

Evaluating the 1980 projections of occupational employment

Job projections prepared by BLS in 1970 proved slightly less accurate than estimates for 1965-75; classification changes again restricted comparability, permitting analysis of fewer than half of 160 occupations

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How reliable were the 1980 occupational employment projections? The Bureau of Labor Statistics' estimates were on target for professional and service occupations, the two fastest growing occupational groups between 1970 and 1980.¹ The projections were fairly accurate for farm, craft, clerical, and sales occupations. For the remaining three major occupational groups, BLS projections missed the mark by significant margins. BLS underestimated employment growth for managerial and administrative occupations and for nonfarm laborers, while overestimating employment in operative occupations.

Among individual occupations, the projections proved accurate for optometrists, physicians, veterinarians, elementary schoolteachers, police, and welders. Opportunities for lawyers and psychologists grew faster than anticipated. In a seeming anomaly of the impending "cashless society," cashiers and bank tellers could count on many more jobs than BLS projected, while the number of credit managers was less than anticipated.

As expected, projections for specific occupations were less accurate than for the major occupational groups. Despite some refinements, the 1980 projections were not quite as accurate as the 1975 estimates, which also spanned 10 years.²

In evaluating the 1980 projections, comparability again proved to be a major problem. Fewer than half of the detailed occupations studied in the base year could be evaluated, specifically, only 64 of 160 occupations.

Results by occupational group

Among the nine major occupational groups, projection errors were relatively large for nonfarm laborers, managers and administrators, and operatives. The number of nonfarm laborers employed in 1980 was underprojected by 17 percent, and the number of managers and administrators, by 13 percent. (See table 1.) By contrast, operative employment was overprojected by 11.8 percent. The average of the absolute percentage errors for all groups was 6.7 percent.

The direction of employment change was not correctly anticipated for nonfarm laborers and operatives. The number of nonfarm laborers was projected to be 3.7 million in 1980, or about 1 percent lower than the 1970 level. Instead of declining, employment in this group increased to almost 4.5 million. This projection was probably influenced by the trend of the 1960's, when employment remained at about the same level. Conversely, operative employment was projected to rise from 13.9 million in 1970 to 15.4 million in 1980, but declined to 13.8 million. The 1.6-million overestimate of operatives was the largest error in number for a major occupational group. Operative employment is concentrated in manufacturing industries, which are sensitive to economic fluctuations. After recovering from the re-

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cession of the mid-1970's, operative employment had grown steadily and might have reached the projected level if the economy had continued to improve. Employment was at 14.5 million in 1979. The direction of employment change was correctly anticipated for managers and administrators, but employment grew twice as rapidly as projected, resulting in a 1.4-million underestimate of the 10.9 million employed in 1980. The projection of managers was probably influenced by the employment trend in 1962-67, when employment only grew from 7.4 million to 7.5 million, with very little fluctuation during that period.

Projection errors in the remaining groups were comparatively small. Differences between projected and actual employment levels ranged from less than 1 percent for professional and technical workers and service workers to 6.7 percent for salesworkers. Moreover, the projected and actual amounts of change were very close in some occupations. The estimated increase in professional and technical workers was only 2.5 percent lower than the approximately 4.5-million increase that occurred, and the estimated growth in service workers was only 3.1 percent greater than the actual increase of 3.2 million. The projections correctly identified the professional and technical workers, service workers, and clerical workers as the three fastest growing groups.

Results by specific occupation

Differences between projected and actual employment in the 64 detailed occupations ranged from an underestimate of 47 percent for psychologists to an overestimate of 89 percent for locomotive engineers' helpers. (See table 2.) The absolute percentage errors for all 64 occupations averaged 22.4 percent. About one-half of the occupations had errors lower than the average. Absolute errors ranged from a 444,000-underestimate of cashier employment in the target year to a 181,000-overestimate of telephone operators.

Employment was overprojected in slightly more than one-half of the occupations; on average, by 25.8 per-

cent. Among the occupations in which employment was overstated by more than 50 percent were photoengravers and lithographers, patternmakers, airplane mechanics, telephone operators, and credit managers. Employment was underprojected in almost one-half of the occupations. The average underestimate was 19.5 percent. Employment in several occupations was underprojected by more than 30 percent, including cooks, bartenders, bank tellers, lawyers, and roofers.

The occupational estimates are products of the projections of industry employment and of industry-occupational staffing patterns. Many of the largest errors resulted primarily from misestimates of industry-occupational staffing patterns. The decline in the ratio of telephone operators to total employment in the telephone industry, for example, was greater than anticipated, and consequently the demand for workers in this occupation was overprojected. Staffing pattern estimates also led to large errors in the projections for locomotive engineers' helpers, psychologists, credit managers, lawyers, and roofers. Misestimates of industry employment totals, rather than industry staffing patterns, were the primary causes of large errors for some occupations. The banking industry, for example, grew much more rapidly than expected, resulting in an underprojection of the demand for bank tellers. Projection errors for cooks, bartenders, and aircraft mechanics also were largely a result of poor projections for the industries in which these workers were concentrated.

Size makes a difference

Projection accuracy was related to size of employment. When weighted by employment in each occupation, the average absolute error drops from 22.4 percent to 14.1 percent, indicating that the largest occupations generally had the more accurate projections. Relatively accurate projections for the following three categories, each with more than 1 million workers in 1980, contributed substantially to the improved results: blue-collar supervisors; elementary schoolteachers; and stenogra-

Table 1. Comparison of projected employment and actual employment in major occupational groups, 1970-80

[Workers in thousands]

Occupational group	1970	1980		Percent change		Difference between projected and actual	
		Projected	Actual	Projected	Actual	Level	Percent
Total	78,627	95,085	97,270	20.9	23.7	-2,185	-2.2
Professional and technical workers	11,140	15,500	15,613	39.1	40.2	-113	-0.7
Managers and administrators	8,289	9,500	10,919	14.6	31.7	-1,419	-13.0
Salesworkers	4,854	5,760	6,172	18.7	27.2	-412	-6.7
Clerical workers	13,715	17,285	18,105	26.0	32.0	-820	-4.5
Craft and kindred workers	10,158	12,240	12,529	20.5	23.3	-289	-2.3
Operatives	13,909	15,440	13,814	11.0	-0.7	1,626	11.8
Nonfarm laborers	3,724	3,700	4,456	-0.6	19.7	-756	-17.0
Service workers	9,712	13,060	12,958	34.5	33.4	102	0.8
Farmworkers	3,126	2,600	2,704	-16.8	-13.5	-104	-3.9

NOTE: Individual items may not add to totals because of rounding. Percent differences are based on unrounded numbers.

phers, typists, and secretaries. Sampling errors for Current Population Survey estimates diminish relatively as employment size increases, so the long-run data for large occupations would be expected to provide more reliable trends to use in the projections:

<i>Number of workers</i>	<i>Number of occupations</i>	<i>Average absolute percent error</i>
Total	64	22.4
Less than 50,000	18	29.5
50,000 to 99,999	9	24.9
100,000 to 299,999	14	26.3
300,000 to 599,999	11	17.2
600,000 and more	12	10.1

The direction of employment change between 1970 and 1980 was correctly anticipated for 50 of the 64 detailed occupations. Again, results were better in the larger fields of employment. Less than one-sixth of the occupations with more than 50,000 workers in 1970 had projections that were in the wrong direction, compared with more than one-third of the smaller fields. Some of the differences, however, between projected increases and actual declines, or vice versa, were relatively small.

For each occupation in which the direction of employment change was correctly anticipated, the percentage of the actual change accounted for by the projection was computed. In about two-thirds of the occupations the projections underestimated the employment change. In the remaining occupations, the projections overestimated the change.

Employment grew in 46 of the occupations between 1970 and 1980 and declined in the remaining 18. Increases were estimated more accurately than decreases. Projections of growth averaged an absolute 16.1 percent off actual employment, while those of loss averaged 38.4 percent off. Employment in two-thirds of growing occupations was underestimated. All employment declines either were underestimated or not foreseen at all.

The direction of employment change was correctly anticipated for all but two of the growing occupations. The number of elementary schoolteachers increased by about 4 percent, instead of declining by 0.9 percent. Jewelers and watchmakers increased more than 37 percent, against a projected 0.9-percent decline.

Occupations with the most rapid growth had the largest projection errors. Projected 1980 levels for those with employment increases of more than 50 percent between 1970 and 1980 averaged 30.1 percent off actual 1980 levels. Projection errors averaged only 9.4 percent for occupations with slower growth. Target-year employment usually was underestimated in the fastest-growing occupations and overestimated in those with the slowest growth. Projections were lower than actual levels in the 15 fastest-growing occupations and higher than actual in 12 of the 15 with the slowest increases.

Decreases were not anticipated in 12 of the 18 occupations that declined in employment. The projections correctly identified weaver, knitter, compositor and typesetter, locomotive engineer's helper, railroad conductor, and brake and switch operator as occupations which would decline in employment, although the rate of decrease was generally underestimated.

Testing for accuracy

One way to judge the accuracy of an occupational employment projection is to determine whether the projection or the base-year employment is closer to the target-year employment. In 45 of the 64 occupations, the projections were closer to the target than base-year employment. In the remaining 19 occupations, the projections either were in the wrong direction or overstated the employment growth by wide margins. Another way to judge projections is to compare them with the results obtained from simple alternative methods. Extrapolations of employment data by simple linear regression would have been an inexpensive and easy way of projecting. Extrapolations based on this simple method were more accurate than the projections for 46 of the 64 occupations.³ Several of the extrapolations, however, missed targets by wide margins, which resulted in a slightly lower weighted error for the projections. The weighted absolute average error was 15.1 percent for the extrapolations, compared to 14.1 percent for the projections. Unweighted errors were about the same for both methods.

The evaluation has focused on differences between projected and actual employment *levels*, rather than differences between actual and projected employment *changes*. Generally, occupations with accurately projected levels also were accurate in terms of the proportion of actual change that was estimated. Comparisons of levels, however, have a conservative bias in that projections for occupations which have relatively little employment change tend to get better marks than those which have the most change, as demonstrated in the following occupations. Employment of psychologists was projected to increase from 33,200 in 1970 to 56,000 in 1980, but actually rose to 106,000, which means that target-year employment was underestimated by 47.2 percent. In contrast, the number of cabinetmakers was projected to increase from 70,000 to 72,700, but rose to 85,000, resulting in an underestimate of 14.5 percent. In terms of the difference between projected and actual employment levels, the projection for cabinetmakers is by far the better of the two. The projection for psychologists, however, accounted for about 31 percent of the employment increase that occurred, while the one for cabinetmakers accounted for only 18 percent. Therefore, if the measure of accuracy is the proportion of actual change that was estimated, the projection for psycholo-

gists is better. Both kinds of accuracy are important. The accuracy of level is particularly important, however, because projected levels are used in calculating replacement needs resulting from retirements and deaths.

Rating the handbook ratings

In addition to publication in *Tomorrow's Manpower Needs*, many of the 1980 projections were used as a basis for qualitative descriptions in another BLS publication, the 1972-73 edition of the *Occupational Outlook Handbook*, designed to help young people make career plans. In most cases, the handbook description of employment outlook for an occupation includes a sentence about the expected change in employment through the 1970's. The adjectives used to describe expected changes in employment requirements generally corresponded to these ranges of percent change (increase or decrease): very rapid, 40 or more; rapid, 30 to 39.9; moderate, 15 to 29.9; slow, 5 to 14.9; little or no change, 0 to 4.9. The handbook contained occupational statements for 45 of the 64 occupations for which projections were evaluated, and the standard adjectives were used in describing the outlook in 34 of these statements. Statements on only two occupations, elementary schoolteachers and telephone operators, were incorrect about the direction of employment change. The handbook expected employment in this teaching field to decline slowly, but it showed little or no change. The number of telephone operators was expected to grow slowly instead of declining moderately. The outlook description for telephone operators was misleading, but the one for elementary teachers was not.

The adjectives were on target or only one category off target for about two-thirds of the remaining statements. Rapid growth in surveyor employment was projected, for example, instead of very rapid growth. Adjectives for about one-fourth of the statements were off by two categories, but in some cases it is difficult to determine whether this degree of inaccuracy was misleading. The difference between moderate growth and very rapid growth, for example, does not seem as significant as the difference between moderate growth and little or no change. Adjectives for the following occupations were three categories off the mark: jewelers and watchmakers, boilermakers, and cement and concrete finishers. The outlook descriptions for these occupations likely were misleading.

The framework

The 1980 projections of occupational requirements were developed within the framework of a 1970-80 matrix that described the relationship of employment in 160 occupations and 116 industries.

The long-term data used in developing the 1970 ma-

trix and projected 1980 matrix were obtained from a variety of sources. The primary sources of data on occupational staffing patterns by industry were the 1950 and 1960 censuses. The primary source of total employment in each industry was the Bureau of Labor Statistics' Current Employment Survey (a payroll survey) for 1947 through 1969. The Current Population Survey (a household survey) was the chief source of total employment of occupational groups and most occupations after 1960. Data for some occupations, however, were obtained from independent sources, such as professional societies and regulatory agencies.

The primary data source for occupational employment by industry was the 1960 census, because information from the 1970 census was not available. However, the 1980 data used in the analysis were largely derived from the 1980 Current Population Survey (CPS), which used the 1970 census occupational classification system. Because the Census Bureau revised its 1960 system for classifying employment by occupation for use in the 1970 census, a large proportion of the 160 occupations examined in 1970 were not sufficiently comparable for evaluation.⁴

According to the Census Bureau, all nine occupational groups had 96 percent or better comparability between the two classification systems. Specifically, if the 1960 labor force data were retabulated, 95 percent or more of the employment reported in a particular major occupational group under the 1960 classification system would remain in the same group under the 1970 system, and these workers would represent 95 percent or more of the total for that group. For detailed occupations, there was far less comparability. Of the 297 occupations in the 1960 census classification system, only 171 had 90 percent or better comparability in the 1970 system. About one-half of these occupations, however, were not included in the matrix. In addition, the accuracy of some of the projections that were based on historical data from sources other than the census could not be verified. After eliminating occupations which were less than 90 percent comparable and those which had verification problems, the evaluation of projections was limited to 64 of the 160 detailed occupations covered in the matrix.

In addition to the comparability and verification problems, the comparison of actual and projected data were hampered by the sampling errors of the CPS. For a CPS estimate of 50,000, for example, the standard error would be about 6,700 or roughly 13 percent of the employment level. This much variance would have a great impact on evaluating accuracy, for projections averaged only 28 percent off the CPS-derived 1980 estimates for occupations with employment of less than 100,000.⁵

Data constraints precluded construction of a 1980

matrix with actual data comparable to the projected 1980 matrix. Consequently, 1980 employment levels for most occupations were estimated from CPS data, the primary source of occupational data for matrices between

decennial censuses. Data on 1980 employment were also obtained from independent sources, such as professional associations, in cases where the 1960 and 1970 matrices used these sources rather than the census or CPS.⁶

Table 2. Comparison of projected, simulated, and actual 1980 employment in selected occupations

[Workers in thousands]

Occupation	1970	1980			Difference between projected and actual		Difference between simulated and actual		Percent change		
		Projected	Simulated	Actual	Level	Percent	Level	Percent	Projected	Simulated	Actual
Composers and typesetters	175.0	165.0	199.5	165.0	0.0	0.0	34.5	20.9	-5.7	14.0	-5.7
Optometrists	17.5	21.0	24.9	20.9	0.1	0.5	4.0	19.1	20.0	42.3	19.4
Delivery, route, and taxi drivers	655.0	750.0	696.7	746.0	4.0	0.5	-49.3	-6.6	14.5	6.4	13.9
Food counter and fountain workers	291.0	411.0	368.4	417.0	-6.0	-1.4	-48.6	-11.7	41.2	26.6	43.3
Blue-collar worker supervisors	1488.0	1700.0	1708.9	1729.0	-29.0	-1.7	-20.1	-1.2	14.2	14.8	16.2
Heat treaters, annealers, and temperers	22.0	24.4	24.7	24.0	0.4	1.7	0.7	2.9	10.9	12.3	9.1
Veterinarians	24.0	33.0	23.3	33.8	-0.8	-2.4	-10.5	-31.1	37.5	-2.9	40.8
Welders and flame cutters	535.0	675.0	616.4	693.0	-18.0	-2.6	-76.6	-11.1	26.2	15.2	29.5
Osteopaths	13.5	19.4	20.1	18.8	0.6	3.2	1.3	6.9	43.7	48.9	39.3
Physicians and surgeons	266.0	395.0	391.5	381.3	13.7	3.6	10.2	2.7	48.5	47.2	43.3
Police and detectives	415.0	600.0	584.7	579.0	21.0	3.6	5.7	1.0	44.6	40.9	39.5
Radio and television repairers	132.0	163.0	148.8	170.0	-7.0	-4.1	-21.2	-12.5	23.5	12.7	28.8
Elementary schoolteachers	1260.0	1249.0	1856.7	1313.0	-64.0	-4.9	543.7	41.4	-0.9	47.4	4.2
Furnace tenders, smelters, and pourers	60.0	64.0	63.3	61.0	3.0	4.9	2.3	3.8	6.7	5.5	1.7
Plumbers and pipefitters	350.0	470.0	439.4	444.0	26.0	5.9	-4.6	-1.0	34.3	25.5	26.9
Railroad conductors	40.0	39.0	31.3	36.7	2.3	6.3	-5.4	-14.7	-2.5	-21.8	-8.3
Electricians	440.0	585.0	534.7	625.0	-40.0	-6.4	-90.3	-14.5	33.0	21.5	42.0
Machinists and related workers	585.0	660.0	671.8	616.0	44.0	7.1	55.8	9.1	12.8	14.8	5.3
Stenographers, typists, and secretaries	3504.0	4580.0	4418.2	4963.0	-383.0	-7.7	-544.8	-11.0	30.7	26.1	41.6
Molders, metal, except coremakers	56.0	62.5	62.3	58.0	4.5	7.8	4.3	7.4	11.6	11.3	3.6
Dentists	96.7	127.6	144.1	118.3	9.3	7.9	25.8	21.8	32.0	49.0	22.3
Meatcutters and butchers, except meatpackers	190.0	200.0	214.4	185.0	15.0	8.1	29.4	15.9	5.3	12.8	-2.6
Carpenters	830.0	1075.0	1079.9	1172.0	-97.0	-8.3	-92.1	-7.9	29.5	30.1	41.2
Railroad brake and switch operators	88.0	85.0	70.2	78.2	6.8	8.7	-8.0	-10.2	-3.4	-20.2	-11.1
Mail carriers, post office	254.0	320.0	315.8	352.2	-37.2	-10.4	-41.4	-11.6	26.0	24.3	40.6
Registered nurses	688.7	983.0	984.6	1101.0	-118.0	-10.7	-116.4	-10.6	42.7	43.0	59.9
Waiters and waitresses	1040.0	1240.0	1225.3	1413.0	-173.0	-12.2	-187.7	-13.3	19.2	17.8	35.9
Millwrights	80.0	94.0	88.7	108.0	-14.0	-13.0	-19.3	-17.9	17.5	10.9	35.0
Cabinetmakers	70.0	72.7	84.6	85.0	-12.3	-14.5	-0.4	-0.5	3.9	20.9	21.4
Shipping and receiving clerks	379.0	430.0	437.9	505.0	-75.0	-14.9	-67.1	-13.3	13.5	15.5	33.2
Postal clerks	300.0	385.0	372.9	456.3	-71.3	-15.6	-83.4	-18.3	28.3	24.3	52.1
Mechanical engineers	206.7	276.8	253.2	232.0	44.8	19.3	21.2	9.1	33.9	22.5	12.2
Firefighters	180.0	275.0	251.2	227.0	48.0	21.2	24.2	10.7	52.8	39.6	26.1
Aeronautical engineers	63.9	77.6	72.9	64.0	13.6	21.3	8.9	13.9	21.4	14.1	0.2
Civil engineers	179.9	235.6	245.7	192.0	43.6	22.7	53.7	28.0	31.0	36.6	6.7
Locomotive engineers	43.0	43.0	34.7	34.2	8.8	25.7	0.5	1.5	0.0	-19.3	-20.5
Surveyors	51.2	68.2	74.8	93.0	-24.8	-26.7	-18.2	-19.6	33.2	46.1	81.6
Dietitians and nutritionists	30.0	37.4	42.0	51.0	-13.6	-26.7	-9.0	-17.6	24.7	40.0	70.0
Jewelers and watchmakers	35.0	34.7	37.6	48.0	-13.3	-27.7	-10.4	-21.7	-0.9	7.4	37.1
Guards	373.0	425.0	507.9	589.0	-164.0	-27.8	-81.1	-13.8	13.9	36.1	57.9
Boilermakers	24.0	26.5	26.5	37.0	-10.5	-28.4	-10.5	-28.4	10.4	10.4	54.2
Cashiers	847.0	1110.0	984.4	1554.0	-444.0	-28.6	-569.6	-36.7	31.1	16.2	83.5
Cement and concrete finishers	65.0	90.0	86.1	70.0	20.0	28.6	16.1	23.0	38.5	32.5	7.7
Chemical engineers	50.9	59.3	58.4	46.0	13.3	28.9	12.4	27.0	16.5	14.7	-9.6
Plasterers	35.0	40.0	46.4	31.0	9.0	29.0	15.4	49.7	14.3	32.6	-11.4
Postmasters and assistants	35.0	35.0	43.5	27.1	7.9	29.2	16.4	60.5	0.0	24.3	-22.6
Cooks, except private household	740.0	930.0	922.5	1335.0	-405.0	-30.3	-412.5	-30.9	25.7	24.7	80.4
Asbestos and insulation workers	25.0	34.0	30.8	49.0	-15.0	-30.6	-18.2	-37.1	36.0	23.2	96.0
Crane, derrick, and hoist operators	145.0	179.0	162.1	137.0	42.0	30.7	25.1	18.3	23.4	11.8	-5.5
Weavers, textile	60.0	50.0	57.1	38.0	12.0	31.6	19.1	50.3	-16.7	-4.8	-36.7
Bank tellers	225.0	337.0	269.7	506.0	-169.0	-33.4	-236.3	-46.7	49.8	19.9	124.9
Photographers	65.0	72.0	87.6	111.0	-39.0	-35.1	-23.4	-21.1	10.8	34.8	70.8
Bartenders	160.0	200.0	185.5	311.0	-111.0	-35.7	-125.5	-40.4	25.0	15.9	94.4
Lawyers and judges	286.9	342.0	381.5	539.0	-197.0	-36.6	-157.5	-29.2	19.2	33.0	87.9
Roofers and slaters	60.0	76.0	78.8	124.0	-48.0	-38.7	-45.2	-36.5	26.7	31.3	106.7
Knitters, loopers, toppers	47.5	46.0	44.9	33.0	13.0	39.4	11.9	36.1	-3.2	-5.5	-30.5
Inspectors, log and lumber	20.0	23.0	21.2	16.0	7.0	43.8	5.2	32.5	15.0	6.0	-20.0
Psychologists	33.2	56.0	47.6	106.0	-50.0	-47.2	-58.4	-55.1	68.7	43.4	219.3
Photoengravers and lithographers	34.0	50.0	38.3	32.0	18.0	56.3	6.3	19.7	47.1	12.6	-5.9
Patternmakers, metal and wood	43.0	56.8	50.7	36.0	20.8	57.8	14.7	40.8	32.1	17.9	-16.3
Airplane mechanics and repairers	140.0	194.0	172.6	121.0	73.0	60.3	51.6	42.6	38.6	23.3	-13.6
Telephone operators	420.0	480.0	497.0	299.0	181.0	60.5	198.0	66.2	14.3	18.3	-28.8
Credit managers	68.0	100.0	80.5	54.0	46.0	85.2	26.5	49.1	47.1	18.4	-20.6
Locomotive engineers' helpers	17.2	14.0	13.4	7.4	6.6	89.2	6.0	81.1	-18.6	-22.1	-57.0

Methods and assumptions. The basic approach used to estimate future occupational employment requirements was to project total employment by industry, project occupational staffing patterns (ratios) by industry, and then multiply the industry totals by the ratios to obtain occupational estimates. The results were then summed across industries to obtain occupational totals.

Projections of the occupational structure of each industry were based on examination of historical statistics and the analysis of the factors that influence occupational structure changes, such as new technology and changes in the product mix of industry. Employment requirements for many occupations, however, were projected independent of their relationships to industry employment. The projection of schoolteachers, for example, was based on an analysis of trends in pupil-teacher ratios and the projected school-age population. This technique was preferred in cases where such reliable predictive relationships could be established.⁷

The 1980 occupational projections embodied certain assumptions about the size of the labor force, Armed Forces strength, the rate of unemployment, and other selected assumptions. Full employment was assumed in the target year and defined as a civilian labor force with a 3-percent unemployment rate. A total labor force of 100.7 million was projected for 1980, and it was assumed that 2.7 million persons would be in the Armed Forces, yielding a civilian labor force of 98 million. With the assumed unemployment rate, the result was projections of 95.1 million employed and 2.9 million unemployed workers. The employment number was used as a control total for the occupational projections.

Total employment underestimated

The projection of total employment for 1980 was 2.2 percent below the actual 97.3 million. Ironically, the error would have been greater if either the labor force or the unemployment rate had been accurately projected. The labor force projection was 5.7 percent lower than the actual 106.8 million, primarily because the number of women entering the labor force was greater than anticipated.⁸ In addition, Armed Forces strength was overprojected by 600,000. The net result was a 6.7-million, or 6.4-percent, understatement of the civilian labor force (workers in thousands):

<i>Labor force group</i>	<i>Projected</i>	<i>Actual</i>	<i>Percent difference</i>
Total	100,700	106,821	-5.7
Armed Forces	2,700	2,102	28.4
Civilian labor force	98,000	104,719	-6.4
Employment	95,085	97,270	-2.2
Unemployment	2,915	7,448	-60.9

The unemployment rate in 1980 averaged 7.1 percent, instead of the assumed 3 percent. Consequently, the number of unemployed workers was underestimated by

about 4.5 million. In terms of employment, however, this error offset a large part of the error in the civilian labor force projection. If the civilian labor force had been projected correctly, the unemployment assumption would have resulted in a 4.4-percent overstatement of 1980 employment, rather than the 2.2-percent underestimate that occurred. Conversely, if the unemployment rate had been accurately anticipated, the civilian labor force projection would have resulted in a 6.4-percent understatement of employment.

The recovery and expansion that followed the 1974 – 75 downturn came to an end in 1980, as the economy felt the effects of the 1979 oil-price shock. After declining from 8.5 percent in 1975 to 5.8 percent in 1979, the unemployment rate rose to 7.1 percent in 1980. Even if the economy had continued to improve, however, it is not likely that unemployment would have declined to the 3-percent rate assumed in the projections. The economic downturn of 1980 affected employment in some occupations more than others. Because unemployment rates for individual occupations were not specified in the assumptions, however, the effect of economic conditions on the accuracy of a projection for any given occupation is difficult to measure.

Simulated projections

A simulated matrix based on projected 1980 industry employment totals and 1970 staffing patterns for each industry was developed to determine whether these base-year patterns would have resulted in better or worse occupational employment estimates than the projected patterns that were used. Neither was clearly superior, but the 1980 estimates for many occupations changed substantially.⁹

The projections were more accurate than the simulations for 6 of the 9 major occupational groups. (See table 3.) However, the average absolute error for all groups declined from 6.7 percent to 5.7 percent as a result of the simulations. The improvement in this average was largely because of a much more accurate estimate for nonfarm laborers. Employment in this group was projected to increase less than 1 percent between 1970 and 1980, but actually rose 19.7 percent. The simulated estimate was very close to actual employment. Simulations also were more accurate than projections for managers and farmworkers.

The simulation improved the projection accuracy for exactly one-half of the 64 detailed occupations in the study and reduced it for the remainder. (See table 2.) The average absolute percentage error increased slightly, from 22.4 percent to 22.9 percent. Errors from the simulation ranged from a 55-percent understatement of psychologists to a 81-percent overstatement of locomotive engineers' helpers. The same occupations had the most extreme errors in the projections, and the values

Table 3. Comparison of projections and simulations of 1980 employment by occupational group

[Workers in thousands]

Occupational group	1980			Difference between projected and actual		Difference between simulated and actual	
	Projected	Simulated	Actual	Level	Percent	Level	Percent
Total	95,085	95,085	97,270	-2,185	-2.2	-2,185	-2.2
Professional and technical workers	15,500	15,117	15,613	-113	-0.7	-496	-3.2
Managers and administrators	9,500	9,910	10,919	-1,419	-13.0	-1,009	-9.2
Salesworkers	5,760	5,541	6,172	-412	-6.7	-631	-10.2
Clerical workers	17,285	16,763	18,105	-820	-4.5	-1,342	-7.4
Craft and kindred workers	12,240	12,143	12,529	-289	-2.3	-386	-3.1
Operatives	15,440	15,830	13,814	1,626	11.8	2,016	14.6
Nonfarm laborers	3,700	4,377	4,456	-756	-17.0	-79	-1.8
Service workers	13,060	12,695	12,958	102	0.8	-263	-2.0
Farmworkers	2,600	2,709	2,704	-104	-3.9	5	0.2

Note: Details may not add to totals because of rounding. Percent differences are based on unrounded numbers.

were about the same. However, considerable differences appear when the occupations are ranked according to accuracy. Only two occupations were among the 10 with the most accurate projections in each version. Even among each top 20, there were only nine occupations in common. Similarly, only two occupations were among the 20 with the worst projections in each version.

The simulation increased projection errors substantially for several occupations. One of the better projections, a 5-percent underestimate of elementary schoolteachers, was raised to a 41-percent overestimate. Because these teachers declined as a percentage of total employment in the educational services industry between 1970 and 1980, the use of 1970 staffing patterns in the matrix resulted in an overstatement of employment.¹⁰ Some other occupations with much less accurate projections as a result of the simulation were veterinarians, optometrists, composers and typesetters, and postmasters. In contrast, projection errors were reduced significantly in several occupations, including credit managers, airplane mechanics, photoengravers and lithographers, and locomotive engineers. Many of the occupations most affected by the simulation were concentrated in relatively small numbers of industries, thus reducing chances of compensating errors in industry-occupation cells in the matrix.

Similar patterns were observed in both the projections and the simulations. The largest occupations generally had the most accurate 1980 estimates. In each case, the direction of employment change was correctly anticipated in about 5 out of every 6 occupations. Employment in about two-thirds of the growing occupations was underestimated, and nearly all employment declines were underestimated.

The simulation exercise indicated that the extrapolation of staffing patterns did not, on average, produce more accurate projections for detailed occupations than the assumption that the patterns would not change over

the projection period. This suggests that future work should concentrate on analysis of factors that affect the patterns, rather than extrapolations based on limited observations.

Projections for 1975

The 1980 occupational projections were slightly less accurate than those previously developed by the Bureau for 1975. The 1980 estimates have the disadvantage of being based on more dated statistics on occupational staffing patterns of detailed industries as the 1960 census was the most recent source for both projections. However, a larger number of CPS annual estimates of total employment in each occupation was available for the 1980 projections.

Although the 1975 projections were published with a 1960 matrix base, CPS estimates of annual employment were available annually through 1965 at the time the projections were being developed and were used in the analysis. Annual CPS estimates through 1970 were available for the 1980 projections. Therefore, both the 1975 and 1980 projections covered a 10-year span.

The projection of total civilian employment in 1975 was 2.9 percent higher than the actual level of 84.8 million. The 1980 projection, by contrast, was 2.2 percent lower than the actual level of 97.3 million. The difference is explained primarily by the underlying labor force projections. In both periods, labor force participation rates for women rose more rapidly than expected, resulting in underestimates. However, the labor force was underestimated by only 2.3 percent in 1975, compared with 5.7 percent in 1980. For each year, it was assumed that Armed Forces strength would be 2.7 million and the unemployment rate would be 3 percent. The number of military personnel was overestimated by about 24 percent in 1975 and by more than 28 percent in 1980. The economic recession of the mid-1970's negated the assumption of a full-employment economy in 1975. The unemployment rate in 1975 averaged 8.5 per-

cent, or almost triple the assumed rate. Although the downturn in 1980 was not as severe, the unemployment rate averaged 7.1 percent.

Among the comparable detailed occupations, the 1975 projections averaged 21.1 percent off the mark, while the 1980 estimates averaged 22.4 percent off. Accuracy improved, however, for about one-half of the occupations. The largest error among the 1975 projections, a 136-percent overestimate of plasterers, was reduced to 29 percent. Large projection errors for civil engineers and knitters, loopers, and toppers also were reduced. Occupations with worse projections in 1980 included airplane mechanics, lawyers, telephone operators, locomotive engineers' helpers, and crane, derrick, and hoist operators.

Only two occupations were among the 10 with the most accurate projections for each year. Among the leading 20, there were eight occupations in common. In addition, relatively few of the same occupations were among the least accurate projections for each year.

Again, similar patterns were observed in both sets of projections. The largest occupations usually had the most accurate projections. The direction of employment change was correctly anticipated for about 5 out of every 6 occupations in each set. In both the 1975 and the 1980 projections, errors for occupations that declined in employment averaged more than twice as high as those with employment growth. Nearly all employment declines were underestimated. However, employment in about one-half of the growing occupations was underprojected in 1975, compared with two-thirds in 1980.

The 1975 projections performed better against simple extrapolations than the 1980 projections, but the extrapolations for these two target years were not based on the same number of employment observations. For the 1975 study, annual employment data were available only for 6 years, whereas most of the extrapolations to 1980 were based on 9 years of data.

The earlier evaluation did not include a simulation of target-year employment using base year occupational staffing patterns and projected industry employment totals. Instead, it focused on a simulation based on projected staffing patterns and actual 1975 employment totals for each industry, which disclosed that errors in the occupational employment projections were mostly a

result of the staffing patterns. Unfortunately, data limitations precluded a similar study of the 1980 projections.

New projections

Since the 1980 projections were published, the Bureau has taken steps to improve its occupational outlook program. Recently, the first matrix to be developed from data from the Occupational Employment Statistics survey was completed and projected to 1990.¹¹ Previous matrices were based largely on census information on trends in staffing patterns from decade to decade. Because census data are collected only once every 10 years, they do not capture the latest developments in occupational employment requirements in different industries. The occupational employment survey provides much more timely information, as it collects data on a 3-year cycle. The survey also is more specific in its definition of occupations and has a larger sample than the census-derived sample.¹²

Both this study and that of the 1975 projections indicated weaknesses in industry-occupation staffing patterns. The evaluation of the 1980 projections disclosed that mechanical extrapolation of staffing patterns in the matrix does not necessarily produce better results than static patterns. In preparing the 1990 survey-based projections, patterns were extrapolated only when detailed analysis showed that there were reasons to expect them to change. As a result, the matrix has more industry-occupation cells that remain static between the base and target years.

The 1980 projections were based on a single set of assumptions. Three alternative sets of occupational employment projections were developed for 1990 from different assumptions about growth of the labor force, production, productivity, and other factors. While many users of the data may prefer a single set of estimates, the Bureau's evaluations have demonstrated a wide range of errors in previous occupational projections. In addition, a single estimate concerning the future inevitably causes users to attribute a precision to it that should not be afforded. Alternatives also are of more value to planners who are concerned with how differences in the assumptions might affect the demand for some occupations more than others. □

FOOTNOTES

¹ The Bureau's occupational projections for 1980 were published in *Tomorrow's Manpower Needs*, Volume IV, revised 1971, Bulletin 1737.

² See Max L. Carey, "Evaluating the 1975 projections of occupational employment," *Monthly Labor Review*, June 1980, pp. 10-20.

³ CPS annual averages of employment for 1962 through 1970 were extrapolated for the 51 occupations which use the Census and CPS as data sources for the matrix. Twelve other occupations had matrix estimates based on independent sources. Rather than attempting to reconstruct annual data from independent sources, estimates from 1960

and 1970 matrixes were extrapolated for these occupations. An extrapolation was not developed for osteopaths because an estimate for this occupation was not available from the 1960 matrix. The extrapolation for locomotive engineers' helpers resulted in negative employment in 1980; the negative number was arbitrarily adjusted to a positive level of 100 workers.

⁴ *Technical Paper 26 1970 Occupation and Industry Classification System in Terms of Their 1960 Occupation and Industry Elements*. (Washington, U.S. Bureau of the Census. 1972.)

⁵ The formula and parameters established from the CPS were not developed specifically for use in identifying standard errors of employment in detailed occupations, but, nevertheless, should approximate the magnitude of error.

⁶ For some occupations, the 1970 matrix employment levels and 1970 CPS employment levels were identical. In these cases, the 1980 CPS employment was accepted without adjustment. For many other occupations, however, differences existed between CPS and matrix employment levels for 1970, even though the matrix estimates were not developed from independent sources. If a difference was large, the occupation was not included in the evaluation. The 1980 CPS employment levels were adjusted to account for small differences in the 1970 numbers from the CPS and the matrix. If matrix employment for an occupation in 1970 was 2 percent higher than CPS employment, for example, the 1980 CPS employment was increased by 2 percent. A similar procedure was followed in preparing employment estimates from data obtained from independent sources.

⁷ For a detailed discussion of the methodology used in developing employment projections, see *Tomorrow's Manpower Needs*, pp. 3-6.

⁸ The total labor force participation rate for women was projected at 43.0 percent for 1980. See "The United States economy in 1980," *Monthly Labor Review*, April 1970, pp. 3-34. The labor force participation rate for women in 1980 was actually 50.9 percent. For an evaluation of the 1980 labor force projections, see Howard N Fullerton, "How accurate were projections of the 1980 labor force?", elsewhere in this issue.

⁹ Other simulations based on different combinations of actual and projected data on staffing patterns and industry employment totals

would have been interesting. The occupational totals resulting from a matrix based on 1970 staffing patterns and actual 1980 industry employment levels could be compared with the actual 1980 occupational totals to determine the extent to which static patterns alone would have affected projection accuracy. Similarly, simulations could be developed by combining actual 1980 staffing patterns with projected 1980 industry employment, and projected 1980 staffing patterns with actual 1980 industry employment. These two simulations could be used to determine whether the projections of staffing patterns or the projections of industry employment contributed most to the projection error for each occupation. Unfortunately, some of the data needed for these studies were unavailable. The Current Population Survey (CPS), which was the primary source of data on total employment by detailed occupation for 1980, gives staffing patterns only for industry groups. The Bureau's establishment survey, which is the source of data on wage and salary employment in each industry, changed from the 1967 Standard Industrial Classification (SIC) to the 1972 SIC in 1978, and, consequently, projected and actual employment levels for 1980 are not comparable for many industries.

¹⁰ Actually, the 1970 staffing patterns for elementary schoolteachers were not the sole source of the overprojection of employment in the simulated matrix. The error was compounded by an overprojection of total employment in the educational services industry for 1980. If the industry projection had been correct, the overprojection of elementary teachers would have been reduced by more than one-third.

¹¹ See Max L. Carey, "Alternative occupational employment projections, 1980-90," *Monthly Labor Review*, August 1981, pp. 42-55.

¹² For a description of the survey, see *Occupational Employment Statistics Handbook*, Bureau of Labor Statistics, April 1979.