

# The quality of BLS projections: a historical account

*Broad trends in occupational employment have been projected fairly accurately, but accuracy has not increased over time*

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Projections of employment change provide the foundation for the statements on employment outlook presented in the *Occupational Outlook Handbook*. Consequently, the quality of employment outlook information presented in the *Handbook* is very dependent on the accuracy of the projections. Prior to 1960, discussions of employment outlook were based primarily on informed judgments about the direction and magnitude of employment change rather than a formal set of numerical projections. Since 1960, the *Handbook* statements on employment outlook have been based on a set of statistical projections. The first numerical projections published by BLS covered the 1960–70 period. However, data were published only for major occupational groups.<sup>1</sup> BLS did not publish information on projected numerical change for detailed occupations until 1966.<sup>2</sup> Since then, projections have been developed and published every other year, conforming to the biennial production of the *Occupational Outlook Handbook*.

The procedures for developing the projections have changed significantly over the years stemming from research devoted to improving methods for developing employment projections. In addition, more employment and related economic data of higher quality have become available over time for use in developing projections. BLS economists also gained experience in developing projections and gathered information from past efforts through detailed methodological and analytical memorandums prepared by economists who preceded them.

This article discusses the changes in procedures used to develop projections over the past 50 years and presents data to see if the quality of the projec-

tions improved as the projection procedures changed. Measurement of projection accuracy, however, is not a simple task. One traditional measure is to compare projected employment with actual employment and compute the difference in percentage terms. For example, if employment were projected to increase from 8,000 in the base year to 11,000 in the target year and actual employment in the target year were 10,000, the projections would have an absolute error of 1,000, or 10 percent. However, actual employment estimates themselves may have error. For example, with a standard error of 10 percent, true employment in the base year could have varied from 7,200 to 8,800 and in the target year from 9,000 to 11,000. Thus, in any evaluation effort, significant weight also should be assigned to a discussion of employment change in reports presenting the projections, such as the *Occupational Outlook Handbook*, in addition to the absolute levels of employment.

Space is not available in this article to present data evaluating all detailed occupational projections ever published by the BLS, so it focuses on projections of the major occupational groups over time. It presents data from five sets of projections prepared from 1960 to 1984 that roughly coincide with procedural changes put in place. Detailed evaluations have been published in the past for those projections and information from the articles presenting those evaluations was used in this article. They can be seen on the BLS website<sup>3</sup> by those seeking more information.

## Changes in procedures

*Mid 1940s through the mid-1960s.* From the beginning of the occupational outlook program through

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the mid-1960s, projections for each occupation were developed independently by the analyst responsible for preparing the *Occupational Outlook Handbook* statement rather than as part of a comprehensive model. In general, statistical extrapolations of historical employment data were used to develop projections or simple regressions that related employment to total population growth. For some occupations such as schoolteachers, the projections were based on statistical relationships, such as pupil-teacher ratios to projections of the school-age population. Although the projections were developed in numerical terms, the information was presented in the *Handbook* only in qualitative terms, such as “continued rapid growth is expected” or “growth is expected to be slow.” The only projections published were for major occupational groups.

Total employment growth was controlled by projections of the labor force, minus an assumption about the unemployed. Labor force and employment data, used as the base year of the projections, were derived either from the decennial census or the Current Population Survey (CPS). The projections, therefore, were on a “persons concept,” used in these surveys in which individuals are counted once in occupational employment data in the job they worked the most hours during the reference week of the survey.

*Mid-1960s through the 1970s.* A major procedural change began with the 1964–75 projections released in 1966—the use of an industry-occupation matrix. Although the matrix was used in developing occupational projections for many occupations, some occupations covered in the *Occupational Outlook Handbook* were not projected in the matrix because the necessary data on employment by industry were not available. For the most part, projections for these occupations were developed as they were in earlier periods. Current and projected employment estimates for these occupations were meshed with the matrix projections in publications presenting the projections.<sup>4</sup> In the mid-1970s, after the 1970 census data became available, fewer occupations were developed independent of the matrix because the number of occupations covered in the 1970 census was much greater than that in the 1960 census.

The main source of data on occupational staffing patterns of industries used to develop the industry-occupation matrix was the decennial census. Industry employment data were derived from the Current Employment Statistics program. The 1960 census data were used until the 1970 census data became available to use in developing the 1974–85 projections. The census data were adjusted to develop data for the base year of the projections because the census industry classification was not directly comparable to the industry classification used by BLS in the Current Employment Statistics Survey. The matrix staffing patterns also were adjusted to make use of data from a number of sources that were considered more preferable than census data. Among the sources used were scientists and engineers by industry from BLS surveys of employ-

ers;<sup>5</sup> teacher and librarian employment collected by the Department of Education; and occupational employment data collected by regulatory agencies for interstate commerce, including railroads, airlines, and telephone and telegraph communications. Data on Federal Government occupational employment were derived from payroll data obtained from the Civil Service Commission, which later became the Office of Personnel Management. Employment data collected from sources other than the Government also were used, including data for some medical and health occupations, compiled by professional associations. After applying the census staffing patterns to Current Employment Statistics industry employment, data from these sources were placed in the matrix and the estimates of employment for the major occupational groups in each major industry were forced to add to actual current year data from the CPS.

With the use of an industry-occupation matrix to develop occupational projections, the development of industry employment projections took on a great deal of importance. Three approaches were used to develop detailed industry projections from the mid-1960s through the 1970s. The first involved the use of regression analysis to develop employment projections, for each detailed industry, that were consistent with projections of total employment and overall economic growth. Equations were developed that related industry wage and salary-worker employment change to combinations of the following variables: Real gross national product (GNP), national unemployment rate, Armed Forces personnel, Civilian noninstitutional population, and time. These variables were selected because they allowed cyclical and other factors to be separated from secular trends.

A second approach to developing detailed industry projections involved the use of input-output analysis. Essentially, this technique requires that final demand (GDP divided into its components—investment, consumption, Government expenditures, and foreign trade) be specified by producing industry. The demand is then traced back through the chain of production to determine the output from each industry supplying materials or services to produce the end product. For example, the final demand for automobiles creates an intermediate demand for steel, rubber, and so forth. The intermediate demand for steel then will create a demand for iron ore, coal, and so forth. By calculating total output requirements for each industry and relating it to projected output per worker-hour in each industry, BLS derived a projection of employment.

The third approach was to conduct an in-depth study of industries for which past employment growth was not considered indicative of future growth or for which the models described earlier had poor statistical results. In this approach, BLS examined factors that were expected to influence future employment growth and developed and tested a variety of regression equations. For example, in projecting employment for the motor vehicle industry, various models were developed

using such variables as personal disposable income, driving age population, motor vehicle registrations, and number of families with income over certain levels. The final projections took into account all the types of models used and, in effect, the projected levels of employment that were used were those judged to be best.

Projections of the occupational structure of each industry in the industry-occupation matrix were based on an analysis of the factors that could cause change in the structure. Initial projections of occupational coefficients in each industry were based on historical trends developed by extrapolating data from the 1950 to 1960 census. These trends then were modified based on an analysis of the factors that caused change in the past, such as changes in technology, product mix, and business practices, and were assessed as to whether those factors would continue to have an impact on occupational staffing of industry in the future. Some occupations were analyzed independent of the matrix and the resulting projections were placed into the matrix. For example, employment projections of elementary and secondary school teachers were based on analyses of pupil-teacher ratios and projections of school enrollments. Projections of automobile mechanics were based on analyses of the growth in the number of motor vehicles.

The industry-occupation matrix only provided employment of wage and salary workers. To develop projections of total employment in each occupation, separate projections were developed for self-employed workers and unpaid family workers. These projections were based on trends developed from cps data and trends in ratios of wage and salary workers to the other classes of workers.

From the mid-1960s through the 1970s, as in earlier periods, the labor force projections were used as the major control for projecting total employment. Unemployment, based on an assumed unemployment rate used in developing the projections, was subtracted from the labor force and the resulting number of persons was used as the control total for the sum of wage and salary, self-employed, and unpaid family workers in all occupations.

*1980 through 1998.* In 1980, the 1978–90 projections were developed using the first national industry-occupation matrix based on occupational staffing patterns of industries from the Occupational Employment Statistics survey rather than decennial census data. Census data were deficient for analyzing trends in industry staffing patterns because they were collected only every 10 years and had limited occupational detail. BLS initiated the Occupational Employment Statistics survey in the early 1970s to collect data on occupational staffing patterns of industries directly from establishments by mail survey and to do so more frequently. This survey, which continues today, is a Federal/State cooperative program in which data are collected by State employment security agencies according to standards, procedures, and methods developed by BLS. Until 1995,

all nonagricultural industries,<sup>6</sup> except private households, were covered in this survey on a 3-year cycle; manufacturing industries during the first year, and roughly half of nonmanufacturing industries in each of the next 2 years.

Because data for all States were not available until the late 1970s, it was not until 1980 that a national matrix for 1978 based on data from the Occupational Employment Statistics survey could be developed. Occupational employment estimates for 1978 were obtained by applying the occupational staffing patterns of industries from the Occupational Employment Statistics survey to total wage-and salary employment from the Bureau's Current Employment Survey. The Occupational Employment Statistics survey included many more detailed industries and occupations than did census data. As a result, employment projections for virtually all occupations in the *Handbook* were developed through the industry-occupation matrix. Although independent analyses continued, such as projecting teachers' employment based on pupil-teacher ratios, those data were placed in the matrix and had to fit within total employment and constraints of employment in all other occupations in the educational services industry.

Wage-and-salary employment totals for agricultural and private household industries continued to be obtained from the cps because the Occupational Employment Statistics survey did not cover employment in these industries. Occupational distributions of employment in these industries were developed from the census-based matrix and, therefore, detailed occupations in the census-based matrix were reclassified into the occupational classification used in the Occupational Employment Statistics survey. This was somewhat different from the classification used in the census. The Occupational Employment Statistics surveys also do not cover self-employed workers and unpaid family workers, but employment estimates for these workers also were developed from cps- and census-based data.<sup>7</sup> To develop total employment estimates by occupation, employment of wage-and-salary workers was added to totals of self-employed and unpaid family workers.

Employment estimates for detailed occupations in the Occupational Employment Statistics survey-based matrices were not comparable with those in previous census-based matrices because of major differences in the underlying data sources. The census counts persons, whereas the Occupational Employment Statistics survey counts jobs. Thus, wage and salary worker employment in the Occupational Employment Statistics-based matrix is higher than that in the census-based matrix, because of multiple jobholders. The difference between the numbers of jobs and of persons employed in 1978 was roughly 10 percent, but it varied among occupations. Also, in the census and cps, individuals report themselves in the occupation in which they work the most hours. Respondents to the Occupational Employment Statistics surveys are instructed to report employees performing more than one job in the one that requires the highest skill level. The definitions for each

occupation are listed on the questionnaire. In the census, the titles reported by respondents are grouped into categories that may include workers with greatly different skill levels. The categories usually take the title of the most prominent occupation in that group. For example, the title “lawyer” includes lawyers and law clerks. These are separate occupations in the Occupational Employment Statistics survey.

In the 1978–90 occupational projections, alternative projections also were developed for the first time, and this practice continued until the 1996–2006 projections were issued in 1998. The alternatives included a base case scenario and high- and low-growth scenario. For discussions in the *Occupational Outlook Handbook* and related career guidance publications, only the base case was used. It was believed that young people, planning their career, could not easily differentiate the nuances of high- and low-growth economic scenarios and would be best served by discussions of employment change that seemed most likely to BLS analysts—the base case scenario. In the 1996–2006 projections, a decision was made not to develop alternative projections because very little use was made of those projections and some uses that were made were not necessarily proper ones.<sup>8</sup>

Beginning with the 1978–90 projections, a major change also was made in the development of industry projections. As discussed earlier, three basic procedures were used to develop industry projections from the mid-1960s through 1980. In 1980, all efforts concentrated on projections developed through the input-output methodology described earlier, and abandoned the regression analysis procedure. By placing more resources in one effort, BLS economists believed that the quality of the projections could be improved. In-depth analysis of specific industries, however, continued and these analyses were coordinated with work on the models used to develop the projections.

Also during this period, the projections reflected a “jobs concept” rather than a “persons concept.” Wage and salary worker employment data reflect payroll employment and therefore include all jobs an individual may hold. CPS data on self-employed include workers whose primary job was as a self-employed worker or unpaid family worker. Thus, if those workers held a wage and salary worker job as well, all their jobs would be included. Excluded from the job count are self-employed jobs that are not a workers’ primary job. Estimates of those jobs will be added to the projections in the 1998–2008 projections to be issued in November 1999.

Despite changes in procedures, use of new data sources, and other technical aspects of the methods used to develop projections over from the 1950s to the 1990s, two factors were constant. First, projections of the labor force always were a significant determinant of growth in total employment, whether the projections were of individuals or of jobs. This is very significant as the projections of the labor force consistently have been the most accurate of the many components of the

projections. Second, in-depth analysis of factors causing change in employment of industries and occupation always was used extensively in conjunction with the statistical models. Changes in technology, whether it affects industry-specific productivity or the staffing patterns of an industry, changes in business practices, and the impact of social change can affect occupational employment significantly. Such changes do not necessarily follow historical patterns in a manner that can be captured in models without changing the statistical relationships in the models that reflect historical patterns. Consequently, when the results of the analyses conflicted with the results of the statistical trends specified in the models, the independent analyses were given significant weight in the specification of the final projections.

## Evaluating the projections

BLS considers evaluation to be an important component of its projections program. Through evaluations, Bureau analysts have been able to identify the strengths and weaknesses in procedures used to prepare the projections and that information has been used to change procedures in developing later projections. The evaluations also have provided users of projections, especially in the fields of career guidance and education planning, with information to enhance their understanding of the problems faced in developing accurate projections.

Many obstacles are faced in evaluating occupational projections. One is that the occupational projections are highly interrelated with the labor force, economic, and industry employment projections. For example, the labor force projections have a great bearing on total employment projections, and industry projections influence occupational projections, because occupations tend to be concentrated by industry. Thus, inaccurate industry projections that stem from inaccurate assumptions underlying the economic projections have a significant impact on the growth of occupations in that industry. Also, identifying the factors that caused differences between projected and actual data is sometimes difficult to uncover 10 or more years after the projections were developed. Another impediment faced in evaluating the projections stems from the changes in occupational classification that occur between the time the projections were developed and the target year. As a result, the projected data are not often comparable with actual data. With each decennial census, occupational classification changes are made that affect data in the CPS, which uses the census classification. In occupational surveys, such as the Occupational Employment Statistics survey, changes to occupational classification that are made to improve the survey’s quality can be made at any time and can cause havoc with data comparability over time. Finally, as mentioned earlier, survey data used to measure employment in both the base year and target year of the projections are subject to normal sampling and response error. Consequently, it is possible that the actual

data used to measure error in projections have errors that could distort conclusions of projections reliability.

The projections from the 1950s through 1994 were all made to target years ending in 0 or 5, generally because of a belief that projections to a specific year such as 1974 or 1977, would imply more preciseness than projections to 1975 or to 1980. In addition, the projections to a specific year are meant to imply changes in employment over the projected period rather than precise time specific projections. The first publication presenting comprehensive detailed occupational employment projections stated:

“...the use of the target year 1975 is not meant to imply that the projections of requirements will be realized in that year and that year only, and regardless of the cyclical conditions which prevail at that time. The projections are thus meant to apply to a year in the mid-1970s when the stated assumptions correctly describe the state of the economy.”<sup>9</sup>

The implied preciseness of the accuracy and error of the occupational projections, however, cannot be avoided completely in evaluations that rely so much on statistics to measure error rates.

This article analyzes projections for five periods when procedures differed and for which evaluations have previously been published. These periods are: 1960–70, the first projections issued; 1960–75, the first projections issued using an industry occupation matrix; the 1968–80 projections, the first set of projections to 1980; the 1980–90 projections, the only 1990 projections used in the *Occupational Outlook Handbook*; and the 1984–95 projections, the last set of projections made before using the target year of 2000. No projections were evaluated that use 1985 as the target year, because the occupa-

tional classification used in the 1980s was so different from the classification used in the 1970s when the projections were prepared, that the statistical analysis would be meaningless, even for major occupational groups.

## Accuracy and error

*Total employment.* Projections of total employment generally were more accurate than the projections of major occupational groups. In two of sets of projections, 1960–70 and 1980–90, the error in total employment was less than 1 percent. The 1960–75 projections, with a projected growth rate of 33 percent and actual growth rate of 31 percent, certainly must be considered very accurate. (See table 1.) The 1968–80 and 1984–95 projections were underprojected, –4.4 percent for the earlier period and –5.6 percent for the later period. (See table 2.) However, even these projections cannot be considered significant errors. In view of the statement made earlier that projections were meant to apply to a year around the target year, those projections would be highly accurate, with an error rate of less than 1 percent, if both sets were measured by data 2 years before the actual target year. It could be assumed that individuals using the projections were not misled by projections that were highly accurate 2-years prior to target years 12 and 11 years into the future. In terms of trends in projection accuracy over time, no pattern is evident, but clearly no improvement can be seen.

*Major groups.* A few general patterns emerge in comparing the projected and actual growth rates for the major occupational groups over time. The first is that the direction of change was always projected correctly. This was no major feat, as all

**Table 1. Projected and actual percent change in employment by major occupational group, selected projection periods**

Occupation group	1960–70		1960–75		1968–80		1980–90		1984–95	
	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual
Total employment .....	20	20	33	31	25	31	19	20	15	22
Executive and managerial .....	23	17	28	27	22	43	17	12	20	33
Professional and technical .....	41	49	73	73	50	55	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )
Professional specialty .....	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	18	37	21	36
Technicians .....	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	32	37	29	29
Clerical and sales .....	26	33	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )
Sales .....	( <sup>1</sup> )	( <sup>1</sup> )	34	31	29	36	22	56	21	31
Clerical (administrative support, including clerical) .....	( <sup>1</sup> )	( <sup>1</sup> )	51	57	35	44	20	27	11	21
Service .....	25	21	53	47	40	41	25	24	20	29
Agriculture, forestry, and fishing ..	–18	–40	–38	–43	–33	–21	–7	–1	–4	–1
Precision production, operators, and laborers .....	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	18	1	( <sup>1</sup> )	( <sup>1</sup> )
Precision production (craft-skilled) .....	23	19	33	30	22	38	( <sup>1</sup> )	( <sup>1</sup> )	12	6
Operators and laborers .....	18	14	18	11	8	7	( <sup>1</sup> )	( <sup>1</sup> )	7	9

<sup>1</sup> The major groups were not comparable in each projection period and detailed occupational data were not available to develop comparable data.

**Table 2. Percent error in level of projected employment by major occupational group, selected projection periods**

Occupation group	1960–70	1960–75	1968–80	1980–90	1984–95
Total employment .....	0.0	3.2	-4.4	-0.9	-5.6
Executive and managerial .....	4.6	.3	-17.2	4.4	-9.9
Professional and technical .....	-5.9	-1	-3.0	( <sup>1</sup> )	( <sup>1</sup> )
Professional specialty .....	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	-14.4	-11.3
Technicians and related support .....	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	-3.1	.5
Clerical and sales .....	-5.4	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )
Sales .....	( <sup>1</sup> )	6.4	-5.1	-21.8	-7.4
Clerical (administrative support, including clerical) .....	( <sup>1</sup> )	-3.8	-6.8	6.0	-8.3
Service .....	3.1	7.4	6.7	.9	-6.6
Agriculture, forestry, and fishing .....	26.3	11.8	-5.4	-6.0	-3.6
Precision production, operators, and laborers .....	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	16.3	( <sup>1</sup> )
Precision production (craft-skilled) .....	3.4	2.2	-4.8	( <sup>1</sup> )	6.2
Operators and laborers .....	3.6	7.2	1.2	( <sup>1</sup> )	-1.7

<sup>1</sup> The major groups were not comparable in each projection period and detailed occupational data were not available to develop comparable data.

groups except for agriculture, forestry, and fishing occupations were always projected to increase and all did so, and that agriculture forestry, and fishing occupations, correctly, were always projected to decline. Notable, however, is that the projected decline was much slower in the last two projection periods than those in the earlier periods and the actual decline also was much less.

Another general pattern is that 7 out of the 9 instances were correctly projected in which employment in major groups grew by less than 20 percent. Only in one of these cases was employment projected very inaccurately; professional specialty workers from 1980 to 1990. A review of the detailed occupations comprising that group shows that projections of three occupations contributed very significantly to that error—college teachers, vocational education teachers, and registered nurses. Employment of college teachers was projected to decline based on Department of Education projections of declining college enrollments because of the shrinking of the traditional college-population aged 18 to 24. During the 1980s, however, colleges were successful in enrolling older individuals in greater numbers than in the past, and enrollment rates of traditional-age college students also rose more than expected. As a result, employment of college teachers increased rather than declined. Vocational education teachers also were underprojected for similar reasons. Employment of registered nurses was projected to grow rapidly, but it grew so much faster than projected that it accounted for 10 percent of the underprojection of professional specialty workers.

Employment of major groups was projected to increase more than 40 percent in six instances and in all these cases, employment did grow faster than 40 percent. Employment was projected to increase faster than 30 percent in three other cases, and in all cases it did.

The 1980–90 projection of salesworkers had the largest projection error. Employment was projected to increase by 22 percent, but actual data indicate it increased by 56 percent. Much of the error was due to the underprojection of three oc-

cupations—self-employed salesworkers, cashiers, and stock clerks. All of these occupations experienced a significant change in definition from the occupational classification used in the base year to that used in the target year. Considering those changes, even though adjustments were made wherever possible for classification changes, and the very rapid 56 percent growth, the projections may have been more accurate than they appear.

From these data, a conclusion could be reached that the fastest growing and slowest growing major occupational groups have been projected, almost always, correctly. In comparing projected and actual growth rates and the percent error in the level of projected employment for major groups, relatively few large discrepancies between projected and actual data can be identified. It also is apparent that the quality of projections as measured by the accuracy of projections has not improved over time. For instance, the 1960–70 projections, the first set of projections published, were the most accurate and the last two sets, 1980–90 and 1984–95 were the least accurate. Clearly, the accuracy of projections of major occupational groups has not improved over time.

*Detailed occupations.* Significant detail has been published in previous articles evaluating the BLS projections.<sup>10</sup> Consequently, much of the information presented here was drawn from articles presenting evaluations of the occupational projections. That information has been synthesized, allowing BLS economists to determine if the quality of the detailed occupational projections has changed over time. As indicated above, detailed occupational projections were not published before the 1960–75 projections issued in 1996, and, therefore, the 1960–70 projections discussed in the section on major occupational groups cannot be discussed in this section.

The number of occupations for which projections were published increased significantly over time. In the 1960–75 projections, 162 occupations were projected through the industry-occupation matrix, but projections for other occupations

included in the *Handbook* were not considered reliable enough to be published at that time. In the 1970–80 projections, the number projected through the matrix was 160, but an additional 80 occupations were independently projected and included in projections publications. The number of occupations projected increased significantly when the industry-occupation matrices shifted to the Occupational Employment Statistics surveys as a source of employment data. In the 1980–90 projections, 687 occupations were projected out of more than 2,000 occupations for which employment data were collected in the Occupational Employment Statistics survey.<sup>11</sup> By the time the 1984–95 projections were developed, the Occupational Employment Statistics survey had reduced the number of occupations to about 750, roughly the same number of occupations as in the Occupational Employment Statistics survey conducted in the late 1990s. All occupations in the Occupational Employment Statistics survey were not projected, generally because of the small employment size of the occupations or because related occupations were aggregated for analytical purposes, such as college teachers by field of study to all college teachers. The 750 occupations were aggregated into 500 occupations or occupation groups before projections were developed. (See table 3.)

All occupations for which projections were developed could not be evaluated because the occupational classification system used to collect the employment data changed before the target year of the projections was reached. For census-based matrices, 47 percent of the 1960–75 projections and 40 percent of the 1970–80 projections could be evaluated. Although the number of occupations that could be evaluated increased significantly with the 1980–90 Occupational Employment Statistics survey projections, the proportion decreased to 19 percent. During the 1980–90 period, the Occupational Employment Statistics survey classification underwent significant revisions. With the introduction of the 1980 Standard Occupational Classification in the 1983 Occupational Employment Statistics survey, the classifications became more stable and the number of occupations that could be evaluated jumped to 348 in the 1984–95 projections—70 percent of the total number of occupations projected.

In evaluating projection error, it is not clear what should be considered a satisfactory or an acceptable level of error and what is unsatisfactory. Some errors obviously indicate a poor

projection, such as actual growth of 100 percent when 5 percent growth or a decline was projected. A similarly poor projection is a percent error in level of 50 percent, when employment was projected to be 50,000 and it actually was to 75,000. However, it is not clear what the statistical dividing line is between a “good” and “poor” projection, whether evaluated by percent change or percent error in employment. What is significant is the impact the information stemming from the projection has on the decisions made based on the projections. Using this criteria, it could be assumed that if employment goes in the opposite direction, decrease instead of the projected increase, the projection is poor. But, this must also be tempered if the projected increase is small. For example, if employment is projected to increase by 5 percent, from 100,000 to 105,000 and employment declines from 100,000 to 95,000, the percent error in level would be only 10.5 percent. Also, because of measurement errors of employment surveys the real direction of change could have been as projected. Despite the uncertainties about “real” quality, it is possible to evaluate differences in the accuracy of different sets of projections, and to see how accuracy has changed over time.

The average absolute percent error of the detailed occupational projections was not significantly different among the four sets of projections. The last set, 1984–95 had a slightly higher error, but this evaluation covered many more occupations than did earlier evaluations. In terms of the direction of change, the proportion of the occupations evaluated that were projected in the correct direction was very similar in the first three sets projections, and slightly lower in the latter.

The vast majority of occupations in all sets of projections that were not projected in the correct direction had projected increases, but actually declined. (See table 3.) A review of the occupations projected to grow, but actually declined, uncovered some interesting information. In the 1960–75 projections, 6 of the 11 occupations were projected to increase, but by less than 10 percent. In career guidance information, this growth would not have been described as favorable for job opportunities. Also, 7 of the 11 occupations had fewer than 50,000 workers in 1960 and, consequently, employment data would be subject to large variances. In the 1970–80 projections, 6 of the 12 occupations projected to increase that actually declined according to matrix data, showed increases from 1970–79 based on cps data. In the 1980–90 projections,

**Table 3. Number of detailed occupations projected and evaluated, selected projections periods**

Projection period	Occupations projected			Average percent error	Correct direction		Not projected in correct direction	
	Number	Number evaluated	Percent evaluated		Number	Percent of total	Number	Number that declined
1960–75 .....	162	76	47	20.8	64	84	12	11
1970–80 .....	160	64	40	22.4	50	78	14	12
1980–90 .....	687	132	19	21.1	107	81	25	24
1984–95 .....	500	348	70	24.0	252	72	96	80

**Table 4. Absolute average percent error for detailed occupations projected and evaluated, selected projections periods**

Projection period	Absolute average percent error for all occupations evaluated	Proportion of occupations with a below average error	Absolute average percent error for occupations by size of employment						
			Less than 50,000	50,000 to 99,999	Less than 100,000	100,000 to 299,000	300,000 to 599,999	500,000 or more	600,000 or more
1960–75 .....	20.8	66	32.4	20.3	( <sup>1</sup> )	15.5	19.8	( <sup>1</sup> )	11.2
1970–80 .....	22.4	50	29.5	24.9	( <sup>1</sup> )	26.3	17.2	( <sup>1</sup> )	10.1
1980–90 .....	21.1	60	( <sup>1</sup> )	( <sup>1</sup> )	25.6	( <sup>1</sup> )	( <sup>1</sup> )	14.5	( <sup>1</sup> )
1984–95 .....	24.0	60	( <sup>1</sup> )	( <sup>1</sup> )	29.0	( <sup>1</sup> )	( <sup>1</sup> )	12.2	( <sup>1</sup> )

<sup>1</sup> Not available.

almost half of the 24 occupations, projected to increase that actually declined according to the evaluation, increased from 1983 to 1990 in the 1983–96 historical matrix. Significant changes in occupational classification took place in the Occupational Employment Statistics survey, collected after 1983, that could have caused significant differences in levels for occupations that were comparable in definition between projections and the actual data. Thus, the projections could be more accurate than depicted in the evaluations.

It is evident that projections for occupations with large employment numbers are more accurate as measured by the average percent error than are occupations with small employment numbers. As shown in table 4, in each set of projections, the percent error for occupations with more than 500,000 or 600,000 workers is significantly less than average, whereas the projection error for occupations with less than 50,000 in employment is much larger than average. Another point becomes clear in reviewing tables 3 and 4. As with the major occupational groups discussed earlier, there was no clearly significant improvement in the accuracy of the projections over time, as data improved and more historical data were available for analysis.

## Conclusions

Significant improvements have been made in the procedures used to develop occupational employment projections over the past 50 years. In the 1950s and 1960s, the requirements for inclusion of an occupation in the *Occupational Outlook Handbook* did not include statistically sound estimates of current employment, and, consequently, projections were often devel-

oped outside of the projections model. Virtually all job outlook statements in recent editions of the *Handbook* have been based on employment projections developed through complex projections models.

Over time, the occupational projections developed by BLS have captured most of the general trends in occupational employment. Projections of major occupational groups are consistently in the correct direction, and rapid growth and slow growth projections for these groups have been very accurate. For detailed occupations, projections have been less accurate than for major occupational groups. The accuracy of the projections is better for occupations of large size than for small occupations. The vast majority of occupations are projected in the correct direction as measured in evaluation studies. It is very likely that the proportion projected in the correct direction is even higher than that shown in evaluations of projections, because of occupational comparability problems in going from projected to actual data.

The accuracy of projections has not changed over time. The projections prepared in the mid-1980s are no more accurate than those prepared in the late 1960s, despite the availability of more data and improved modeling. Biases found in the projections in evaluations found in the late 1980s and 1990s resulted in significant changes in analytical procedures to projections made to the year 2000 and beyond. The results could be significant. For example, in the 1984–95 projections only 39 occupations were projected to decline as it seemed there was a reluctance to project employment declines. In the 1996–2006 projections, 125 occupations were projected to decline. Time will tell if the analytical changes that were made will have a real impact on projection accuracy. □

## Notes

<sup>1</sup> *Manpower Challenge of the 1960s* (U.S. Department of Labor, 1960).

<sup>2</sup> *The Outlook for Technological Change and Employment, Appendix Volume I, Technology and the American Economy* (Washington, National Commission on Technology, Automation, and Economic Progress, February 1996).

<sup>3</sup> On the Internet at: <http://stats.bls.gov/empbib06.htm>

<sup>4</sup> Projections for occupations developed through an industry-occupation matrix and independently that were merged for publication purposes can be seen in *Occupational Projections and Training Data*, Bulletin 1824 (Bureau of Labor Statistics, 1974), pp. 79–87.

<sup>5</sup> BLS conducted a Survey of Scientific and Technical Personnel in Industry, funded by the National Science Foundation, from the late 1950s through the 1960s. This survey program was the forerunner to the Occupational



Employment Statistics survey. Similar information was collected in the Occupational Employment Statistics survey when it began.

<sup>6</sup> Agricultural Services was covered by the Occupational Employment Statistics survey beginning in the early 1990s.

<sup>7</sup> Because of data limitations and resource constraints, the occupational estimates for self-employed and unpaid family workers were not distributed across industries. Consequently, occupation/industry cross-tabulations were available only for wage and salary employment.

<sup>8</sup> Some users considered the difference between the high- and low-sce-

nario projections to be a range rather than projections having different assumptions.

<sup>9</sup> See *The Outlook for Technological Change and Employment*, page I-15.

<sup>10</sup> The latest example in the *Monthly Labor Review* is, "Evaluating the 1995 projections," September 1997, pp. 3-31.

<sup>11</sup> Occupations not projected were listed, by size of employment, in the *Occupational Projections and Training Data, 1982 Edition*, Bulletin 2202 (Bureau of Labor Statistics, December 1982), pp. 89-96.

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## Bureau of Labor Statistics Internet

The Bureau of Labor Statistics World Wide Web site on the Internet contains a range of data on consumer and producer prices, employment and unemployment, occupational compensation, employee benefits, workplace injuries and illnesses, and productivity. The homepage can be accessed using any Web browser

**<http://stats.bls.gov>**

Also, some data can be accessed through anonymous FTP or Gopher at

**<stats.bls.gov>**

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