Evaluating the 1990 projections of occupational employment

Occupational employment projections for 1990 were conservative; too many occupations were projected to have average growth and most of those expected to have rapid growth were underprojected

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The Bureau of Labor Statistics occupational projections are a valuable resource for counselors, students, and others concerned with the future occupational composition of the U.S. labor force. The development of these projections requires careful analysis of large amounts of data to identify occupational employment trends and the factors causing them, and to determine a likely course for those trends in the future.

However, there is inherent uncertainty in any projection. Consequently, BLS periodically evaluates the results of past projections to gauge how well the projections tracked against actual occupational employment change. This process provides users of occupational projections with information about the accuracy of projections of the future growth of occupations that may be valuable in career decisionmaking, education planning, and other endeavors. In addition, analysts developing projections gain insight into the process that resulted in errors or accurate projections that can be used in the development of future projections. Thus, BLS considers evaluation to be an important stage of the projections program.

The last BLS occupational projections to be formally evaluated were the projections to 1980 from a base year of 1970.[1] The projections to 1985 were not evaluated because they were based on the 1970 census occupational classification system, which was so different from the classification system in use in 1985 that the projected and actual data were not comparable. The projections for the period 1978–90 also were not evaluated because they were not used in any edition of the BLS *Occupational Outlook Handbook* and, as indicated below, assessing information presented in the *Handbook* is an important aspect of the evaluation. However, projected 1990 employment in the 1978–90 set of projections[2] was nearly identical to the 1980–90 projections evaluated in this article. Consequently, the evaluation of those projections would be virtually the same as that presented here, because the differences between projected and actual 1990 employment were used as the basic measure of accuracy.

Like the previous evaluations of occupational projections, this article identifies the errors and accuracies of projections for major occupational groups and for a selected number of detailed occupations; discusses the major causes of error for many of the occupations having the largest errors; and compares the errors with those found in earlier projections. In addition, it discusses some of the technical concerns about the accuracy of the evaluation process itself, summarizes some of the lessons learned that can be used to benefit future projections efforts, and comments on an evaluation of the projections made by researchers outside of BLS.

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Table 1. **Projected and actual employment by major occupational group from the industry-occupation matrix, and actual change from the Current Population Survey, 1980–90**

[In thousands]

Occupation	Industry-occupation matrix							Current Population Survey		
	Employment			Percent change		Percent error	Numerical error	Employment		Percent change, 1980–90
	Actual 1980	Projected 1990	Actual 1990	Projected	Actual			1980	1990	
Total	102,107	121,449	122,573	19	20	–0.9	–1,124	99,303	117,914	19
Executive, administrative, and managerial	11,136	13,004	12,451	17	12	4.4	553	10,215	14,839	45
Professional specialty	11,502	13,559	15,800	18	37	–14.4	–3,241	11,823	15,818	34
Technicians and related support	3,079	4,075	4,204	32	37	–3.1	–1,292	2,834	3,842	36
Marketing and sales	9,023	11,023	14,088	22	56	–21.8	–3,065	10,852	14,191	31
Administrative support occupations, including clerical	17,264	20,640	21,951	20	27	6.0	–1,311	16,638	18,641	12
Service occupations	15,547	19,374	19,204	25	24	.9	170	13,071	15,759	21
Precision production, craft, and repair; and operators, fabricators, and laborers	31,032	36,483	31,369	18	1	16.3	5,114	30,299	31,416	4
Agricultural, forestry, fishing, and related occupations	3,524	3,291	3,506	–7	–1	–6.0	–215	3,634	3,408	–6

Major occupational groups

Total employment for 1990 was projected very accurately, as actual employment was less than 1 percent greater than projected.[3] Among the major occupational groups, the 1990 projections were on target for service occupations, with projected employment less than 1 percent more than actual employment. The one group to experience an employment decline—agriculture, forestry, fishing, and related occupations—was correctly projected to be the only major occupational group to lose jobs. Although the decline was somewhat less than projected, the projection was only 6 percent lower than actual employment. The projections also were reasonably accurate for the following major groups: executive, administrative, and managerial; technicians and related support; and administrative support occupations, including clerical. The difference between actual and projected employment for these groups ranged from 3.1 percent to 6.0 percent. (See table 1.)

Projection errors were fairly large for salesworkers and professional specialty occupations, the two fastest-growing occupational groups between 1980 and 1990. The marketing and sales group had the largest projection error. Over the 1980–90 period, actual employment derived from the 1980 and 1990 industry-occupation matrixes (described below) increased from 9 million to 14.1 million, or by 56 percent[4]—much faster than that of any other major occupational group. Employment was projected to grow to 11 million by 1990, an increase of 22 percent. About 60 percent of the error of 3 million in the 1990 projections can be accounted for by the low rates of increase projected for self-employed salesworkers and for wage and salary workers in two occupations—cashiers and stock clerks, sales floor. Data on self-employed workers are derived from the Current Population Survey (CPS), rather than from the industry-occupation matrix, and the 1990 projection for salesworkers was 700,000 workers less than the actual number. Cashiers in wage and salary jobs were projected to increase rapidly—by 30 percent—but the actual growth rate was even faster—67 percent. This resulted in an underprojection of 573,000. Similarly, stock clerks, sales floor were underprojected by 521,000. Without these projection errors, the overall error for salesworkers would have been a far more respectable 9 percent.

It is interesting to note that, in the occupational classification system used in 1980, both cashiers and stock clerks, sales floor were in other major occupational groups. Cashiers were in the clerical worker group (now called administrative support, including clerical) and stock clerks, sales floor were in the laborer category. Because each of those major groups was expected to be significantly affected by technological change—and they were—the placement of cashiers and stock clerks, sales floor in the classification system had a major influence on the analytical decision not to project extremely rapid employment increases for them.

The error for professional specialty occupations was due largely to an underprojection in numbers of teachers. College teachers were projected to decline, as were graduate assistants and other occupations associated with higher education. The projections were based on a drop in college enrollments, projected by the U.S. Department of Education's National Center for Educational Statistics, that was tied to a shrinking of the traditional college-age population of 18- to 24-year-olds. During the 1980's, however, colleges were successful in enrolling older individuals in greater numbers than in the past, and enrollment rates of students of traditional college age also rose more rapidly than expected. Consequently, employment of college teachers grew, rather than declined. An underprojection of vocational education teachers also contributed significantly to the underprojection of professional workers. In addition, the number of registered nurses, although projected to grow rapidly, increased at an even faster pace than expected, and contributed more than 10 percent of the underprojection of professional specialty occupations.

Errors also were large for a combined group of precision production, craft, and repair occupations, and operators, fabricators, and laborers. (Because of the occupational classification changes between 1980 and 1990, it was not possible to aggregate projected 1990 employment—which was based on the 1980 classification—for the detailed occupations to yield estimates comparable to observations for the two major occupational groups contained in the 1990 occupational classification.) One major cause of the error for this group is easily identified. About 40 percent of these workers are concentrated in manufacturing and about two-thirds of manufacturing employment is composed of such workers. Employment of wage and salary workers in manufacturing was projected to increase to 23.7 million by 1990. However, actual 1990 employment was 19.1 million, or 4.6 million lower.[5]

The methodology used to develop occupational projections uses industry employment projections and an estimate of the proportion of employment associated with each occupation in every industry. (The framework of the projections is described in detail later in this article.) As a result, employment in the combined group of precision production, craft, and repair occupations and operators, fabricators, and laborers in manufacturing was projected at 15.6 million, about 3.2 million more than actual 1990 employment. Thus, about 60 percent of the 5.1 million error for this occupational group is accounted for by the overprojection of manufacturing employment. Another 10 percent of the error results from the overprojection, by 600,000, of construction industry workers, of whom 75 percent also are classified in this occupational group.

Detailed occupations

Some 132 detailed occupations were chosen for evaluation, according to criteria enumerated in a later section. Differences between projected and actual employment among these occupations ranged from an underestimate of 97 percent for securities salesworkers to an overestimate of 56 percent for mining engineers and boilermakers. (See table 2.) The absolute percentage errors for all 132 occupations averaged 21.1 percent. About three-fifths of the occupations had errors below the average.

Employment was overprojected for nearly three-fifths of the occupations, by an average of 20.5 percent. Employment was underprojected for nearly two-fifths of the occupations, by an average of 22.8 percent.

Projection error was inversely related to size of employment. Occupations employing fewer than 100,000 workers in 1980 had an average projection error of 25.6 percent. Those with 1980 employment of between 100,000 and 500,000 had an average error of 20.5 percent. The largest occupations—those with more than 500,000 workers—had the lowest error, 14.5 percent.

The direction of employment change was projected correctly for 107 of the 132 occupations. Increases were projected more accurately than decreases. All but one of the occupations (secondary schoolteachers) that did grow were projected to increase or have no change, but only 4 of 29 occupations that declined were projected to decline—railroad conductors, stenographers, farmers, and private household workers. Projections for occupations in which employment fell had an average absolute error of 32.1 percent. All 29 declining occupations were overprojected.

However, an analysis of the employment trends from the CPS and industry-occupation matrix trends raises questions about the actual trends for five occupations showing declines in the matrix. Chemical engineers; counselors; wholesale and retail trade buyers, except farm products; stock clerks, stockroom, warehouse, and yard; and electricians show employment increases in the CPS. It is possible that the change made in the early 1980's to the occupational classification system used in the Occupational Employment Statistics (OES) survey—the survey used to construct the industry-occupation matrix—could have distorted actual matrix employment trends for these occupations. (This change in classification is discussed in detail later in this article.)

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Table 2. **Comparison of projected and actual 1990 employment in selected occupations**

[In thousands]

Occupation and data source	Actual employment		Projected employment, 1990	Percent change, 1980–90		Error	
	1980	1990		Actual	Projected	Level	Percent
Architects:							
Matrix	80	108	108	35	36	0	0
CPS	90	142	—	58	—	—	—
Librarians and audiovisual specialists:							
Matrix	145	149	149	3	3	0	0
CPS	182	192	—	5	—	—	—
Painters and paperhangers:							
Matrix	403	453	454	12	13	1	0
CPS	490	575	—	17	—	—	—
Engineers:							
Matrix	1,178	1,519	1,531	29	30	12	1
CPS	1,433	1,862	—	30	—	—	—
Police and detectives:							
Matrix	559	655	651	17	16	–4	–1
CPS	512	829	—	62	—	—	—
Heat, air conditioning, and refrigeration mechanics:							
Matrix	180	219	217	22	21	–2	–1
CPS	207	267	—	29	—	—	—
Clinical lab technologists and technicians:							
Matrix	193	258	261	34	35	3	2
CPS	234	297	—	27	—	—	—
Construction and building inspectors:							
Matrix	48	60	61	25	26	1	2
CPS	29	70	—	141	—	—	—
Aircraft mechanics:							
Matrix	108	122	126	13	16	4	3
CPS	121	110	—	–9	—	—	—
Radiologic technolgists and technicians:							
Matrix	106	149	144	41	36	–5	–3
CPS	100	122	—	22	—	—	—
Roofers:							
Matrix	113	138	134	22	19	–4	–3
CPS	139	212	—	53	—	—	—
Electrical and electronics engineers:							
Matrix	327	426	449	30	38	23	5
CPS	357	581	—	63	—	—	—
Mathematicians:							
Matrix	18	22	21	22	16	–1	–5
CPS	8	7	—	–13	—	—	—
Public relations specialists:							
Matrix	87	109	104	25	20	–5	–5
CPS	126	162	—	29	—	—	—
Civil engineers:							
Matrix	165	198	210	20	27	12	6
CPS	180	234	—	30	—	—	—
Podiatrists:							
Matrix	12	16	17	33	3	1	6
CPS	10	15	—	50	—	—	—
Veterinarians:							
Matrix	36	47	50	31	39	3	6
CPS	36	58	—	61	—	—	—
Aircraft pilots and flight engineers:							
Matrix	82	90	96	10	17	6	6
CPS	76	114	—	50	—	—	—
Air traffic controllers:							
Matrix	29	32	34	10	16	2	6
CPS	32	36	—	13	—	—	—
Cosmetologists and related workers:							
Matrix	466	597	565	28	21	–32	–6
CPS	565	734	—	30	—	—	—
Geologists, geophysicists, and oceanographers:							
Matrix	40	48	52	20	30	4	8
CPS	45	53	—	18	—	—	—

Table 2. **Continued—Comparison of projected and actual 1990 employment in selected occupations**

[In thousands]

Occupation and data source	Actual employment		Projected employment, 1990	Percent change, 1980–90		Error	
	1980	1990		Actual	Projected	Level	Percent
Physicians:							
Matrix	491	580	631	18	29	51	8
CPS	426	575	—	35	—	—	—
Dental assistants:							
Matrix	139	176	192	27	38	16	8
CPS	138	187	—	36	—	—	—
Salespersons, retail:							
Matrix	2,880	3,619	3,359	26	17	–260	–8
CPS	2,862	3,074	—	7	—	—	—
Lawyers:							
Matrix	416	587	543	41	31	–44	–8
CPS	522	729	—	40	—	—	—
Purchasing agents, except wholesale, retail, and farm:							
Matrix	172	218	202	27	18	–16	–8
CPS	244	259	—	6	—	—	—
Plasterers:							
Matrix	24	28	26	17	12	–2	–8
CPS	26	38	—	46	—	—	—
Guards:							
Matrix	648	883	820	36	27	–63	–8
CPS	548	768	—	40	—	—	—
Refuse collectors:							
Matrix	117	124	137	6	16	13	9
CPS	69	49	—	30	—	—	—
Industrial engineers:							
Matrix	116	135	148	16	28	13	9
CPS	245	204	—	–17	—	—	—
Telephone operators:							
Matrix	337	325	356	–4	6	31	9
CPS	316	208	—	–34	—	—	—
Janitors and cleaners:							
Matrix	2,751	3,007	3,313	9	20	306	9
CPS	1,359	2,191	—	61	—	—	—
Pharmacists:							
Matrix	141	169	155	20	10	–14	–9
CPS	120	171	—	43	—	—	—
Insurance salesworkers:							
Matrix	327	439	405	34	24	–34	–9
CPS	532	604	—	14	—	—	—
Accountants:							
Matrix	833	985	1,079	18	30	94	10
CPS	1,047	1,438	—	37	—	—	—
Social scientists:							
Matrix	190	224	248	18	31	24	10
CPS	278	363	—	31	—	—	—
Sheet-metal workers and duct installers:							
Matrix	218	233	258	7	19	25	10
CPS	161	122	—	–22	—	—	—
Licensed practical nurses:							
Matrix	522	644	717	23	38	73	10
CPS	375	443	—	18	—	—	—
Truckdrivers and driver-salesworkers:							
Matrix	2,522	2,701	3,006	7	19	305	10
CPS	2,736	2,807	—	6	—	—	—
Teachers, elementary:							
Matrix	1,286	1,362	1,533	6	19	171	11
CPS	1,383	1,506	—	9	—	—	—
Statistical clerks:							
Matrix	85	85	96	0	12	11	11
CPS	387	88	—	–77	—	—	—
Carpenters:							
Matrix	970	1,057	1,186	9	22	129	11
CPS	1,185	1,360	—	15	—	—	—
Waiters and waitresses:							
Matrix	1,711	1,747	2,085	2	22	238	11
CPS	1,416	1,392	—	–2	—	—	—

Table 2. **Continued—Comparison of projected and actual 1990 employment in selected occupations**

[In thousands]

Occupation and data source	Actual employment		Projected employment, 1990	Percent change, 1980–90		Error	
	1980	1990		Actual	Projected	Level	Percent
Registered nurses:							
Matrix	1,104	1,727	1,551	56	41	−176	−11
CPS	1,302	1,673	—	28	—	—	—
Dancers and choreographers:							
Matrix	7	9	8	14	22	−1	−11
CPS	10	14	—	40	—	—	—
Secretaries:							
Matrix	2,469	3,576	3,228	45	31	−348	−11
CPS	3,876	3,956	—	2	—	—	—
Foresters and conservation scientists:							
Matrix	30	29	33	−3	12	4	12
CPS	65	26	—	60	—	—	—
Bartenders:							
Matrix	382	400	457	5	20	57	12
CPS	299	307	—	3	—	—	—
Drywall installers and finishers:							
Matrix	96	143	128	49	33	−15	−12
CPS	91	153	—	68	—	—	—
Optometrists:							
Matrix	27	37	33	37	22	−4	−12
CPS	21	23	—	10	—	—	—
Firefighting occupations:							
Matrix	279	280	322	1	17	42	13
CPS	227	220	—	−3	—	—	—
Railroad conductors:							
Matrix	33	28	32	−15	−5	4	13
CPS	37	37	—	0	—	—	—
Automotive body and related occupations:							
Matrix	153	219	193	43	26	−26	−13
CPS	179	201	—	12	—	—	—
Bookkeeping, accounting, and auditing clerks:							
Matrix	1,715	2,276	2,006	33	17	−270	−13
CPS	1,904	1,912	—	0	—	—	—
Metallurgists and metallurgical engineers:							
Matrix	15	18	21	20	35	3	14
CPS	17	24	—	41	—	—	—
Economists:							
Matrix	29	37	43	28	44	6	14
CPS	138	114	—	−17	—	—	—
Radio and television announcers and newscasters:							
Matrix	51	57	66	12	29	9	14
CPS	19	52	—	174	—	—	—
Glaziers:							
Matrix	38	42	49	11	27	7	14
CPS	43	44	—	2	—	—	—
Parking lot attendants:							
Matrix	36	50	58	39	62	8	14
CPS	41	50	—	22	—	—	—
Farmers:							
Matrix-CPS	1,447	1,074	1,248	−26	−14	174	14
Agricultural and food scientists:							
Matrix	20	25	22	25	12	−3	−14
CPS	21	23	—	10	—	—	—
Gardeners and groundskeepers, except farm:							
Matrix	653	874	764	34	17	−110	−14
CPS	601	852	—	42	—	—	—
Bank tellers:							
Matrix	480	517	606	8	26	89	15
CPS	531	468	—	−12	—	—	—
Animal caretakers, except farm:							
Matrix	94	106	124	13	31	18	15
CPS	96	107	—	11	—	—	—
Dental hygienists:							
Matrix	61	97	84	59	38	−13	−15
CPS	41	87	—	112	—	—	—

Table 2. **Continued—Comparison of projected and actual 1990 employment in selected occupations**

[In thousands]

Occupation and data source	Actual employment		Projected employment, 1990	Percent change, 1980–90		Error	
	1980	1990		Actual	Projected	Level	Percent
Psychologists:							
Matrix	83	125	109	51	32	–16	–15
CPS	111	123	—	11	—	—	—
Photographers:							
Matrix	91	120	104	32	14	–16	–15
CPS	111	123	—	11	—	—	—
Machinists:							
Matrix	282	386	335	37	19	–51	–15
CPS	567	488	—	–14	—	—	—
Mechanical engineers:							
Matrix	213	233	279	9	31	46	16
CPS	237	316	—	33	—	—	—
Physicists and astronomers:							
Matrix	21	20	24	–5	15	4	17
CPS	24	27	—	13	—	—	—
Engineering and science technicians:							
Matrix	1,268	1,327	1,610	5	27	283	17
CPS	1,095	1,220	—	11	—	—	—
Real estate agents, brokers, and appraisers:							
Matrix	366	413	497	13	36	84	17
CPS	582	752	—	29	—	—	—
Biological scientists:							
Matrix	45	62	53	38	16	–9	–17
CPS	64	74	—	16	—	—	—
Dentists:							
Matrix	171	174	212	2	24	38	18
CPS	140	162	—	16	—	—	—
File clerks:							
Matrix	271	271	329	0	22	58	18
CPS	324	299	—	–8	—	—	—
Actuaries:							
Matrix	8	13	11	63	45	–2	–18
CPS	16	19	—	19	—	—	—
Medical records technicians:							
Matrix	32	52	44	63	38	–8	–18
CPS	16	69	—	331	—	—	—
Upholsterers:							
Matrix	43	64	54	48	26	–10	–18
CPS	67	66	—	–2	—	—	—
Computer operators and peripheral equipment operators:							
Matrix	233	320	394	37	69	74	19
CPS	522	815	—	56	—	—	—
Payroll and timekeeping clerks:							
Matrix	179	171	214	–4	20	43	20
CPS	232	195	—	–16	—	—	—
Electricians:							
Matrix	560	548	684	–2	22	136	20
CPS	648	698	—	8	—	—	—
Teachers, secondary school:							
Matrix	1,237	1,280	1,059	3	–14	–221	–20
CPS	1,243	1,209	—	–3	—	—	—
Private household workers:							
Matrix							
CPS	988	782	987	–21	0	205	21
Drafters:							
Matrix	322	326	419	1	30	93	22
CPS	335	282	—	–16	—	—	—
Inspectors and compliance officers, except construction:							
Matrix	112	156	128	39	12	–28	–22
CPS	109	196	—	80	—	—	—
Typists and word processors:							
Matrix	1,067	972	1,271	–9	19	299	23
CPS	1,023	640	—	–37	—	—	—
Tool and die makers:							
Matrix	166	141	184	–15	11	43	23
CPS	176	152	—	–14	—	—	—

Table 2. **Continued—Comparison of projected and actual 1990 employment in selected occupations**

[In thousands]

Occupation and data source	Actual employment		Projected employment, 1990	Percent change, 1980–90		Error	
	1980	1990		Actual	Projected	Level	Percent
Stock clerks, stockroom, warehouse, or yard:							
Matrix	822	752	977	–9	19	225	23
CPS	533	598	—	12	—		
Urban planners:							
Matrix	23	23	30	0	29	7	23
CPS	18	15	—	–17	—	—	—
Electrical and electronic technicians and technologists:							
Matrix	360	363	480	1	34	117	24
CPS	260	352	—	35	—	—	—
Plumbers, pipefitters, and steamfitters:							
Matrix	407	379	501	–7	23	122	24
CPS	478	455	—	–5	—	—	—
Dental lab technicians:							
Matrix	53	57	71	8	32	14	24
CPS	52	62	—	19	—	—	—
Systems analysts and computer scientists:							
Matrix	205	463	351	126	71	–112	–24
CPS	244	605	—	148	—	—	—
Dispatchers:							
Matrix	143	209	167	46	17	–42	–25
CPS	103	224	—	117	—	—	—
Nursing aides and psychiatric aides:							
Matrix	1,175	1,274	1,725	8	47	451	26
CPS	1,093	1,452	—	33	—	—	—
Proofreaders and copy markers:							
Matrix	20	29	23	45	17	–6	–26
CPS	38	30	—	–21	—	—	—
Dining room and cafeteria attendants and bar helpers:							
Matrix	280	461	366	65	31	–95	–26
CPS	204	360	—	76	—	—	—
Aeronautical and astronautical engineers:							
Matrix	68	73	100	7	47	27	27
CPS	73	109	—	49	—	—	—
Dietitians and nutritionists:							
Matrix	44	45	62	2	41	17	27
CPS	59	83	—	41	—	—	—
Sewing machine operators:							
Matrix	896	716	987	–20	10	271	27
CPS	788	710	—	–10	—	—	—
Cashiers:							
Matrix	1,593	2,633	2,069	65	30	–564	–27
CPS	1,554	2,492	—	60	—	—	—
Chemists:							
Matrix	94	83	115	–12	23	32	28
CPS	128	125	—	–2	—	—	—
Bricklayers and stonemasons:							
Matrix	146	153	211	4	45	58	28
CPS	168	193	—	15	—	—	—
Automotive mechanics:							
Matrix	846	757	1,082	–11	28	325	30
CPS	1,018	862	—	–15	—	—	—
Furniture finishers:							
Matrix	22	34	26	55	20	–8	–31
CPS	32	38	—	19	—	—	—
Counselors:							
Matrix	208	144	212	–33	2	68	32
CPS	181	216	—	19	—	—	—
Millwrights:							
Matrix	91	73	109	–20	20	36	33
CPS	108	94	—	–13	—	—	—
Petroleum engineers:							
Matrix	18	17	26	–5	44	9	35
CPS	190	219	—	15	—	—	—
Barbers:							
Matrix	112	77	127	–31	13	50	39
CPS	108	93	—	–14	—	—	—

Table 2. **Continued—Comparison of projected and actual 1990 employment in selected occupations**

[In thousands]

Occupation and data source	Actual employment		Projected employment, 1990	Percent change, 1980–90		Error	
	1980	1990		Actual	Projected	Level	Percent
Computer programmers:							
Matrix	228	565	347	148	52	–218	–39
CPS	341	594	—	74	—	—	—
Therapists:							
Matrix	150	311	219	107	46	–92	–42
CPS	213	325	—	53	—	—	—
Programmers, numerical, tool, and process control:							
Matrix	12	8	14	–33	18	6	43
CPS	5	5	—	0	—	—	—
Chemical engineers:							
Matrix	56	48	70	–14	26	22	45
CPS	48	71	—	48	—	—	—
Service station attendants:							
Matrix	401	246	481	–39	20	235	49
CPS	337	220	—	–35	—	—	—
Statisticians:							
Matrix	27	16	32	–41	19	16	50
CPS	24	23	—	–4	—	—	—
Stenographers:							
Matrix	281	132	262	–53	–7	130	50
CPS	64	58	—	9	—	—	—
Data processing equipment repairers:							
Matrix	83	84	167	1	101	83	50
CPS	83	157	—	89	—	—	—
Taxi drivers and chauffers:							
Matrix	71	108	72	52	1	–36	–50
CPS	162	208	—	28	—	—	—
Stationary engineers:							
Matrix	62	35	72	–44	15	37	51
CPS	182	117	—	–36	—	—	—
Custom tailors and sewers:							
Matrix	63	116	77	84	23	–39	–51
CPS	26	49	—	88	—	—	—
Locomotive engineers:							
Matrix	47	25	52	–47	11	27	52
CPS	59	46	—	–22	—	—	—
Musicians:							
Matrix	138	252	165	83	20	–87	–53
CPS	143	162	—	13	—	—	—
Farm equipment mechanics:							
Matrix	25	48	31	92	27	–17	–55
CPS	57	40	—	–30	—	—	—
Boilermakers:							
Matrix	44	22	50	–50	14	28	56
CPS	35	29	—	–17	—	—	—
Mining engineers:							
Matrix	6	4	9	–33	43	5	56
CPS	9	6	—	–33	—	—	—
Opticians:							
Matrix	33	64	41	94	23	–23	–56
CPS	43	62	—	44	—	—	—
Bill and account collectors:							
Matrix	89	183	113	106	27	–70	–62
CPS	78	151	—	94	—	—	—
Teachers aides and educational assistants:							
Matrix	415	808	492	95	18	–316	–64
CPS	383	493	—	29	—	—	—
Shipping and receiving clerks:							
Matrix	397	762	461	82	16	–301	–65
CPS	505	546	—	8	—	—	—
Receptionists and information clerks:							
Matrix	402	900	505	124	26	–395	–78
CPS	629	851	—	35	—	—	—
Securities and financial services salesworkers:							
Matrix	69	191	97	177	41	–94	–97
CPS	134	300	—	124	—	—	—

Projections for occupations expected to grow or remain stable between 1980 and 1990 were, on average, 18 percent off actual 1990 employment levels. Projected employment for the 21 occupations that increased by 50 percent or more between 1980 and 1990 averaged 42.7 percent off 1990 levels. All of these occupations were underprojected. At the other end of the growth scale, only 1 of the 15 occupations that increased by 5 percent or less during 1980–90 was underprojected. The projections error for these occupations averaged 19.6 percent. All other occupations in which employment expanded had a respectable mean error of 10.7 percent. Of the 27 occupations that grew by between 28 and 49 percent—the second-fastest growth category (see the discussion of *Occupational Outlook Handbook* growth categories below)—18, or two-thirds, were underprojected, but the average error was only 11.6 percent. In the second-slowest growth category—6 percent to 14 percent—18 of the 20 occupations were overprojected, but the average error was only 12.7 percent. Twenty occupations fell in the average-growth category—15 percent to 27 percent. These occupations had a mean projection error of only 7.4 percent, and there was no tendency towards over- or underprojection.

Handbook growth categories

One of the major uses of BLS occupational projections is in the development of career guidance information for high school and college students. The Bureau's principal career guidance publication is the *Occupational Outlook Handbook*. Future job prospects are discussed for each occupation covered in the *Handbook*, although projected percentage changes are not presented. Rather, each discussion addresses prospective percent changes in the number of jobs in an occupation in terms of expected changes in employment relative to average employment growth. It is believed that a set of categories describing estimated ranges of relative growth is more meaningful than a numerical value to individuals, such as high school students, who do not know the growth expected for total employment.

The BLS 1980–90 occupational projections were the basis for such "qualitative" descriptions of prospective occupational employment growth, presented in the 1982–83 edition of the *Occupational Outlook Handbook*.[6] The discussion used growth categories that corresponded to a range of projected occupational employment changes, as follows: Much faster than average, 50 percent or more; faster than average, 28 percent to 49 percent; average, 15 percent to 27 percent; slower than average, 6 percent to 14 percent; little or no change, 5 percent to –5 percent; decline, –6 percent or more. Of the 132 occupations evaluated, 26 were not covered in the 1982–83 edition of the *Handbook*. However, they are evaluated here as if they had been included, according to the criteria set forth above. It should be noted that the average absolute error of the 26 occupations not included in the *Handbook* was 26.1 percent, somewhat higher than the overall error. It is interesting that, of those 26 occupations, only farmers—a declining occupation—fell into identical projected and actual growth ranges. Perhaps these occupations would have been projected more accurately if they had undergone the extensive analysis conducted for occupations presented in the *Handbook*. Nevertheless, if the 26 occupations not included in the *Handbook* were excluded from this evaluation, the analysis of the remaining occupations would be very similar to that presented below.

The percent-change ranges were on target or one category away for 80, or three-fifths, of the 132 occupations evaluated. For nearly another one-fourth, the ranges were two categories away. (See table 3.) For the remaining 16 percent of the occupations, the growth category was very misleading. In most of these cases, increases were projected for occupations that actually declined. However, as indicated above, comparing CPS data with trend data from the industry-occupation matrix raises questions about the true trend, and the projected growth ranges for some of these occupations may have been accurate. For example, the number of data processing equipment repairers was projected to grow much faster than average (101 percent, the fastest rate projected for any occupation), but the matrix data show only 1-percent growth for the 1980–90 period. However, the CPS shows an 89-percent increase for this occupation over the same interval. Analysis indicates that the CPS estimate is probably more accurate, because the matrix data for 1986–90 also indicate rapid growth. Thus, the 1980 matrix estimates for data processing equipment repairers very likely are not comparable to the 1990 data.

The projection framework

The 1980–90 projections of occupational employment were developed within the framework of an industry-occupation matrix that presented occupational employment for nearly 1,600 occupations in 378 industries. The distribution of industry employment by occupation in the matrix for 1980, the base year of the 1980–90 projections, was derived from the Occupational Employment Statistics survey. The primary source of total employment in each industry was the BLS Current Employment Statistics survey. Both surveys are surveys of business establishments and cover wage and salary workers.

Table 3. **Differences between the projected 1980–90 growth for 132 selected occupations, by projected growth categories and actual growth categories**

Projected growth category	Actual growth category				
	Same	One category away	Two categories away	Other	Opposite direction
Total:					
Number (132)	25	55	31	21	26
Percent (100)	19	42	23	16	20
Much faster than average (50 percent or more):					
Number (5)	2	2	0	1	0
Percent (100)	40	40	0	20	0
Faster than average (28 to 49 percent):					
Number (43)	11	17	7	8	3
Percent (100)	26	40	16	19	7
Average (15 to 27 percent):					
Number (63)	9	25	18	11	13
Percent (100)	14	40	29	17	21
Slower than average (6 to 14 percent):					
Number (13)	0	7	6	0	6
Percent (100)	0	54	46	0	46
Little or no change (5 to –5 percent):					
Number (5)	1	3	0	1	3
Percent (100)	20	60	0	20	60
Decline (–6 percent or more):					
Number (3)	2	1	0	0	1
Percent (100)	67	33	0	0	33

NOTE: Sum of details may be different from the total because occupations projected in the wrong direction are also included in another category.

The basic approach used to estimate future occupational employment was to project total employment by industry, project the occupational distribution of each industry, and then multiply the industry totals by the occupational distribution. The results were then summed across industries to obtain economy-wide occupational totals for wage and salary workers. Projections of self-employed and unpaid family workers were made independently, based on CPS data, and added to the wage and salary worker totals to develop total employment projections.

Projections of industry employment are developed through an analytical process that begins with the use of a macromodel of the U.S. economy, tied to population and labor force projections. Projections of gross national product and its distribution by demand category, derived from the model, are translated into output by industry and, in turn, into industry employment projections, through the use of projections of output per worker hour. The projections of occupational distribution of industries are based on examination of historical data and analysis of factors that influence changes in occupational structure.[7]

The occupational projections also are affected by the overall growth of employment and by the economic framework used in the models. Total 1990 employment was projected to be 121.4 million, compared to actual employment of 122.6 million—an error of less than 1 percent. Although some projection errors in the components of total employment offset others to yield the highly accurate overall employment projection, none was tied to factors that would have a significant impact on employment in specific occupations. For example, the unemployment rate projected for 1990 was 4.5 percent, whereas it actually was 5.5 percent. The unemployment rate projection is designed to reflect general economic conditions, rather than jobless levels for individual occupations; thus, the error in the unemployment rate projection was not significant because it did reflect an assumption of relatively full employment. Consequently, nearly all of the error in the occupational projections can be tied to errors either in the industry employment projections or in projections of the occupational distribution of industries. Errors in both appear to have caused some of the largest occupational projection errors.

The effects of errors in projecting industry employment and staffing patterns can be seen in reviewing the projections for 13 occupations that declined between 1980 and 1990, and that have

significant proportions of their employment in manufacturing. Projected 1990 employment in manufacturing was 24 percent higher than actual employment; having been projected to increase by 16 percent, it in fact declined by 6 percent.

In each of the 13 declining occupations, projected total employment and projected employment in manufacturing were higher than actual 1990 levels. In all of them, the actual proportion of 1990 manufacturing employment composed of workers in the occupation (the industry-occupation matrix coefficient) was lower than the projected proportion. Thus, for all 13 occupations, projection error was caused by errors in projecting both industry employment and occupational coefficients. The coefficients actually declined in 12 of the 13 occupations, but decreases for 4 of them were relatively small. Only 2 of the 13 occupations were projected to increase as a proportion of all workers within manufacturing, and one of these—chemical engineers—did so.

If the projections in manufacturing had been perfectly accurate for the 13 occupations, 6 would have shown a projected decline in total employment. For the others, the projected increase in representation in other industries still would have resulted in a projection of growth, rather than a decline. Also, if the occupational coefficients in manufacturing had been accurately projected to decline, employment growth still would have been projected for all 13 occupations because of the overprojection of manufacturing employment as a whole.

Technical concerns

There are several technical concerns involved in this evaluation, and the assumptions made to deal with them have great significance. The first has to do with methods of evaluating projections. The most common way of measuring error is to compare projected employment in the target year of the projections with actual employment for that year. If an estimate of absolute average error is used, the direction of the error—that is, whether the projection is above or below actual employment—has no bearing on the percent error.

Another way of measuring error is to compare projected change with actual change and compute the proportion of actual change that was projected. However, it is difficult to evaluate the merits of a projection in this manner. For example, if employment in an occupation were projected to grow from 100,000 to 105,000—a small increase—but actually grew to 110,000, this would constitute an error of 50 percent. But if employment in the same occupation were projected to increase to 160,000, but actually grew to 220,000, the error rate also would be 50 percent. In terms of job openings, such a difference is very significant: one projection has an error of 5,000, while the other has an error of 60,000. Because occupational employment levels are so important in estimating job prospects, the comparison of actual and projected levels was used in this evaluation.

Evaluations can also be made by comparing the projections with simple extrapolations, base-year levels, and other simulated estimates. Although these methods have been used in previous evaluations, none of them was used here because the necessary industry-occupation matrix data were not available in electronic format, and the recreation of those data would be very expensive. The contribution of results of alternative approaches, as indicated by past experience, did not seem to warrant the investment.

Another concern in preparing this evaluation was choosing the best method of identifying actual employment trends and levels to compare with the projected estimates. Analysts frequently take it on faith that employment data generated by a survey—the "actual" data—are correct, both for the base and for the target years. Consequently, differences between projected and actual employment are assumed to be due to projection error. Sampling error and response error that are part of any surveys that provide actual employment are thus ignored.

In general, then, one assumes that data derived from a survey are close enough to fact to be considered fact. However, to appreciate in more detail the problems encountered in evaluation of occupational projections, let us look at two sources of occupational employment data provided by the Bureau of Labor Statistics: 1) the Current Population Survey (CPS), and 2) the national industry-occupation matrix based on the Occupational Employment Statistics (OES) survey. The CPS is a household survey in which individuals provide information on their own jobs, classified by occupation. In this survey, each individual is counted only once, in his or her primary occupation. In contrast, the OES survey is an establishment-based survey in which employers indicate the occupations of individuals on their payrolls, and workers are counted on more than one payroll if they have more than one job. In addition, there are other conceptual differences between the surveys relating to the definition of employment that are not discussed here.[8]

In 1990, both of the above surveys used the Standard Occupational Classification (SOC) system as the basis for classifying workers by occupation. Nevertheless, the surveys did not have identical classification systems. More detail is provided in the OES survey. Yet, both surveys yield data for the major occupational groups, identically defined.

In 1980, however, the CPS used the 1970 census occupational classification system and the OES

survey used its own classification system. The projections evaluated in this article were based on the 1980 industry-occupation matrix, which used the 1980 OES survey classification. To compare actual with projected change, the 1,600 occupations in the 1980 industry-occupation matrix that was projected to 1990 were aggregated to major groups reflecting the 1990 SOC-based classification system. The 1980 CPS data could be aggregated in a similar manner to approximate the SOC-based classification system used in 1990.

Selection of the occupations. The 1980–90 projections for detailed occupations were selected for evaluation only if they met specific criteria. The first criterion was that the occupation had to be comparably defined in the projected 1990 and actual 1990 industry-occupation matrixes. The second criterion was that employment in the occupation in the 1980 matrix, which used the unique OES survey classification system of the 1970's, had to be reasonably close to that in the 1984 matrix, which was the first to use the SOC-based occupational classification underlying OES surveys since 1983. The occupation from the 1980 matrix also had to be definitionally comparable to its counterpart in the actual 1990 matrix. In addition, the 1990 matrix occupation had to be definitionally comparable to an occupation found in the 1990 CPS classification. In turn, the 1990 CPS occupation had to be comparable with one in the 1970 census, which provided the occupational structure for CPS data for 1980.[9] Although the employment projections were evaluated on the basis of OES data, the OES trend was considered much more reliable if the CPS showed a similar trend. Only 132 of the 687 occupations in the 1980 matrix and 507 occupations in the 1990 matrix met the criteria, but these occupations accounted for more than 57 million workers in the 1990 matrix, representing 47 percent of total employment.

Comparability of CPS and OES matrix employment. As shown in table 1, employment levels for the major occupational groups from the two data sources were quite comparable in 1990. The overall matrix estimate, which is a count of jobs rather than individuals, is about 4.5 million higher than that from the CPS, with higher totals for clerical and service occupations—categories with significant numbers of dual jobholders. The only major occupational group for which the estimates are significantly different, for no obvious reason, is the managerial group, which is 2.4 million larger in the CPS.

The 1980 employment levels for major occupational groups in the CPS and in the 1980 industry-occupation matrix also are not radically different after adjustment to the 1990 occupational classification. Consequently, the employment change between 1980 and 1990 is similar in the CPS and the matrix for most of these groups. However, there is a significant difference for managers—a 12-percent change in the matrix, which is below-average growth, and a 45-percent change in the CPS, by far the fastest rate of increase among CPS major occupational groups. Salesworkers grew by 56 percent in the OES matrix, much faster than all other groups. The CPS shows a faster-than-average increase for this group but, at 31 percent, the rate of growth was much slower than that in the OES matrix. It is interesting that the actual growth rate reported in the CPS for salesworkers was lower than those of three other major groups, rather than the fastest. Also, the employment levels for this group in 1990 are very similar in the CPS and industry-occupation matrix—14.1 million and 14.2 million—but they were significantly different in 1980. Because of the occupational classification change in the 1980's, it is possible that the "real" growth rate for salesworkers is really somewhat different from the actual rate calculated with estimates developed from the available data. The remaining occupational groups show very similar growth rates in the two data sources.

Determining the correct growth rates for major occupational groups obviously poses a dilemma. Was the managerial group the fastest growing, as shown in the CPS, or a slow-growing group as suggested by the matrix? Were salesworkers the fastest-growing group, as shown in the matrix, or only one of the fastest growing, as indicated by the CPS? There is no doubt that the change in classification and the errors caused by reclassifying the 1980 data within the 1990 classification system had some impact on the calculation of actual growth rates in the two occupational series. Nevertheless, one cannot be certain that either series yields the true growth rate.

Also, one cannot conclude that classification changes are the source of all differences between the CPS and industry-occupation matrix estimates. The individual occupations not affected by such change, at least on a theoretical basis, also show different growth rates. For example, of the 132 occupations evaluated, *10 percent posted employment changes in opposite directions in the two data sources and another 30 percent had significantly different growth rates* when classified according to the employment-growth ranges used in BLS career guidance information.

In evaluating the projections, a decision was made to rely on the OES survey-based matrix employment change, because the matrix was used to develop the projections. However, because of the differences in occupational classification systems used in the base and projected years, the actual change and the implied error rate must be considered somewhat suspect. For this reason, rates of

change also were developed from the CPS data. If the CPS and OES indicate a similar growth rate, more confidence can be given to the occupational estimates. For example, systems analysts had a very high growth rate according to both the CPS and the matrix, so that one might conclude with a high degree of confidence that this occupation grew rapidly over the 1980–90 period. In contrast, actual employment growth for vocational and education counselors showed a 33-percent decline in the OES matrix, but an increase of 13 percent in the CPS. The 2-percent projected growth rate for this occupation could be compared to the "actual" decline shown by the matrix, or to the "actual" increase shown in the CPS data. However, the merits of either comparison are somewhat questionable. Therefore, the error for a specific occupation must be viewed in the context of all data and information available, rather than as the one number representing the percent absolute error. For the 132 occupations as a whole, however, the number of comparisons that yield questionable results does not negate the broad conclusions of this evaluation.

Implications of the evaluation

There is an important lesson to be learned from the evaluation of projections for the major occupational groups. It is that implications about the future stemming from these projections are limited in terms of their practical usefulness. Professional specialty occupations, for example, were projected to post an average rate of growth, but the actual rate was quite rapid. The error was largely due to projection errors for a few, more detailed occupations—especially in the case of college teachers, whose numbers grew rapidly, rather than declining as projected. Such errors for a few occupations had no effect on the demand for workers in science, engineering, health professions, law, journalism, or other professional fields. However, they just happened to be large enough that they affected the accuracy of the overall rate of growth for the professional specialty major group. Detailed occupations can be found in each of the other major groups that are large enough that their trends can affect the overall trend for the parent occupational group. For example, underprojection of numbers of cashiers and stock clerks, sales floor resulted in an average projected growth rate for the larger salesworker category, which actually grew much faster than any other occupational group. Thus, users of projections should be wary of statements about the future that are based on an analysis of the projections for major occupational groups. And, developers of projections and persons who use the projections to prepare materials for use by the public should be somewhat cautious in presenting conclusions based on projections of major occupational groups.

Implications of the detailed projections. Several conclusions may be drawn from the evaluation of the 1980–90 occupational projections. Perhaps the most important is that the BLS projections are too conservative. All occupations correctly projected to have the most rapid employment growth were underprojected in terms of the magnitude of that growth. Furthermore, those occupations correctly projected to decline or to have slow employment growth generally had greater declines or grew

Table 4. **Actual 1980–90 employment growth in the industry-occupation matrix, actual 1980–90 employment growth in the Current Population Survey (CPS), and projected 1980–90 and 1990–2005 employment growth in the industry-occupation matrix, by growth category**

Growth category	Change, 1980–90						Change, 1990–2005	
	Actual				Projected, matrix		Projected, matrix	
	Matrix		CPS					
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	132	100	132	100	132	100	507	100
Much faster than average	21	16	26	20	5	4	58	11
Faster than average	27	20	28	21	43	33	78	15
Average	20	15	15	11	63	48	138	27
Slower than average	20	15	18	14	13	10	88	17
Little or no change	21	16	14	11	5	4	61	12
Decline	23	17	31	23	3	2	84	17

NOTE: Data for 1980–90 are for the 132 selected occupations evaluated in this article. The 1990–2005 data are for all detailed occupations included in the 1990–2005 matrixes.

more slowly than projected. This same pattern was observed in evaluations of the 1975 and 1980 projections. Thus, the conservatism of the BLS projections should be addressed or projection errors noted here and in earlier evaluations will not be improved upon in the future.

The conservative nature of the occupational projections may be shown by comparing the actual occupational employment changes in the CPS and the OES matrix, and the changes projected with the matrix, in terms of the ranges of percentage employment growth discussed earlier. (See table 4.) The actual 1980–90 changes, both in the CPS and in the industry-occupation matrixes, yield a somewhat equivalent distribution of occupations by growth-range category. However, the CPS has a greater number with declines and a slightly larger number in the two fastest-growing categories. In contrast, the occupational projections were heavily concentrated in the average range, with very few in the fastest-growing category and in the categories showing a decline or little or no change. A much higher total was projected in the faster-than-average category than is shown by actual data. However, the sum of the numbers of occupations in the projected faster-than-average and much-faster-than-average ranges was close to the sum for the same categories in the actual data from both the CPS and the OES.

The impact of specific technology, whether laborsaving or labor creating, on occupational employment trends should be given more weight in projecting occupation-industry matrix coefficients. When the 1990 projections were prepared, the analyses for typists, drafters, file clerks, and payroll and timekeeping clerks clearly indicated that technology would reduce the demand for these workers. Yet, the matrix coefficients for these workers were not reduced sufficiently. Similarly, the role of technology in the growing demand for systems analysts and computer programmers, although recognized, was not fully accounted for in the occupational projections.

Like the impact of technological change, the probable effects of a wide variety of other factors driving the demand for workers in specific occupations were not adequately reflected in the 1990 projections round. For example, the growing need to keep records on patients in health facilities to meet the requirements of insurance providers was recognized but underprojected, with the result that the number of health records technologists was underprojected. Similarly, the increasing tendency of retail establishments to use cashiers instead of salesworkers was given consideration by BLS analysts, but not enough to result in a good projection for the former occupation. Other trends that research did not adequately target include the rising demand for musicians in hotels and eating and drinking places, and the growth of individual investment, with its consequences for the employment of securities salesworkers.

It also is the case that good occupational projections are very dependent on good industry projections. The poor 1990 projections for many occupations can be tied directly to the fact that employment in the manufacturing sector was misprojected to grow during the preceding decade. Yet, evaluations also show that, over a 10- to 15-year period, some occurrences will be impossible to project. For example, the breakup of the Soviet Union and the resulting reduction in the need for U.S. defense efforts could hardly have been foreseen in the early 1980's.

It is clear that analysts directing the projections effort at BLS realized all of the above-mentioned pitfalls early in the 1980's, when the 1990 projections were developed. Only the future will tell if the tendency toward conservatism noted above can be overcome. However, a review of the distribution, by growth-rate range, of projected employment change for all of the occupations covered in the 1990–2005 projections is promising. (See table 4.) Those data indicate that the distribution of occupations by projected employment growth in the most recent projections round, covering the period 1990–2005, is more closely in line with the distribution (for the 132 occupations evaluated) of the actual 1980–90 OES matrix and CPS growth patterns than were the 1980–90 projections.

Handbook growth-rate categories. The review of the accuracies and inaccuracies noted in the analysis of the growth-rate ranges reinforces the conclusion that the occupational projections are conservative. There is a significant clustering in the average-growth category. (See table 3.) Yet, when rapid growth or a decline is projected, the growth categories tend to be correct. A review of the projected growth rates associated with each category showed that there was a clustering of occupations (eight) in the average-growth range having a projected growth rate of 26 or 27 percent. Experience suggests that the initial analyses of likely employment change for some of these occupations hinted at faster-than-average growth, but the conservatism that prevailed in the analytical review resulted in the lowering of the projection, so that the occupation would fall in the average-growth category. Of the eight occupations, three grew much faster than average and three grew faster than average.

Results of this review suggest that adjustments to the projections that are made because of the structure of the growth-rate categories incorporated in the *Occupational Outlook Handbook* presentation may tend to reinforce a conservative

approach. BLS plans to review its procedures to ensure that the analysis is not biased in this way in the future.

The 1980 and 1975 projections

The accuracy of the 1990 occupational projections was very similar to that of projections developed by the Bureau for 1975 and 1980.[10] The 1990 projections for those occupations evaluated averaged 21.1 percent off actual employment, as did the 1980 projections, while the 1975 projections were an average 22.4 percent off. The accuracy did not vary much among the three projections rounds, even though the 1990 projections were based on the OES survey-based industry-occupation matrix rather than the census-based matrix used in the earlier rounds, and the 1990 evaluation covered 132 occupations, compared with 64 in 1980 and 76 in 1975.

The observed patterns of error for the 1990 round were similar to those in the earlier sets of projections. The largest occupations had less error than small occupations. The direction of change was correctly projected for about 5 out of 6 occupations in each set. In all three sets, errors for occupations that declined in employment were much greater than those for occupations that increased, but the difference was a little less in the 1990 projections. The distribution of the occupations evaluated by employment size was similar in 1980 and 1990, and the error was similar for each size class. Of the 29 occupations included in both the 1980 and 1990 evaluations, 14 had an increase in the error between the two rounds, errors for 2 were the same, and for 13 occupations, the error decreased.

In the 1990 projections, all of the declines were underprojected (projected employment was at a higher level than actual employment), whereas, in each of the earlier projections, one decline was overprojected. As in the 1990 round, about half of the growing occupations were underprojected for 1975; two-thirds were underprojected for the 1980 round. Simulations using simple extrapolations and tests applying base-year industry staffing patterns to the projected industry employment levels were not conducted in the evaluation of the 1990 projections because the necessary data could not be obtained at acceptable cost. In any case, review of the available data indicates that the simulations would tell us exactly what was determined in evaluating the 1980 projections: further work is needed to reduce errors in assumptions regarding staffing patterns if the accuracy of occupational projections is to be improved.

Alternative evaluations

A series of articles evaluating the accuracy of BLS projections has been prepared by John H. Bishop and Shani Carter, one of which was published in the October 1991 issue of the *Monthly Labor Review*.[11] The evaluations cover several BLS projections rounds, but focus on the 1978–90 projections. As indicated above, the projected 1990 employment levels in the 1978–90 projections are virtually identical to the 1980–90 projections evaluated in this article. One assumes, then, that the observations of Bishop and Carter would be very similar to their earlier evaluation if they had analyzed the same 1990 projections evaluated here.

Bishop and Carter used 1990 CPS data as the actual employment data to compare with the projected data, and they used only the data for major occupational groups. To evaluate growth, they adjusted the base-year data to agree with the 1990 occupational classification, but that classification was the one used for the OES survey-based industry-occupation matrix. As a result, their major conclusion that BLS has systematically underprojected highly skilled occupations—those requiring a college degree—is questionable, or at least overstated. As indicated above, the CPS shows a much faster rate of growth for managers than does the OES survey-based matrix. For this reason, Bishop and Carter appear to demonstrate that BLS underprojected managers significantly. In contrast, the BLS evaluation procedure indicates that managers were overprojected. However, the Bureau did underproject numbers of professional workers to a significant extent, so that the employment of college-trained workers was underprojected.

Bishop and Carter also developed a simulated projection of employment by major occupational group, using trend analysis of occupational shares of total employment accounted for by each major group. They demonstrate that those projections come closer to the actual 1990 levels than do the BLS projections. Although their analysis is based on CPS data—which, as indicated above, is different in important respects from the OES survey-based matrix—perhaps their projections did prove to be more accurate. However, they did not develop projections for individual occupations, which is a major product of the BLS projections program. Actually, our projections for major groups are sums of estimates for individual occupations, rather than independent projections. As shown earlier, errors in the BLS projections for major groups can nearly always be tied to poor projections for a few detailed occupations or, as in the case of operatives, to misprojected growth of an industry or economic sector.

Developing projections in the manner suggested by Bishop and Carter would eliminate analytical input to the process. For example, an extrapolation of past trends may have yielded an

overall 1980–90 projection for professional workers that was closer to the actual employment level. But, as shown above, the error in the BLS projection for that major group was due largely to an underprojection of college teachers. This being the case, it is not apparent how the projections for the detailed occupations could have been reconciled with an independently projected higher overall total, except perhaps by increasing errors for each occupation through some scaling process.

Bishop and Carter extensively analyze the source of error in the BLS projections. They correctly target the pitfalls, such as the problems in accurately projecting staffing patterns that are based on a short time series for which the trend may not be stable in the long run. BLS agrees.

They also make several suggestions on ways in which BLS should develop projections in the future. Their primary recommendation is that we carefully review the data and project change (in the staffing patterns of industries) where it is apparent that change is taking place. BLS has arrived at very similar conclusions, and such procedures have been in place since 1984. Since that time, Bureau analysts have reviewed all available OES survey and CPS data and, in fact, now project change in the occupation-industry cells for more than half of the occupations. However, with regard to Bishop's and Carter's observation that BLS systematically underprojects changes in staffing patterns for highly skilled (college-educated) workers, a difficulty arises. Underprojection of change is a greater problem for college-trained workers because they are in the occupations that are, on average, projected to increase the fastest. However, the tendency to underproject affects estimates for all occupations, including cashiers and other occupations that do not require a college degree.

In summary, BLS agrees with Bishop's and Carter's commentary dealing with the cause of error in the Bureau's occupational projections. However, we disagree on the specific levels of error they have calculated, and with their conclusions about the amount of error in our overall projections for highly trained workers, based as they are on "actual" data from the CPS, rather than on OES survey-based data. □

Footnotes

[1] See Max L. Carey and Kevin Kasunic, "Evaluating the 1980 projections of occupational employment," *Monthly Labor Review*, July 1982, pp. 22–30.

[2] Two sets of 1978–90 projections were developed. One set was based on occupational staffing patterns from the 1970 census, and the other, on occupational staffing patterns from the Occupational Employment Statistics survey. The latter were not used in any edition of the *Occupational Outlook Handbook*. The former were used in the 1980–81 edition of the *Handbook*, but the occupational classification is not comparable to that used in 1990.

[3] Three alternative 1980–90 projections were developed. This evaluation focuses on the alternative termed High II, which was the basic scenario, and was used as the source of data on projected employment growth in the 1982–83 edition of the *Occupational Outlook Handbook*. More information about the alternatives is presented in the article by Norman C. Saunders elsewhere in this issue.

[4] As discussed later in the article, the industry-occupation matrixes based on the occupational staffing patterns of industries from the Occupational Employment Statistics survey were used as the primary measure of occupational employment in the evaluation, but employment data from the Current Population Survey also are presented.

[5] The projected data are for the High II alternative discussed in the evaluation of the 1990 industry employment projections by Norman C. Saunders, elsewhere in this issue.

[6] *Occupational Outlook Handbook, 1982–83 Edition*, Bulletin 2200 (Bureau of Labor Statistics, 1982).

[7] For more information on the methodology used to develop the projections, see *Outlook: 1990-2005*, Bulletin 2402 (Bureau of Labor Statistics, 1992).

[8] For more information on the concepts underlying counts of employment in the Current Population Survey and in establishment surveys, see the section on "Explanatory Notes" in any issue of *Employment and Earnings*, a monthly periodical issued by the Bureau of Labor Statistics.

[9] The 1990 CPS occupational classification, which is compatible with the Standard Occupational Classification, has been used in the CPS since 1983. From 1972 to 1982, the CPS used the occupational classification system from the 1970 census.

[10] See Max L. Carey, "Evaluating the 1975 projections of occupational employment," *Monthly Labor Review*, June 1980, pp. 10–21; and Carey and Kasunic, "Evaluating the 1980 projections."

[11] See John H. Bishop and Shani Carter, "How accurate are recent BLS occupational projections?" *Monthly Labor Review*, October 1991, pp. 37–43; and John H. Bishop and Shani Carter, "The Worsening Shortage of College-Graduate Workers," *Educational Evaluation and Policy Analysis*, Fall 1991, pp. 221–46.