount that is larger than last year's revisions; (2) the sum-of-states employment total likely will be revised upward by an amount substantially larger than last year's revisions; and (3) at the state level, forty-four states are likely to record upward revisions over the twelve-month period while seven are likely to record downward revisions. As a result, these models suggest that between April 1993 and March 1994 the U.S. economy grew more rapidly than originally indicated by preliminary survey data.[16]

Conclusion

On the first Friday of every month the BLS releases two separate pieces of labor market information that are eagerly anticipated—the national unemployment rate for the preceding month (and related national labor force statistics) and total nonfarm payroll employment, one of the many national industry statistics contained in the establishment payroll report. This set of labor market data includes not only national totals but also employment information for states and industries. It is important because it can directly affect the planning

and policy decisions made by businesses, governmental bodies, and individuals. However, the first reported estimates of total nonfarm employment levels for the nation and for states are subject to revision more than a year after the first estimate. Thus, the question arises whether the direction and magnitude of revisions to national payroll employment statistics can be predicted so as to give a more accurate picture of the economy well in advance of their revision.

The research reported in this article confirms research by Neumark and Wascher (1991) that indicated that the answer to this question is yes. Neumark and Wascher demonstrated that the BLS's preliminary, survey-based estimates of national payroll employment might be improved through the development of forecasting models that incorporate additional but concurrently available labor market information. The research reported here confirms Neumark and Wascher's findings, improves on their projections at the national level, and demonstrates that preliminary payroll employment estimates for a majority of states could also be improved using the forecasting methodology developed for the national data. In future research, it will be important to explore extensions of this model that analyze state and national employment trends at the industry level as well.[17] Given the relatively important role that payroll employment data play in the decision-making processes of private businesses and government policymakers, this and similar research efforts are likely to be of interest to both regional and macro economists for some time to come.

Notes

1. The industry data released in this and other BLS publications are categorized according to the Standard Industrial Classification (SIC) system. This system divides the economy into distinct sectors, the sum of which produces total employment figures for individual states or the nation. These sectors range from highly aggregated one-digit sectors (for example, mining, construction, manufacturing, and so forth) to much more disaggregated four-digit SIC industries (such as, manufacturing firms producing men's and boys' neckwear or retail sales establishments selling household appliances), with the two- and three-digit levels of disaggregation representing levels of industry detail that fall somewhere in between.
2. In addition, state administrators and BLS officials have slightly different definitions of federal government employment. While the states identify federal employees to be those covered by Unemployment Compensation for Federal Employees (UCFE) records, the BLS uses Office of Personnel Management (OPM) records to account for federal employees. This definitional difference drives a small wedge between the BLS and sum-of-states nonfarm employment totals, a fact which will be illustrated later in this article.
3. Each year, the BLS releases revised state and national industry statistics in the June issue of *Employment and Earnings*. In conjunction with this annual release, the BLS publishes an article that explains and analyzes the rebenchmarking procedure that produces these revisions. The information presented in the next few paragraphs represents a summary of BLS methodology as described in four such articles: Cronkite (1988), Getz (1990, 1992), and Roosma (1994).
4. Although the resulting 250 by 9 matrix has more than 2,000 elements, many of these remain blank because some industries such as auto manufacturing are dominated primarily by large firms while others like providers of household services are dominated by small firms.
5. In practice these data may be revised again, as discussed later.
6. For example, with the release of the March 1993 benchmarks, preliminary estimates going back to April 1992 were revised for the last time, thereby closing the books on the year 1992. The preliminary estimates for the months following March 1993 reflect this benchmark revision, but 1993 industry data will not be revised fully until benchmark revisions through March 1994 are released in 1995.
7. For the states, revised preliminary data at the sectoral level are reported monthly in Table B-9 of the BLS publication *Employment and Earnings*. The sum-of-states total, therefore, is derived by adding up these state estimates. Comparable national industry estimates are reported in Table B-2 of this same publication. It should be noted that the BLS changed the numbering of these tables in January 1994. Prior to that time, unadjusted state data were reported in Table B-8.
8. As Tom Plewes, associate commissioner of the BLS, reported in an address to the 1993 annual meeting of the National Association of Business Economists (NABE), further adjustments were required in addition to normal benchmark revisions. These adjustments were required in order to correct past errors introduced by the processing firms that originally compiled the ES-202 report results. According to Plewes, "Nearly 85 percent of this difference was due to subsequently documented problems with payroll processing firms' software" (*NABE News* 1994, 11). Upon recognition of these recording errors, Plewes stated that "it was necessary to 'wedge in' revisions to previous estimates through 1981 to correct the problem" (11).
9. For example, the final revised national total for March 1990 originally was reported to be 109,114,000 in the June 1992 issue of *Employment and Earnings* but has since been re-

vised downward to 108,606,000. Another notable set of revisions was released along with the 1989 annual benchmark revisions. At that time, the underlying set of SIC codes used to categorize the BLS series were updated from their 1972 definitions to the 1987 standard presently in use. As Getz (1990, 6) pointed out: "Approximately two-thirds of the published industry series were unaffected by the SIC revision. There were almost no changes in scope at the major industry division levels, with only very minor shifts between wholesale and retail trade and between the finance, insurance, and real estate division and services. However, there were several significant redefinitions at the 2-digit level."

10. March values for these data are reported rather than annual averages because 1992 is the latest year for which complete revised data are available. By contrast, fully revised monthly data are available through March 1993.
11. Augmented Dickey-Fuller unit root tests were used to test two sets of hypotheses: (1) that the two revised national employment totals do not contain a unit root and (2) that the pair of revised total employment series are not cointegrated. In each case these hypotheses were rejected. Taken together, the results lend support to the alternative hypothesis that the pair of series are cointegrated.
12. Berger and Phillips (1994) have demonstrated that differences in the seasonal behavior between preliminary and final revised BLS data series are responsible for introducing a "blip" in state employment totals that distorts the month-to-month changes in the preliminary series, particularly for the month of January. They describe a methodology for improving the seasonal adjustment of preliminary BLS data. The focus of the present author's research, therefore, has been upon improving the prediction of unadjusted employment totals: the raw data ultimately submitted for purposes of seasonal adjustment.
13. Each of the three variable systems created for the states were unique and included one equation for the national total, one equation for the sum-of-states national total minus the state under examination, and one equation for that particular state. Tests performed on each of the individual states and their three variable triples indicated that, in each case, the three variables likely were cointegrated. In addition to the fifty states, a separate model was developed for the District of Columbia, bringing the total number of states for which models were specified to fifty-one.
14. In each case the size of the relative forecast error was calculated as the absolute value of the following: (Forecast – Actual)/Actual, where the forecasted value was supplied by the model, and the actual value was the final revised employment total reported by the BLS. In the case of the actual revisions reported in third column of Table 5, this measure was calculated as the absolute value of the following: (Preliminary – Actual)/Actual.
15. Krikelas (1991) performed a large number of out-of-sample forecasting experiments on industry employment data for the state of Wisconsin with a variety of multisectoral vector autoregressions. One fairly consistent result of that research was that more highly disaggregated models performed better in these competitions.
16. On November 4, 1994, Katharine G. Abraham, commissioner of the Bureau of Labor Statistics, noted the following in a press release: "Preliminary 1994 first quarter universe tabulations suggest that there was stronger job growth than we previously reported for the 12-month period ending in March 1994. Indications at this time are that the March 1994 payroll employment estimate will be revised upward by approximately 760,000, or 0.7 percent" (4).
17. In fact, this author already has collected one-digit level data for the nation and all fifty-one states and has begun to explore this alternative modeling strategy. Such models will be studied for their performance in comparison with the more highly aggregated models examined to this point.

References

Berger, Franklin D., and Keith R. Phillips. "Solving the Mystery of the Disappearing January Blip in State Employment Data." Federal Reserve Bank of Dallas *Economic Review* (Second Quarter 1994): 53-62.

Cronkite, Fred R. "BLS Establishment Estimates Revised to March 1987 Benchmarks." *Employment and Earnings* 35 (June 1988): 6-11.

Engle, Robert F., and Clive W.J. Granger. "Co-integration and Error Correction: Representation, Estimation, and Testing." *Econometrica* 55 (March 1987): 251-76.

Getz, Patricia M. "Establishment Estimates Revised to March 1989 Benchmarks and 1987 SIC Codes." *Employment and Earnings* 37 (September 1990): 6-10.

_____. "BLS Establishment Estimates Revised to March 1991 Benchmarks." *Employment and Earnings* 39 (June 1992): 6-11.

Krikelas, Andrew C. "Industry Structure and Regional Growth: A Vector Autoregression Forecasting Model of the Wisconsin Regional Economy." Ph.D. diss., University of Wisconsin–Madison, 1991.

NABE News. "Government Statistics—Quality Issues." January 1994, 11.

Neumark, David, and William L. Wascher. "Can We Improve upon Preliminary Estimates of Payroll Employment Growth?" *Journal of Business and Economic Statistics* 9 (April 1991): 197-205.

Roosma, Michael W. "BLS Establishment Estimates Revised to Incorporate March 1993 Benchmarks." *Employment and Earnings* 41 (June 1994): 7-12.