Evaluation of labor force projections to 1990

The projections to 1990, although more accurate than those of the 1975, 1980, and 1985 labor force, were significantly affected by population projections

Howard N Fullerton, Jr.

As the final step in the projection process, the Bureau of Labor Statistics assesses its labor force projections.[1] Such evaluations help persons making projections better understand the types of problems and errors that could occur and allow users to focus on the accuracy of projections for a specific group in the labor force or on overall accuracy.

This article examines the errors in the labor force projections to 1990 and their sources. It does this by examining projected levels of the labor force and the rates of labor force participation of specific age groups for men and women, and for whites and blacks and others. Where appropriate, the accuracy of the 1990 labor force projections is compared with evaluations of BLS projections of the 1975, 1980, and 1985 labor force.[2]

The 1990 projections

Each of the six projections to 1990 had three alternatives: high, moderate, and low. This analysis, for the most part, focuses on the middle or "moderate" growth projection in each series. (See table 1.) The following tabulation shows the projections to 1990 (in millions) and the level and percentage-point errors made in each year the projections were developed.[3]

Projection for 1990 made in:	*Labor force*	*Error*	*Percent error*
1973	110.6	–14.2	11.4
1976	113.8	–10.9	8.8
1978	119.4	–5.4	4.3
1980	122.4	–2.4	1.9
1983	125.0	.2	.1
1985	122.6	–2.1	1.7
1990 labor force (actual)	124.8	—	—

The overall error became progressively smaller through the 1983 projection, when it was 0.1 percent, or fewer than a quarter of a million persons, but increased in the next projection (1985) to 1.7 percent, to near that of 1980. What were the sources of labor force error and why, with one exception, did the error fall as time passed?

A closer look at the 1990 labor force projections rounds for men and women provides a clue. For most of the rounds, labor force levels for both women and men were projected too low. The 1983 projection of women in the labor force was too high, but in 1980, there was no difference between the actual and the projected estimates of women in the labor force. Men had the most accurately projected labor force estimates in 1983, the year their labor force was slightly overprojected. In the 1985

Howard N Fullerton, Jr., is a demographic statistician in the Office of Employment Projections, Bureau of Labor Statistics.

Table 1. **Characteristics of the 1990 labor force, and labor force participation rates, actual and as projected in 1973, 1976, 1978, 1980, 1983, and 1985**

Labor force group	Labor force (in thousands)							Participation rate (in percent)						
	As projected in —						Actual 1990	As projected in —						Actual 1990
	1973	1976	1978	1980	1983	1985		1973	1976	1978	1980	1983	1985	
Total	110,576	13,839	119,366	122,375	124,951	122,653	124,787	62.0	63.6	66.2	67.9	66.9	65.7	66.4
Men, 16 and older	66,947	65,220	65,115	65,880	67,701	67,146	68,234	79.1	77.3	76.4	77.2	76.5	75.8	76.1
16 and 17 years	1,511	1,612	1,740	1,733	1,664	1,453	1,477	45.6	50.8	54.9	54.5	51.0	44.4	43.7
18 and 19 years	2,159	2,364	2,459	2,483	2,459	2,387	2,389	63.2	71.4	74.4	74.3	73.2	70.2	67.0
20 to 24 years	6,462	6,671	6,957	7,066	7,151	7,323	7,291	81.1	82.1	85.0	86.4	84.4	86.3	84.3
25 to 34 years	19,382	18,545	18,401	18,453	19,569	19,665	19,813	95.4	94.7	93.9	94.3	93.7	94.1	94.2
35 to 44 years	17,131	16,571	16,593	16,672	17,469	17,318	17,268	95.6	94.8	94.8	95.2	95.6	94.7	94.4
45 to 54 years	10,863	10,901	10,851	11,022	11,142	11,096	11,177	92.5	90.2	89.4	90.8	91.3	90.8	90.7
55 to 59 years	4,109	3,990	3,870	3,922	3,842	3,849	4,014	86.9	81.6	77.6	78.7	78.1	78.3	79.8
60 to 64 years	3,195	2,714	2,513	2,703	2,577	2,446	2,771	69.9	57.7	52.0	55.9	52.8	50.2	55.5
65 to 69 years	1,365	1,125	932	1,019	1,019	873	1,192	34.4	26.6	21.2	23.2	23.3	20.0	26.0
70 years and older	770	727	799	807	809	736	841	11.6	10.7	11.2	11.3	10.3	9.4	10.8
Women, 16 and older	43,629	48,619	54,253	56,495	57,250	55,507	56,554	46.5	51.4	57.1	59.6	58.3	56.6	57.5
16 and 17 years	1,205	1,448	1,608	1,685	1,461	1,309	1,356	37.4	46.9	52.1	54.7	46.2	41.4	41.9
18 and 19 years	1,975	2,201	2,531	2,509	2,317	2,139	2,188	56.2	62.5	72.1	72.1	66.5	61.3	60.5
20 to 24 years	5,808	6,656	7,086	7,131	7,035	6,641	6,552	66.3	75.2	80.4	81.4	78.1	73.8	71.6
25 to 34 years	10,669	13,077	16,063	16,568	16,804	16,366	15,990	51.6	63.5	78.1	80.7	78.1	76.2	73.6
35 to 44 years	10,216	11,678	13,820	14,581	14,974	14,458	14,576	54.0	63.0	74.5	78.6	78.6	75.9	76.5
45 to 54 years	7,362	7,795	7,830	8,320	8,718	8,808	9,316	58.3	60.3	60.5	64.3	67.1	67.8	71.2
55 to 59 years	2,853	2,703	2,642	2,650	2,791	2,779	3,059	53.3	51.0	49.5	49.7	51.1	51.0	55.3
60 to 64 years	2,150	1,811	1,628	1,826	1,821	1,869	2,016	39.2	33.7	30.1	33.8	32.1	33.0	35.5
65 to 69 years	864	768	649	772	829	705	941	16.7	14.2	11.9	14.1	15.1	12.9	17.0
70 years and older	527	482	394	453	500	433	561	5.0	4.4	3.5	4.0	4.0	3.5	4.8
Whites	—	—	103,751	105,867	107,734	105,467	107,177	—	—	66.9	68.3	67.3	65.9	66.8
Men	—	—	57,185	57,800	59,201	58,524	59,298	—	—	77.4	78.1	77.4	76.5	76.9
Women	—	—	46,586	48,067	48,533	46,943	47,879	—	—	57.4	59.3	58.1	56.2	57.5
Blacks and others	—	—	15,615	16,508	17,217	17,186	17,610	—	—	62.0	65.8	64.8	64.5	63.7
Men	—	—	7,930	8,080	8,500	8,622	8,936	—	—	69.9	71.5	71.0	71.7	71.1
Women	—	—	7,683	8,428	8,717	8,564	8,674	—	—	55.6	61.1	59.7	58.6	57.6

NOTE: Dash indicates data not available.

projection, the error was about the same size for men and for women.

It is to be expected that the earlier projections to 1990 are less accurate than the more recent ones. The following tabulation displays the growth rates for the total civilian labor force historically with the projected annual rate and the actual annual rate of change. (All three rates are measured over the same number of years. The historic rate is calculated over the same number of years *before* the date of the projection as 1990 is *after* the date of the projection.) The historic rate gives a standard of comparison—a naive projection:

Projection for 1990 made in:	*Historical rate*	*Projected rate*	*Actual rate*	*Error*
1973	1.75	1.34	2.02	-0.68
1976	2.00	1.30	1.92	-.62
1978	2.36	1.45	1.80	-.35
1980	2.65	1.41	1.59	-.18
1983	2.29	1.58	1.57	-.01
1985	1.76	1.29	1.59	-.30

The error in the projected growth rate in 1985 was greater than the error in the 1980 projection. Still, the more recent projections are the more accurate. The 1983 projected labor force growth rate is the only one that exceeded the actual growth rate. This tabulation also allows us to characterize labor force projections: All six projections reflected a view that the labor force would grow more slowly in the future. This did not happen over the 1973 to 1990 period, but did hold for the remainder of the projections.

Population projections

In reviewing labor force projections, there are two possible sources of error—the population projection, prepared by the Bureau of the Census, and the participation rate projection, prepared by BLS. Before the 1980 census, population projections were considered to be a trivial source of error and their potential contribution to the errors in the labor force projections was ignored. However, after the 1980 census, there was a significant upward

revision in the estimated civilian noninstitutional population that resulted in a similar upward revision in the labor force estimates for the 1971–82 period. The current labor force estimates are consistent with those revisions.

The following tabulation shows 1990 projections for the civilian, noninstitutional population aged 16 and older for men and women (in millions) and the errors associated with the total population projections:

Projection of 1990 population made in:	*Total*	*Men*	*Women*	*Error of total*
1973	179	85	94	–9.5
1976	179	84	95	–9.1
1978	180	85	95	–7.8
1980	180	85	95	–7.9
1983	180	85	95	–7.9
1985	187	89	98	–1.4
1990 (estimated)	188	90	98	—

As indicated, the error in the population projection fell over the 1973–78 period, was steady in 1980 and 1983, and then dropped sharply in 1985.[4] To determine further the effects of the population projection error, the projected labor force participation rates for 1990 were multiplied by the actual 1990 civilian, noninstitutional population; the results are displayed in tables 2 and 3. As table 3 indicates, had the actual civilian, noninstitutional population been known or projected accurately, all labor force projections, except those made in 1983, would have been more accurate. The 1983 and 1985 projections errors would have been trivial (less than 1 percent). The size of errors in the labor force attributable to population projections varied (unlike the projections prepared to 1985). For the 1976 through 1980 projections of the 1990 labor force, population errors added more than 5 million persons to the labor force errors. (See table 3.)

The error attributable to low population projections affected male labor force projections more than female labor force projections. The panel in table 3 illustrating errors attributable to population projections shows an error of more than a million for men aged 25 to 34 for the projections made over the 1976–80 period. With adjustments for immigration reflected in the 1983–85 projections, the error attributable to population projections dropped sharply for this age group and overall.

There are four elements of a population projection: the base-year estimate and birth, death, and net immigration estimates. If the estimated structure or size of the population in the base year is incorrect, the error will be reflected throughout the early years of the projection pe-

Table 2. **Characteristics of the 1990 labor force, actual and as projected using the participation rates projected in 1973, 1976, 1978, 1980, 1983, and 1985, with the actual 1990 population and associated errors**

Labor force group	Labor force (in thousands)												
	As projected in —						Actual 1990	Errors due to participation rate projections[1]					
	1973	1976	1978	1980	1983	1985		1973	1976	1978	1980	1983	1985
Total	115,217	119,153	124,542	127,749	126,232	123,872	124,787	–9,570	–5,634	–245	2,962	1,445	–915
Men, 16 and older	70,098	68,772	68,304	69,088	68,509	67,859	68,234	1,864	538	70	854	275	–375
16 and 17 years	1,541	1,717	1,856	1,842	1,724	1,501	1,477	64	240	379	365	247	24
18 and 19 years	2,254	2,546	2,653	2,650	2,610	2,503	2,389	–135	157	264	261	221	114
20 to 24 years	7,013	7,099	7,350	7,471	7,298	7,462	7,291	–278	–192	59	180	7	171
25 to 34 years	20,069	19,922	19,754	19,838	19,712	19,796	19,813	256	109	–59	25	–101	–17
35 to 44 years	17,480	17,334	17,334	17,407	17,480	17,316	17,268	212	66	66	139	212	48
45 to 54 years	11,395	11,112	11,013	11,186	11,247	11,186	11,177	218	–65	–164	9	70	9
55 to 59 years	4,371	4,104	3,903	3,959	3,928	3,938	4,014	357	90	–111	–55	–86	–76
60 to 64 years	3,490	2,881	2,596	2,791	2,636	2,506	2,771	719	110	–175	20	–135	–265
65 to 69 years	1,580	1,221	974	1,065	1,070	918	1,192	388	29	–218	–127	–122	–274
70 years and older	905	835	871	880	803	732	841	64	–6	30	39	–38	–109
Women, 16 and older	45,119	50,381	56,238	58,661	57,723	56,013	56,554	–11,435	–6,173	–316	2,107	1,169	–541
16 and 17 years	1,209	1,516	1,684	1,768	1,494	1,338	1,356	–147	160	328	412	138	–18
18 and 19 years	2,031	2,259	2,606	2,606	2,403	2,215	2,188	–157	71	418	418	215	27
20 to 24 years	6,068	6,882	7,358	7,450	7,148	6,754	6,552	–484	330	806	898	596	202
25 to 34 years	11,205	13,789	16,959	17,524	16,959	16,547	15,990	–4,785	–2,201	969	1,534	969	557
35 to 44 years	10,291	12,006	14,197	14,979	14,979	14,464	14,576	–4,285	–2,570	–379	403	403	–112
45 to 54 years	7,628	7,890	7,916	8,413	8,779	8,871	9,316	–1,688	–1,426	–1,400	–903	–537	–445
55 to 59 years	2,948	2,821	2,738	2,749	2,826	2,821	3,059	–111	–238	–321	–310	–233	–238
60 to 64 years	2,225	1,912	1,708	1,918	1,822	1,873	2,016	209	–104	–308	–98	–194	–143
65 to 69 years	925	787	659	781	836	715	941	–16	–154	–282	–160	–105	–226
70 years and older	590	519	412	473	476	415	561	29	–42	–149	–88	–85	–146

[1] Difference from actual 1990 values.

Table 3. **Difference between the projected and actual labor force, and between the original labor force projection and one using the actual 1990 population, by age and sex, 1973, 1976, 1978, 1980, 1983, and 1985**

[Numbers in thousands]

Labor force group	Difference between the projected and actual 1990 labor force based on projections made in —						Errors due to population projections[1]					
	1973	1976	1978	1980	1983	1985	1973	1976	1978	1980	1983	1985
Total	–14,211	–10,948	–5,421	–2,412	164	–2,134	–4,641	–5,314	–5,176	–5,374	–1,281	–1,219
Men, 16 and older	–1,287	–3,014	–3,119	–2,354	–533	–1,088	–3,151	–3,552	–3,189	–3,208	–808	–713
16 and 17 years	34	135	263	256	187	–24	–30	–105	–116	–109	–60	–48
18 and 19 years	–230	–25	70	94	70	–2	–95	–182	–194	–167	–151	–116
20 to 24 years	–829	–620	–334	–225	–140	32	–551	–428	–393	–405	–147	–139
25 to 34 years	–431	–1,268	–1,412	–1,360	–244	–148	–687	–1,377	–1,353	–1,385	–143	–131
35 to 44 years	–137	–697	–675	–596	201	50	–349	–763	–741	–735	–11	2
45 to 54 years	–314	–276	–326	–155	–35	–81	–532	–211	–162	–164	–105	–90
55 to 59 years	95	–24	–144	–92	–172	–165	–262	–114	–33	–37	–86	–89
60 to 64 years	424	–57	–258	–68	–194	–325	–295	–167	–83	–88	–59	–60
65 to 69 years	173	–67	–260	–173	–173	–319	–215	–96	–42	–46	–51	–45
70 years and older	–71	–114	–42	–34	–32	–105	–135	–108	–72	–73	6	4
Women, 16 and older	–12,925	–7,935	–2,301	–59	696	–1,047	–1,490	–1,762	–1,985	–2,166	–473	–506
16 and 17 years	–151	92	252	329	105	–47	–4	–68	–76	–83	–33	–29
18 and 19 years	–213	13	343	321	129	–49	–56	–58	–75	–97	–86	–76
20 to 24 years	–744	104	534	579	483	89	–260	–226	–272	–319	–113	–113
25 to 34 years	–5,321	–2,913	73	578	814	376	–536	–712	–896	–956	–155	–181
35 to 44 years	–4,360	–2,898	–756	5	398	–118	–75	–328	–377	–398	–5	–6
45 to 54 years	–1,954	–1,521	–1,486	–996	–598	–508	–266	–95	–86	–93	–61	–63
55 to 59 years	–206	–356	–417	–409	–268	–280	–95	–118	–96	–99	–35	–42
60 to 64 years	134	–205	–388	–190	–195	–147	–75	–101	–80	–92	–1	–4
65 to 69 years	–77	–173	–292	–169	–112	–236	–61	–19	–10	–9	–7	–10
70 years and older	–34	–79	–167	–108	–61	–128	–63	–37	–18	–20	24	18

[1] Difference between the projection made with the actual 1990 population and the population projection made in the reference year.

riod. If net immigration is projected too low or too high, both the level and the age composition of the population will be affected. Errors in the base-year and net immigration estimates significantly affect labor force projections. For the period during which BLS makes projections, the fertility and mortality assumptions have only a minor effect.

Although base-year estimates and net immigration projections were the sources of error in population projections that significantly affected the labor force projections, the causes of the errors were essentially the same: underestimates or underprojections of immigration. More specifically, the sources of these errors were undocumented aliens and refugees. The base-year estimates for projections using the 1970 census reflected underenumeration of immigrants in the 1970 census as well as underestimation of immigration during the 1970's. The 1980 census also differed significantly from the 1970 census in coverage—the proportion of the population enumerated. Much of this, but not all, can be attributed to immigration during the period.

Until 1989, the Census Bureau did not incorporate estimates of undocumented immigrants into the middle series population projections because such persons were not counted in current estimates. Thus, the base-year estimates were too low because of underenumeration in the census and because undocumented immigrants were not included in the population estimates for the intervening years. Further, between 1985 and 1990, there were major revisions to the immigration law; the likely effect on the level and composition of immigration could not have been incorporated because the projections do not anticipate major changes in policy. Currently, the Census Bureau and BLS use more than one immigration scenario to reflect the effect of alternative assumptions about immigration on the size and composition of the population and labor force.

Although the population projection errors cannot be allocated between the base-year errors and the specific immigration projection errors, it is possible to determine the share of overall error in each labor force projection attributable to population and the share attributable to participation rate error. Table 2 shows labor force projection errors associated with using the projected participation rates and the actual 1990 population. The final set of errors in table 3 show population-induced errors.[5] The following tabulation shows the total labor force errors attributable to participation and population errors (in millions):

Projection for 1990 made in:	Total labor force error	Error attributed to— Participation	Population
1973	–14.2	–9.6	–4.6
1976	–10.9	–5.6	–5.3
1978	–5.4	–.2	–5.2
1980	–2.4	3.0	–5.4
1983	.1	1.4	–1.3
1985	–2.1	–.9	–1.2

The errors attributable to the population projection dropped over the projection period from 4.6 million for the 1973 projection to 1.2 million for the 1985 projection. Because errors attributable to participation rates dropped for the first three projections, the population errors became a greater proportion of the overall error in the labor force projections in each succeeding projection. Two-thirds of the error in the 1973 projection may be attributed to the participation rate errors; by the 1985 projection, that share had dropped to less than one-half of the error.

The size of errors in the population projection varied over the five projection years. Population accounted for a small proportion of the error in the earliest projection. As the participation rate error decreased in later projections, population accounted for an increasing proportion of the error in the projected labor force level. This happened despite decreases in population projection error. By 1980, the errors in projecting labor force participation and in projecting population largely offset each other. The primary source of error for the population projections was underestimates of immigration, in particular, lack of any accounting for undocumented immigrants.[6]

Measures of errors

For each of the six projections of the 1990 labor force, there are 20 combinations of age-sex groups and, therefore, 20 possible errors. The errors in participation rates can be examined. One can either look at each error or calculate a statistic to summarize the error for a specific projection. Different summary statistics emphasize different problems with the projections.

Mean absolute percentage error. This measure is calculated using the mean of the absolute value of percent errors in the age-sex specific labor force participation rates. The percent or relative errors attach more significance to errors in groups with low participation. The mean absolute percentage errors for the projected participation rates ranged from 6.8 to 11.8, with the 1973, 1978, and 1980 projections having by far the greatest values. (See table 4.) The three remaining projection years (1976, 1983, and 1985) had the same mean absolute percentage error, around 6.9, with the 1983 projection having the lowest error. This is consistent with the earlier finding that the growth rate projected in 1983 had the least error. It appears that the 1976 projection error is closer in size to the 1983 and 1985 projections than the 1973 and 1978 projections.

Regression. Another summary measure of the errors in the labor force projection is the regression of projected labor force participation rates against actual 1990 labor force participation rates. If the projections were perfect, the actual labor force participation rate plotted against the projected rate would yield a straight line through the origin with a slope of 1.[7] The following tabulation presents estimates of the slope and intercept of these lines for each projection with a test of the hypothesis that the intercept is zero and the slope 1:

Projection for 1990 made in:	Intercept	Slope	F-test	Probability >F
1973	3.2	1.0	0.52	0.60
1976	1.2	1.0	.30	.74
1978	3.2	.9	.98	.39
1980	1.3	.9	2.31	.13
1983	1.6	1.0	1.49	.25
1985	3.7	1.0	5.29	.02

Except for the 1985 projection, the hypothesis of "perfect forecast" cannot be rejected.[8] Generally, the slopes are consistent with an interpretation of the errors being widely diffused among groups—no specific groups were overprojected or underprojected. The large values for the intercept reflect the errors in the participation rates. Tests of the hypothesis that the intercept is zero are not rejected. Thus, we conclude from these tests that the projections are unbiased, but have sizable errors.

The regression results for three of the projection years are shown in chart 1. Each panel displays projected labor force participation rates plotted against the actual for 1990 for 20 age groups. The dashed diagonal line from corner to corner shows the "line of perfect forecast": the line where the markers would be if the projection were perfect. The solid diagonal lines summarizes how well the projected values, taken together, approximate the "line of perfect fit." For the 1973 projection (top panel), the fitted line is not parallel to the line of perfect forecast. It is pulled up by the cluster of rates projected to be 50 to 60 percent, but which were in the 60- to 70-percent range. The value most overprojected was for men aged 60 to 64. Labor force participation rates for women aged 25 to 34 were underprojected the most. For the 1978 projection, a "good" one, the lines are

Table 4. **Difference between the 1990 labor force participation rates and the projections made in 1973, 1976, 1978, 1980, 1983, and 1985**

Labor force group	Percentage-point difference						Absolute relative error					
	1973	1976	1978	1980	1983	1985	1973	1976	1978	1980	1983	1985
Total	–4.4	–2.8	–0.2	1.5	0.5	–0.7	6.6	4.2	0.3	2.3	0.8	1.1
Men, 16 and older	3.0	1.2	.3	1.1	.4	–.3	3.9	1.6	.4	1.4	.5	.4
16 and 17 years	1.9	7.1	11.2	10.8	7.3	.7	4.3	16.2	25.6	24.7	16.7	1.6
18 and 19 years	–3.8	4.4	7.4	7.3	6.2	3.2	5.7	6.6	11.0	10.9	9.3	4.8
20 to 24 years	–3.2	–2.2	.7	2.1	.1	2.0	3.8	2.6	.8	2.5	.1	2.4
25 to 34 years	1.2	.5	–.3	.1	–.5	–.1	1.3	.5	.3	.1	.5	.1
35 to 44 years	1.2	.4	.4	.8	1.2	.3	1.3	.4	.4	.8	1.3	.3
45 to 54 years	1.8	–.5	–1.3	.1	.6	.1	2.0	.6	1.4	.1	.7	.1
55 to 59 years	7.1	1.8	–2.2	–1.1	–1.7	–1.5	8.9	2.3	2.8	1.4	2.1	1.9
60 to 64 years	14.4	2.2	–3.5	.4	–2.7	–5.3	25.9	4.0	6.3	.7	4.9	9.5
65 to 69 years	8.4	.6	–4.8	–2.8	–2.7	–6.0	32.3	2.3	18.5	10.8	10.4	23.1
70 years and older	.8	–.1	.4	.5	–.5	–1.4	7.6	.8	3.6	4.6	4.5	13.0
Women, 16 and older	–11.0	–6.1	–.4	2.1	.8	–.9	19.1	10.6	.7	3.7	1.4	1.6
16 and 17 years	–4.5	5.0	10.2	12.8	4.3	–.5	10.7	11.9	24.3	30.5	10.3	1.2
18 and 19 years	–4.3	2.0	11.6	11.6	6.0	.8	7.1	3.3	19.2	19.2	9.9	1.3
20 to 24 years	–5.3	3.6	6.8	9.8	6.5	2.2	7.4	5.0	12.3	13.7	9.1	3.1
25 to 34 years	–22.0	–10.1	4.5	7.1	4.5	2.6	29.9	13.7	6.1	9.6	6.1	3.5
35 to 44 years	–22.5	–13.5	–2.0	2.1	2.1	–.6	29.4	17.6	2.6	2.7	2.7	.8
45 to 54 years	–12.9	–10.9	–10.7	–6.9	–4.1	–3.4	18.1	15.3	15.0	9.7	5.8	4.8
55 to 59 years	–2.0	–4.3	–5.8	–5.6	–4.2	–4.3	3.6	7.8	10.5	10.1	7.6	7.8
60 to 64 years	3.7	–1.8	–5.4	–1.7	–3.4	–2.5	10.4	5.1	15.2	4.8	9.6	7.0
65 to 69 years	–.3	–2.8	–5.1	–2.9	–1.9	–4.1	1.8	16.5	30.0	17.1	11.2	24.1
70 years and older	.2	–.4	–1.3	–.7	–.7	–1.2	5.2	7.5	26.6	15.7	15.1	26.1
Whites	—	—	.1	1.5	.5	–.9	—	—	.1	2.2	.7	1.3
Men	—	—	.5	1.2	.5	–.4	—	—	.7	1.6	.7	.5
Women	—	—	–.1	1.8	.6	–1.3	—	—	.2	3.1	1.0	2.3
Blacks and others	—	—	–1.7	2.1	1.1	.8	—	—	2.7	3.3	1.7	1.3
Men	—	—	–1.2	.4	–.1	.6	—	—	1.7	.6	.1	.8
Women	—	—	–2.0	3.5	2.1	1.0	—	—	3.5	6.1	3.6	1.7
Mean absolute percent error	—	—	—	—	—	—	10.8	7.0	11.6	9.5	6.9	6.8

NOTE: Dash indicates data not available or not applicable.

close. The test indicates that they coincide. The observations are not as far from the line as in the 1973 projection. For this projection, there were overprojections of the rates for teenagers, while the rates were underprojected for women aged 45 to 54 and men 60 to 64. The 1983 projection exhibits more precision—the values are even closer to the fitted line, but again, this does not coincide with the line of perfect forecast, although the test statistics indicate that the lines may indeed coincide. The panels as a group suggest that the projections improved over time; the errors being equally likely to be extremely positive or negative.

Median error. The errors made in the 1973 projection of participation rates to 1990 for the various age-sex groups range from 22.5 percentage points too low for women aged 35 to 44 to 14.4 percentage points too high for men aged 60 to 64. (See table 4.) For the other projections to 1990, one of the teenage groups had the greatest overprojection, reflecting the drop in their participation that occurred at the end of the projection period.[9] The following tabulation shows the median error for each year a projection of the 1990 labor force was made, the dispersion of the error, and the extreme values of the errors:

Year	*Median*	*Mean absolute deviation*	*Greatest overprojection*	*Lowest underprojection*
1973	–0.05	6.1	14.4	–22.5
1976	.15	3.7	7.1	–13.5
1978	–.08	4.9	11.6	–10.7
1980	.45	4.4	12.8	–6.9
1983	–.20	3.1	7.3	–4.2
1985	–.55	2.1	3.2	–6.0

If BLS is improving its projections, the median error would be closer to zero in 1985 than in 1973. This pattern does not appear, but all median errors are less than 1 percentage point, suggesting a random drift with a small error. A median error near zero indicates that the projection was unbiased. That is not helpful if large positive and negative errors tended to cancel each other. The dispersion, here measured by the mean absolute deviation, does become smaller. A low measure of dispersion

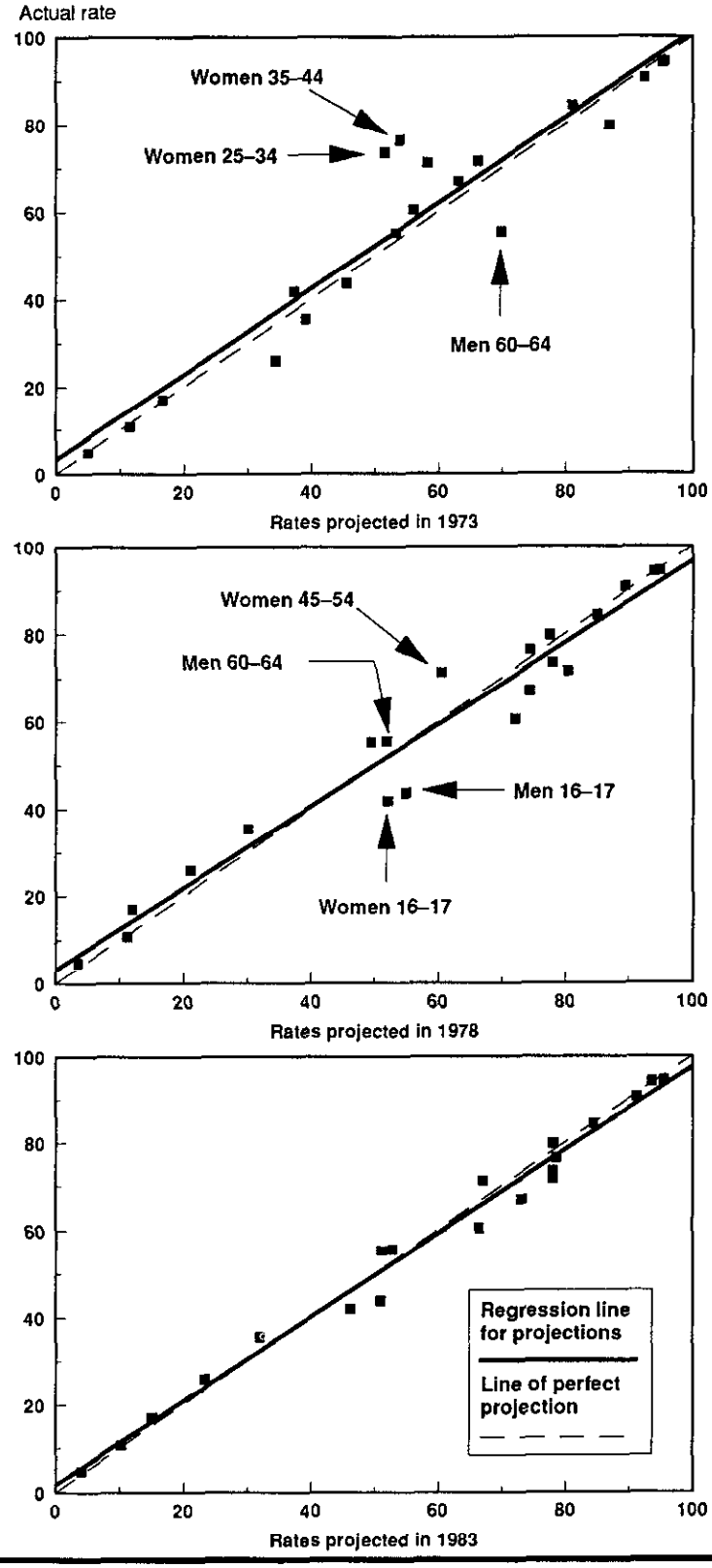
indicates that there were few large, offsetting errors. Another way to verify this is to look at the greatest overprojection and lowest underprojection. We see that these numbers did become closer in the more recent projections. The projections made in 1983 and in 1985 had their greatest errors at less than 10 percent. This contrasts with the projection made in 1973, with errors greater than 20 percent. By comparison, an evaluation of projections of the 1985 labor force shows a 25-percent greatest error—more than any error in the projections for 1990.

Shapiro-Wilk test. Generally, it is assumed that errors are distributed according to the normal, or Gaussian, law. We can examine this using the Shapiro-Wilk test.[10] Values for the statistic ranged from 0.90 to 0.92 for the 1973 to 1983 projections; the hypothesis of normality would be rejected. The 1985 projection test value was 0.96, which is consistent with Gaussian errors. The departures could occur because the errors were not symmetric, for example, more negative than positive errors, or because the tails of the distribution were too "fat" (there were several errors with very large positive or negative values) or too thin. Kurtosis statistics indicate the errors are more closely grouped around the mean than a Gaussian distribution making significance tests, such as regression tests, conservative. However, it appears that the distribution of errors did become more symmetric in the more recent projections.

Age, sex, and race errors. In the first two projections (1973 and 1976) to 1990, there were large errors in the participation of women aged 25 to 54, reflecting assumptions that the participation rates of mothers would not grow sharply. They did. The pattern of errors reflects problems in projecting the participation rates of women born in the 1940's. Thus, BLS moved from an underprojection of 10 percent in the 1976 projection of participation rates of women aged 25 to 34 to an overprojection of 4.5 percent in 1978. The overprojection grew to 7.1 percentage points before dropping to an overprojection of 2.6 percentage points in 1985.

The pattern of groups with greatest errors shifted from women aged 25 to 54 in the 1973 projection to teenagers in the 1985 projection. Given the cyclical responsiveness of the teenage groups and the small number of these persons in the labor force, it is not surprising that this is where the larger error is found. Of greater concern is the error in projecting the participation rates of older workers—men aged 60 to 74 and women 65 to 69—because these errors may reflect a change in the long-term trend in labor force participation for older workers. To illustrate this, the error in the participation rate for men 60 to 64 made in 1973

Chart 1. **Moderate projections of 1990 labor force participation rates, compared with actual rates for 20 groups**



was 14 percentage points too high; by 1985, it was projected 5 percentage points too low. The 1973 to 1985 period was a time of rapid decreases in participation at these ages. Since 1985, participation for this age group has barely dropped. The same pattern of projecting participation too high at the beginning of the 1973–85 period and too low at the end also applies to women aged 60 to 64, although the percentage-point error is lower.

In general, the labor force participation rate for men was projected higher than the actual—the overall rates were too high for five projections, with the lowest error in 1978 and the greatest, in 1973. For women, the first three and the last projections of participation were too low—by 11 percentage points in the 1973 projection. The 1980 and 1983 projections had participation too high for women, as measured by their overall rate. (See table 4.) This suggests that as time passed, the projections of women's and men's participation rates were adjusted to reflect the changes in participation observed. Because the errors in participation for women were greater than those for men in all six projections, overall participation was underprojected or overprojected according to the pattern for women.

Starting with 1978, the labor force was projected by two race groups independently: whites and blacks and others (hereafter, blacks). Because the white labor force is still the much larger component, errors in the projection of this group have a greater effect on the overall error. Overall white participation was overprojected in 1978 through 1983. Participation of white men and white women was overprojected in all projections, with the greatest error in 1980.

In 1978, labor force participation of both black men and black women was underprojected. The errors were much greater for blacks than for whites. In the 1980 and 1983 projections, rates were more accurately projected for black men than for white men or white women. However, the rates for women were projected too high. The overall projected rate for black men was very near their actual 1990 rate. The errors were equivalent in participation rates by sex and race for 1985. Given that the black participation rates as measured are more variable than those for whites, the relative accuracy of black labor force participation is a surprise.

Relative errors. As noted earlier, the errors in the labor force participation rate of older women are small. That is not surprising, as their participation is low. Relatively, their participation error is larger than other groups with higher participation and higher error. For example, the 1.3-percentage-point error for women aged 70 and older is a 26.6-percent relative error. By contrast, men in the prime working years have a participation rate of more than 95 percent, with relative errors roughly the same size as their percentage point errors; women's participation is lower and their relative errors are larger than percentage-point errors.

The earliest characterization of 1973 being by far the least accurate and 1978 being the most accurate holds for the relative error in overall participation. Overall, participation was more accurately projected for men than for women. Participation of men was equally accurate in 1978, 1983, and in 1985, whereas participation of women was projected most accurately in 1978. There was an improvement in the projection of participation rates of both women and men over the last two projections.

The relative errors by race were higher for blacks than for whites. Black women had the highest relative error; black men, the lowest.

To summarize the findings for detailed age groups, for the early years, the largest relative errors were for women aged 25 to 44. Starting in 1978, the relative errors were no longer large for women aged 25 to 44, but were for teenagers and persons 65 and older. These errors approached the size of the earlier relative errors for women aged 25 to 44. For women aged 20 to 34—principal ages of childbearing—the relative error was least for the 1985 projection. Since 1978, there has been an overprojection of participation rates for women in this age group. The 1976, 1983, and 1985 projections had about the same accuracy; the 1978 projection was worst.

Composition errors. Much of the interest in projections of the labor force centers on its size and growth. To understand these, we must also consider labor force participation rates. However, there is interest in the composition of the labor force or the proportion of men and women in each age group. (See table 5.) The index of dissimilarity measures how much the projected composition of the labor force would have to change to be like the 1990 actual composition.[11] For example, the 1980 projected composition would have to change by 3.7 percent to have the same composition as in the actual 1990. Although the projected composition was worst in 1973, it improved with each projection, with the greatest improvement between the 1973 and 1976 projections. The errors in distribution for the 1973 projection were concentrated in the categories of men and women aged 25 to 44. For other projections, the error is widely distributed with small errors for any group.

Alternative labor force projections

For each projection, two alternative projections were made. Did the range from low-to-high alter-

Table 5. **Percent distribution of the 1990 labor force and as projected in 1973, 1976, 1978, 1980, 1983, and 1985**

Labor force group	Distribution as projected in —						Actual 1990	Percentage-point difference from 1990					
	1973	1976	1978	1980	1983	1985		1973	1976	1978	1980	1983	1985
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	—	—	—	—	—	—
Men, 16 and older	60.5	57.3	54.6	53.8	54.2	54.7	54.7	5.9	2.6	–0.1	–0.8	–0.5	0.1
16 and 17 years	1.4	1.4	1.5	1.4	1.3	1.2	1.2	.2	.2	.3	.2	.1	.0
18 and 19 years	2.0	2.1	2.1	2.0	2.0	1.9	1.9	.0	.2	.1	.1	.1	.0
20 to 24 years	5.8	5.9	5.8	5.8	5.7	6.0	5.8	.0	.0	.0	–.1	–.1	.1
25 to 34 years	17.5	16.3	15.4	15.1	15.7	16.0	15.9	1.7	.4	–.5	–.8	–.2	.2
35 to 44 years	15.5	14.6	13.9	13.6	14.0	14.1	13.8	1.7	.7	.1	–.2	.1	.3
45 to 54 years	9.8	9.6	9.1	9.0	8.9	9.0	9.0	.9	.6	.1	.0	.0	.1
55 to 59 years	3.7	3.5	3.2	3.2	3.1	3.1	3.2	.5	.3	.0	.0	–.1	–.1
60 to 64 years	2.9	2.4	2.1	2.2	2.1	2.0	2.2	.7	.2	–.1	.0	–.2	–.2
65 to 69 years	1.2	1.0	.8	.8	.8	.7	1.0	.3	.0	–.2	–.1	–.1	–.2
70 years and older	.7	.6	.7	.7	.6	.6	.7	.0	.0	.0	.0	.0	–.1
Women, 16 and older	39.5	42.7	45.5	46.2	45.8	45.3	45.3	–5.9	–2.6	.1	.8	.5	–.1
16 and 17 years	1.1	1.3	1.3	1.4	1.2	1.1	1.1	.0	.2	.3	.3	.1	.0
18 and 19 years	1.8	1.9	2.1	2.1	1.9	1.7	1.8	.0	.2	.4	.3	.1	.0
20 to 24 years	5.3	5.8	5.9	5.8	5.6	5.4	5.3	.0	.6	.7	.6	.4	.2
25 to 34 years	9.6	11.5	13.5	13.5	13.4	13.3	12.8	–3.2	–1.3	.6	.7	.6	.5
35 to 44 years	9.2	10.3	11.6	11.9	12.0	11.8	11.7	–2.4	–1.4	–.1	.2	.3	.1
45 to 54 years	6.7	6.8	6.6	6.8	7.0	7.2	7.5	–.8	–.6	–.9	–.7	–.5	–.3
55 to 59 years	2.6	2.4	2.2	2.2	2.2	2.3	2.5	.1	–.1	–.2	–.3	–.2	–.2
60 to 64 years	1.9	1.6	1.4	1.5	1.5	1.5	1.6	.3	.0	–.3	–.1	–.2	–.1
65 to 69 years	.8	.7	.5	.6	.7	.6	.8	.0	–.1	–.2	–.1	–.1	–.2
70 years and older	.5	.4	.3	.4	.4	.4	.4	.0	.0	–.1	–.1	.0	–.1
Whites	—	—	86.9	86.5	86.2	86.0	85.9	—	—	1.0	.6	.3	.1
Men	—	—	47.9	47.2	47.4	47.7	47.5	—	—	.4	–.3	–.1	.2
Women	—	—	39.0	39.3	38.8	38.3	38.4	—	—	.7	.9	.5	–.1
Blacks and others	—	—	13.1	13.5	13.8	14.0	14.1	—	—	–1.0	–.6	–.3	–.1
Men	—	—	6.6	6.6	6.8	7.0	7.2	—	—	–.5	–.6	–.4	–.1
Women	—	—	6.4	6.9	7.0	7.0	7.0	—	—	–.5	–.1	.0	.0
Dissimilarity index	—	—	—	—	—	—	—	6.4	3.6	2.6	2.5	1.8	1.5

NOTE: Dash indicates data not available or not applicable.

natives span the actual? And, was the high or low alternative closer to the 1990 actual figures than was the middle alternative? For evidence, chart 2 shows that the last four projections had a range that did indeed cover the actual 1990 level. The 1978 high alternative was closer to the actual levels than was the middle alternative; the low alternative was closest in 1985.

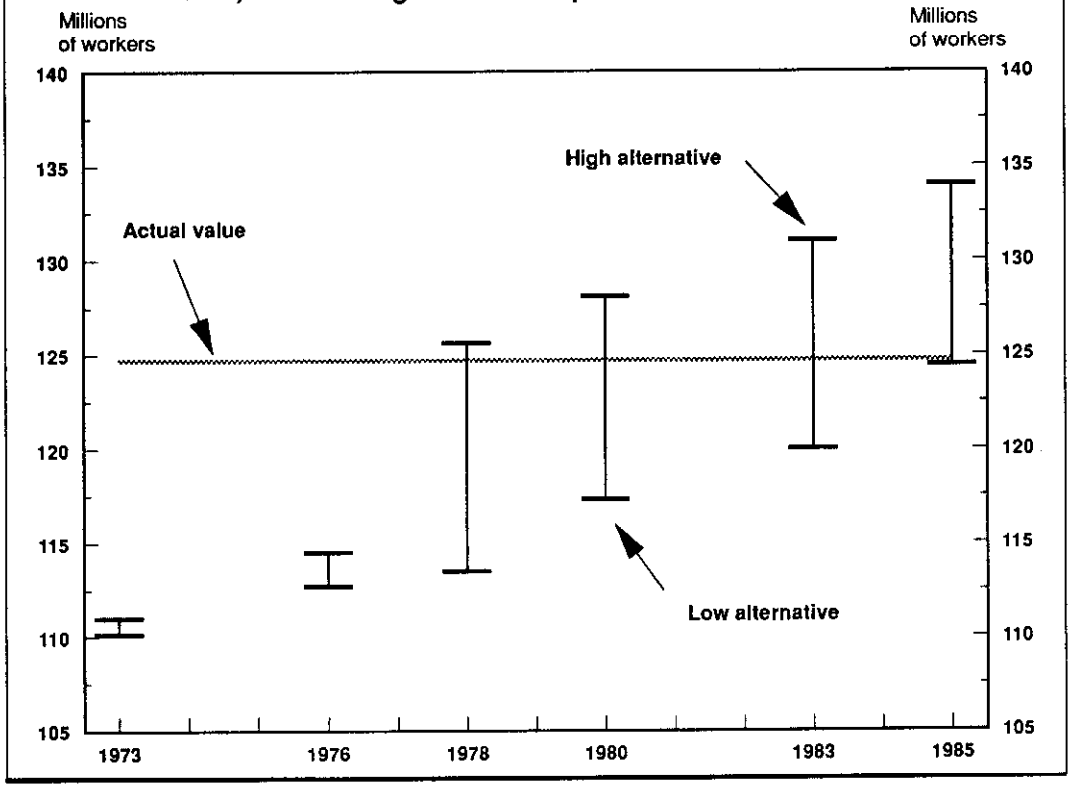
The first two projections in chart 2 are striking. Not only did the 1973 and 1976 projections fail to cover the actual line, but both ranges were much smaller. At the time the projections were made, women in the 25-to-44 age group were a small part of the labor force. Their labor force participation rate, although low, was growing rapidly. Although these women were the most significant source of error for the projections, they were too small a group to yield a large variation in the size of the overall labor force. BLS changed its methodology in 1978 to accommodate variations in labor force participation for all age groups.

For any year, BLS alternatives plotted through time have a "fan" shape; they are further apart the further from the take-off year. It would then appear that these plots of alternatives should exhibit a "funnel" shape, the closer one got to the target year, the closer the alternative projections should be to the actual. Over the 1978 to 1985 period, BLS was interested in making the range of projections approximate a confidence or credible interval. By the time the 1985 labor force projection was made, it was apparent that economic variables could not be used to account for the variability in the labor force that a confidence interval approach implied. The alternative labor force projections are used in the aggregate economic projections; thus, there must be some economic content in the alternatives. Starting with the 1985 labor force projection, the "fan" of alternatives did not spread more widely with each successive projection. Thus, in later evaluations, we should observe some of the "funnel" shape.

Assumptions

One of the questions of concern in the evaluation of projections is, "Why does one set of projections have fewer errors than another, particularly if the

Chart 2. **Range of high and low alternative projections of the 1990 labor force, made during the 1973–85 period**



reasons for the errors yield information that could improve future projections?" The BLS labor force projection method involves a high level of disaggregation followed by extrapolation of the labor force participation rate. The refinement of the methodology over time has included using age groups spanning 5 years (1973 to present), using parental status for women (1973 to 1978), and disaggregating by race (1978 to present). The extrapolation technique developed for the 1973 projection rapidly dampened the estimated growth rates for women. For the 1976–85 projections, tapering of rates was greatest toward the end of the projection period. Because the projections improved over the years, the question arises whether such enhancements result from changes in methods or simply later data.

For the labor force projections made over the 1973–85 period, changes in participation rates were projected. These changes were applied to a "take-off" (or base) participation rate and then successive participation rates were projected. To project the changes, past changes in participation rates were estimated. It was *assumed* that participation rate changes would ultimately cease. For the 1973 projection, when the drop in fertility rates had just begun, it was assumed that the rapid growth in women's labor force participation would soon cease as fertility increased. In fact, the opposite occurred and fertility dropped to the levels prevailing in the early 1930's and remained there. If a behavioral model relating fertility and women's labor force participation had been developed and used, the expectation that fertility would rise also would have led to participation lower than that which actually occurred. For the remaining projections, it was also assumed that changes in participation would also end, but that the greatest slowdown would be towards the end of the projection period—for the 1976 projection, between 1990 and 1995; for later projections, after 1995. For the 1980 projection, it was assumed that participation rates for women aged 20 to 44 would increase rapidly, then slow down.

Several analysts have discussed the problems involved in selecting a take-off point.[12] According to such studies, the problem arises when estimating the current level. The accuracy of a projection can be affected by the choice of a take-off point, especially in the short run. Because the 1973 projection was to be made for the years 1980, 1985, and 1990, 1970 was used as a take-off point. This affected the accuracy of the 1973 projection. The 1976 projection used the average of the last 3 years; later projections have used the last year in the sample period. If the rate of change is underes-

timated because a linear estimate is made when change is actually growing nonlinearly, then every year the take-off year is moved back compounds the problem. The effect of not using the most recent year is to shift the entire projection down (or up) for the entire period.

The 1973 through 1978 projections explicitly used the fertility assumptions to derive the number of women with young children. The use of these assumptions overstated the number of women with young children for the 1973 and 1976 projections and understated it slightly for the 1978 projection.

Summary

Overall comparison. Eleven tabulations or explicit tests were made of the six projections of the 1990 labor force. Which projection is best? In considering this, there are several ways a projection can be best. For example, if the errors are offset, the projected level of the labor force would be very near the actual level, yet the participation rates and the projected population would be incorrectly projected. However, if the main use of the projected labor force was the level or growth of the overall labor force, these details would not matter. The following tabulation lists the number of times a projection of the 1990 labor force was calculated to be best or worst:

Projection	*Best*	*Worst*
1973	1	6
1976	1	...
1978	1	3
1980	1	1
1983	2	...
1985	5	1

These tests help users evaluate projections in terms of their own needs: for an accurate level of the total labor force; for accurate participation rate projections; or for accurate projections of composition of the labor force. Different tests of the accuracy of the participation rate projections allow the user to focus on overall accuracy or accuracy of specific groups.

Earlier evaluations. As a group, the projections of the 1990 labor force were more accurate than the projections of the 1980 or 1985 labor force. The following tabulation shows a summary of measures used to compare accuracy of the 1990 and 1985 projections of the labor force.

	Projection to 1990		*Projection to 1985*	
	Error	*Year*	*Error*	*Year*
Error level (in millions):				
Best	0.2	1983	–0.5	1980
Worst	–14.2	1973	–11.0	1970
Error in growth rate (percent):				
Best	.02	1983	.07	1978
Worst	–.68	1973	.61	1970
Mean absolute percent error:				
Best	6.8	1985	6.0	1980
Worst	10.8	1973	17.0	1970
Index of dissimilarity:				
Best	2.6	1985	1.4	1980
Worst	7.6	1973	7.5	1970

According to these summary measures, the worst projection to 1990 (–14.2 percent) was less accurate than the worst projection to 1985 (–11.0 percent), but the best projection to 1990 was often significantly more accurate than the best to 1985. When adjusted for the actual population, four projections to 1990 were more accurate. Generally, the more recent projections were more accurate, with those made in 1985 being the most accurate.

Evaluations also have been made of the projections to 1975, 1980, and 1985.[13] The evaluations for 1980 concluded that the projections of the labor force had been too low, with the level of the male labor force being projected to be too high and that of women, too low; in fact, so low that the overall level of the projected labor force was too low. By 1985, the projections, though generally low, also included some cases where the overall level (including that for women) was too high. Indeed, the conclusion was that BLS had improved the accuracy of its labor force projections.

Furthermore, the labor force projections made to 1985 were low by some 3.4 million persons because of errors associated with estimating the population size and making population projections. For the 1970 and 1973 projections, this amounted to a third of the error. For the 1976 and later projections made for 1985, the error attributable to participation rate dropped, so the share of error attributed to population increased. □

Footnotes

[1] For the 1990 evaluations, see the following *Monthly Labor Review* articles: Denis F. Johnston, "The U.S. labor force: projections," July 1973, pp. 3–13, reprinted as *Special Labor Force Report* 156; Howard N Fullerton, Jr. and Paul O. Flaim, "New labor force projections to 1990," December 1976, pp. 3–13, reprinted as *Special Labor Force Report* 197;

Paul O. Flaim and Howard N Fullerton, Jr. "Labor force projections to 1990: three possible paths," December 1978, pp. 25–35, reprinted in *Employment Projections for the 1980's*, Bulletin 2030 (Bureau of Labor Statistics, 1979); Howard N Fullerton, Jr., "The 1995 labor force: a first look," December 1980, pp. 11–21, reprinted in *Economic Projections to 1990*, Bulletin 2121 (Bureau of Labor Statistics, 1982); Howard N Fullerton, Jr., and John Tschetter, "The 1995 labor force: a second look," *Monthly Labor Review*, November 1983, pp. 3–10, reprinted in *Employment Projections for 1995*, Bulletin 2197 (Bureau of Labor Statistics, 1984); and Howard N Fullerton, Jr., "The 1995 labor force: BLS's latest projections," *Monthly Labor Review*, November 1985, pp. 17–25, reprinted in *Employment Projections for 1995: Data and Methods*, Bulletin 2253 (Bureau of Labor Statistics, 1986).

[2] See Sol Swerdloff, "How good were manpower projections for the 1960's," *Monthly Labor Review*, November 1969, pp. 17–22; Paul Ryscavage, "BLS labor force projections: a review of methods and results," *Monthly Labor Review*, April 1979, pp. 14–22; Howard N Fullerton, Jr., "How accurate were the projections of the 1980 labor force?" *Monthly Labor Review*, July 1982, pp. 15–21; and Howard N Fullerton, Jr., "An evaluation of labor force projections to 1985," *Monthly Labor Review*, November 1988, pp. 7–17.

[3] In this analysis, we compare the projected labor force numbers for 1990 with the annual average estimates of the labor force derived from the Current Population Survey, using weights from the 1980 census. We call such estimates "the actual."

[4] The population projection for the 1973 labor force projection was published in the following Bureau of the Census publications: "Projections of the Population of the United States by Age and Sex: 1972 to 2020," *Current Population Reports*, Series P-25, No. 493 (1972); the population projection for the 1976 labor force projection was published in "Projections of the Population of the United States: 1975 to 2050," *Current Population Reports*, Series P-25, No. 601 (1975); the population projection for the 1978 and 1980 labor force projections was published in "Projections of the Population of the United States: 1977 to 2050," *Current Population Reports*, Series P-25, No. 704 (1977); the population projection for the 1983 labor force projections was published in "Projections of the Population of the United States: 1982 to 2050," *Current Population Reports*, Series P-25, No. 922 (1982); the population projection for the 1985 labor force projections was published in "Projections of the Population of the United States: 1983 to 2080," *Current Population Reports*, Series P-25, No. 952 (1984).

[5] The population error displayed in table 3 is the difference between the total error and the participation rate error. It thus may include an interaction term.

[6] This was anticipated by the authors of the 1978 projections, who suggested that "The population projections might have to be revised to reflect a better knowledge of net migration trends, particularly with regard to the inflows of undocumented aliens." See "Labor force projections to 1990: three possible paths."

[7] This hypothesis is different from the usual test because 1) we are testing two coefficients at the same time and 2) we are hypothesizing that the slope coefficient is different from 1 rather than different from zero. This kind of test is covered in standard analysis of variance textbooks.

[8] Later errors in the projections are found not to be normally distributed, so the reader may ask why an F-test is used because the normal distribution is required for such a test. A short answer is that it still provides a useful indication. For a discussion of the problem and methods of handling the problem, see Henry Scheffé, *The Analysis of Variance* (New York, John Wiley & Sons, 1959), ch. 10, "The Effects of Departures from the Underlying Assumptions," pp. 331–69.

[9] The most recent BLS labor force projection assumes that participation for these ages will return to their levels of the late 1980's. See Howard N Fullerton, Jr., "Labor force projections: the baby-boom moves on," *Monthly Labor Review*, November 1991, pp. 312–44.

[10] S. S. Shapiro and M. B. Wilk, "An analysis of variance test for normality (complete samples)," *Biometrika*, 1965, pp. 591–611; also see E. S. Pearson and H. O. Hartley, eds., *Biometrika Tables for Statisticians*, Vol. II, (London, Biometrika Trust, 1976), table 16 and discussion, pp. 36–37.

[11] The index of dissimilarity is half the sum of the absolute values of the differences in distribution of the two groups being compared.

[12] Paul Ryscavage, "BLS labor force projections: a review of methods and results," p. 15; Lucy Kok and Chris de Neubourg, *Projecting labor supply, methods, theory and research: an international comparison* (The Hague, Organisatie voor Strategisch Arbeidsmarktonderzoek, 1986), p. 47; and J. Scott Armstrong, *Long-Range Forecasting* (New York, John Wiley, 1978), pp. 53–55.

[13] See Sol Swerdloff, "How good were manpower projections"; Paul Ryscavage, "BLS labor force projections"; and Howard N Fullerton, Jr., "How accurate were the projections?" and "An evaluation of labor force projections."