THE IMPACT OF CHANGES IN THE CURRENT POPULATION SURVEY ON TIME-IN-SAMPLE BIAS AND CORRELATIONS BETWEEN ROTATION GROUPS

Khandaker A. Mansur, Harland H. Shoemaker, Jr., U. S. Census Bureau*
Khandaker A. Mansur, U.S. Census Bureau, Washington, D.C. 20233

Key Words: Rotation group; Time-in-Sample (TIS) Bias; Bias Indices; Composite Estimates.

I. Introduction

The Current Population Survey (CPS) is a monthly household survey conducted by the Bureau of the Census for the Bureau of Labor Statistics. Its primary purpose is to provide monthly labor force and related estimates for the total U.S. civilian noninstitutional population. The information on the employment status of respondents is collected by the interviewers from a sample of about 50,000 households located in 754 sample areas. Since its inception in 1940, the CPS has been the primary source of information on the unemployed, employed, and persons not in the labor force in the United States.

In January 1994, major changes to the CPS were introduced, which included a complete redesign of the questionnaire and the use of computer-assisted interviewing for the entire survey. Prior to this, the survey questionnaire had been virtually unchanged for nearly three decades. The last major revisions were made in 1967. Since that time, problems with the questionnaire in measuring certain labor market concepts were identified. For example, there had been tremendous growth in the number of service-sector jobs, a more prominent role of women in the work force, and a growing popularity of alternative work schedules. These changes raised issues which were not being fully addressed with the old questionnaire. In addition, there had been major advances in survey research methods and data collection methodology.

The CPS questionnaire was totally redesigned in order to obtain more accurate, comprehensive, and relevant information, and to take advantage of state-of-the art computer interviewing techniques. A new questionnaire conducted entirely by computer-assisted personal or telephone interviewing (CAPI/CATI) replaced the paper-and-pencil or computer assisted telephone interviewing (PAPI/CATI). Interviewers conduct the survey either in person at the respondent's home or from one of the Bureau's centralized telephone facilities using computers on which the questionnaire has been programmed.

Also, in January 1994, more objective criteria were added to the definition of discouraged workers. Prior to this date, to be classified as a discouraged worker a person must have wanted a job and been reported as not currently looking for a job because of a belief that no jobs were available or that there were none for which he or she would qualify. Beginning in 1994, persons classified as discouraged workers must also have looked for a job within the past year (or since their last job, if they worked during the year), and must have been available for work during the reference week (the week containing the 12th day of the month).

Beginning in April 1994 a new sample design based on the 1990 census was phased in. The new design included a new sample of housing units located in areas already in the CPS sample. In addition, new sample areas were added and some sample areas were dropped. The entire phase in process was completed by July 1995.

In this paper, we discuss the impact of changes in the CPS (sample redesign, questionnaire redesign, and automated data collection) on the time-in-sample bias pattern of labor force estimates. In section II, we define the time-in-sample (TIS) bias. Section III compares TIS bias indices for unemployed (UE) and civilian labor force (CLF) estimates computed using the data collected with the "new" questionnaire and the new automated data collection procedure with those bias indices that were obtained from the "old" questionnaire and old data collection procedure. Section IV discusses correlation estimates for UE within the same rotation group several months apart and compares the correlation structure for the 1990 sample design to that for the previous (1980) sample design. The summary is given in section V.

II. Time-in-Sample Bias

The CPS sample is a two-stage probability sample of housing units, covering the entire U.S. A household whose address is selected for the sample is interviewed for four consecutive months, rotated out of the sample for eight months, and then interviewed for another four months before being retired from the sample. This is referred to as the 4-8-4 rotation scheme. As a result, in any particular month, the CPS sample consists of eight subsamples or rotation groups: the households in the survey for the first time, for the second time, .., for the eighth time. The eight rotation groups in sample for a given month can also be considered " time-in-sample (TIS)" groups. The 'time-in-sample' represents the number of months (including the current month) a rotation

group is in the sample.

Under this system, approximately 75 percent of the sample is common from month-to-month and 50 percent from year-to-year for the same month. This rotation scheme provides a substantial amount of month-to-month and year-to-year overlap, thus providing better estimates of change and reducing discontinuities in the series of data without burdening any specific group of households with an unduly long period of inquiry.

Personal visits are generally conducted the first and fifth times in sample (TIS 1 and TIS 5)[1]. Other interviews are mostly conducted by telephone, either from the field representative's (FR's) home or from one of the Bureau's centralized telephone facilities.

In the Current Population Survey, the direct survey estimate at time h can be modeled as

$$(2.1) \qquad x_{i,h} = X_h + u_{i,h}$$

Where $x_{i,h}$ is the estimate from a rotation group which is in its i-th time in sample at time h, X_h is the population characteristic of interest at time h and $u_{i,h}$ is an error due to sampling.

Since all the rotation groups are random samples of the population, they can be used to generate eight separate estimates of a population characteristic such as the number of unemployed. In principle, the estimates should differ only by random error. In practice, though, the estimates from different rotation groups show sizeable systematic differences. It has been observed that the estimates from eight rotation groups for some characteristics relating to the same time period do not have the same expected value. Historically, the most pronounced differences occurred between the rotation groups in sample for the first time when compared with an average estimate from all eight rotation groups (Bailar, 1975). This is often referred to as the 'rotation group bias' or time-in-sample bias. Why responses vary with time in the sample is unknown, but possible factors previously cited include conditioning of respondents or FRs by repeated contacts, differences among rotation groups in the length and content of the questionnaire, which household member is interviewed, and whether the interview is conducted by telephone or in person.

The TIS bias index is the ratio of the expected value of the estimate based on the sample units in a particular time-in-sample group to the average of the expected value of the estimate from all eight groups combined, multiplied by 100. That is, the bias index for the ith TIS group in month h is defined as

$$(2.2) \qquad I_{i,h} = \left(E(x_{i,h}) / E\left(\sum_{j=1}^{8} x_{j,h}/8\right) \right) \times 100, \qquad i = 1,...8$$

so that an index greater than 100 implies an overestimate in that group relative to the other seven groups.

III. Comparison of Time-in-Sample bias indices between 1987 and 1998

We examine whether the changes in the questionnaire including the change in the definition of discouraged worker and data collection methods implemented in January 1994 has caused any discernable changes in the TIS bias pattern. In the new instrument, certain questions are asked of all discouraged workers in each month. Between 1970 and 1994 they were asked only in months-in- sample 4 and 8. Because these questions have a tendency to raise the estimate of the number of people unemployed asking them in every month may well change the time-in-sample bias pattern for that characteristic (Bailar, 1975).

Also, changing the sample areas when we redesign the survey also may affect the time-in-sample bias. Every ten years some areas are phased into or out of the CPS over a period of 15 months. For the sample design based on the 1990 census, this process began in April 1994 and continued through June 1995. During this time, a small number of sample units were interviewed only four times rather than eight to minimize field costs as we phased out some old (1980 design) sample areas in favor of newly selected (1990 design) areas. This disrupted the usual 4-8-4 pattern of interviews. For example, some households that would normally have been interviewed for the fifth time were replaced by households in a different area just entering the survey and interviewed for the first time. During this phase-in period, we have some indication that the TIS bias may have been affected temporarily (Mansur, 1995).

We wanted to see if these indicated changes were still evident after the phase-in period was completed and the new data collection procedures were stabilized, and if any changes were statistically significant. To investigate these changes we used the 1998 data from the 1990 design and 1987 data from the 1980 design to compute the bias indices. We compared bias indices for UE and CLF using the 1998 data collected with the "new" questionnaire and new data collection procedure (also referred to as "new" CPS) with bias indices obtained from the "old"

[1] 15 to 20 percent of TIS 1 personal visit cases are actually completed by telephone. For TIS 5, the figure is 30 to 40 percent.

questionnaire and old data collection procedure (also referred to as "old" CPS). The 1987 data were collected through PAPI/CATI and do not include any effects from the phase-in of the 1990 redesigned sample. The 1987 data represent the "old" CPS. The 1998 data are used to represent the "new" CPS after the new questionnaire, the new data collection methodology, and the redesigned sample were introduced. For each year, bias indices were computed for each month and then averaged across all twelve months to obtain an average bias index.

For both time periods, replicate weights were used to compute the standard errors of the bias indices. A statistical test accounting for multiple comparisons (using the Bonferroni procedure) was performed among the differences in the bias indices at an overall 10 percent significance level with a critical value of 3.03. If the value of the t-statistic (absolute value of the difference in estimates divided by the square root of the sum of their variances) is greater than the critical value, then the difference is statistically significant. The average bias indices of these two time periods and their differences along with their standard errors and statistical test results are given in Tables 3.1 through 3.5.

Although some of the differences are quite large, only two are statistically significant. Both of these were for Total CLF. The lack of statistically significant differences is due in part to the relatively large variability in the bias indices from month-to month.

It is clear from the tables, however, that the bias index for total unemployed for TIS 1 is still significantly larger than the indices for any other TIS group regardless of the time period. This finding is partially consistent with earlier research conducted by Bailar (1975) which concluded that unemployment estimates were higher for persons in their first and fifth times in sample. However, the current data do not support the previous finding of higher bias indices for TIS 5.

IV. Comparison of Correlations Between Month-in-Sample Groups Over Time

The old (pre 1998) composite estimation procedure used the same coefficients K and A for all characteristics (Lent ,1996). The current compositing weighting procedure uses different values of the coefficients K and A for different labor force categories to improve the accuracy of the labor force estimates. The optimal values of the coefficients K and A depend on the TIS bias pattern and correlation structure of the characteristic to be estimated. The composite weighting procedure was discussed in Lent (1994). Lent (1996) also discussed the impact of the CPS time-in-sample bias and correlation structure on the optimal coefficients to be used in the composite estimator. Previous research showed for example, that higher values of K and A result in more reliable estimates for employment level because the ratio estimators for employment are more strongly correlated across time than those for unemployment. The optimal values of K and A used currently are based on correlations computed from the CPS (September 1976 through December 1977) data (Lent ,1996). Since this time period the correlation structure of labor force estimates may have changed because of the change of the sample design and the introduction of the new questionnaire. For this reason we would like to investigate the present correlation structure. Lent (1996) suggested a similar investigation.

This section discusses the effect of changes in the sample design and the change in the questionnaire on correlations between estimates from the same rotation groups. In order to investigate any change in the correlation pattern, we compared the correlation structure for the 1990 design using the CPS data from January 1996 to January 1997 to that of the 1980 design using the data from January 1987 through January 1988 (Fisher,1993). The first and second-stage combined (FSC) ratio estimates are used for both time periods.

Table 4.1 compares average correlations for several important labor force characteristics between the two time periods. The standard errors given in the table are only approximations. The correlations are not independent because more than one correlation is computed from some rotation groups and the computed correlations are autocorrelations.

The table does not show the correlations for a specific rotation group for lags 4 through 8 because under the CPS 4-8-4 rotation plan, a specific rotation group is not in sample in month m and month m+h, where h is 4,5,6,7, or 8.

For any labor force characteristic, the estimates for different months from the same rotation group are correlated because of their common sample. In general, correlations are highest for lag 1, and drop off as the lag (the number of months between the two estimates) increases. For example, Table 4.1 shows that for 1996-97 period, the correlation is 0.39 for unemployed for lag 1 and decreases gradually to 0.05 for lag 11. The correlations are low for unemployed because of the shorter duration of unemployment and much higher for the large characteristic like employed.

Table 4.1 shows correlations for unemployed for the period 1996-97 are significantly lower in lags 1 through 3 than those of the previous period. For lags 1 through 3,

the correlation estimates for employed from the most recent period are comparable with those of the previous period, and for lags 9 through 11 correlations for the more recent time period are significantly lower. Note that the sample sizes in this case are small only 3 or 4; the results could change with more observations. The correlations for CLF follow almost the same pattern as employed.

Our research indicates that the correlation structures of the labor force estimates may have changed between the 1980 design and the 1990 design. Values of the coefficients K and A currently used for composite estimates were computed based on correlations from the 1970 design. Correlations were similar for both 1970 and 1980 designs (Adam,1992). We suggest that coefficients K and A should be reexamined with these more recent correlation estimates.

V. Summary and Concluding Remarks

Our research finds that the changes in the questionnaire and the automated data collection methodology introduced in 1990 design have some impact on both the time-in-sample bias and the correlation structure of unemployed and civilian labor force estimates.
Tables 3.1 through 3.4 show that the bias index for TIS1 for total unemployed is still larger than the index for any other time-in-sample group. We also see from the tables that some large differences in bias indices exist for total and other unemployed characteristics, but none are statistically significant. For the civilian labor force (Table 3.5), the bias index of TIS 3 is higher and TIS 8 is lower in the 1990 design than in the 1980 design.

We see from Table 4.1 that correlations of unemployed estimates for the 1990 design are significantly lower in lags 1 through 3 than those of the previous design . For the 1990 design, correlations may be significantly lower in lags 9 through 11 for the employed and significantly lower in lags 10 and 11 for CLF. Because values presently used for the parameters K and A of composite estimators were computed based on the correlations from the previous design, we would like to re-examine the correlation structure of the larger lags for employed and CLF using additional years of data. If we determine that a change in correlation structure has occurred, we suggest re-examining the optimum values for K and A.
*This paper reports the general results of research undertaken by Census Bureau staff. The views expressed are attributed to the authors and do not necessarily reflect those on the Census Bureau.

References

Adam, A.; and W. Fuller (1992). " Covariance of Estimators for the Current Population Survey." *Proceedings of the Section on Survey Research Methods, American statistical Association,* 586-591.

Bailar, B. (1975). " The effects of Rotation Group Bias on Estimates from Panel Surveys." *Journal of the American Statistical Association, 70, 23-30.*

Fisher, R.; and R. McGuinness (1993). Internal memorandum for Documentation, dated January 6, 1993, "Correlations and Adjustment Factors for CPS (VAR80_1)," Bureau of the Census, Washington, DC.

Lent, J.; S. Miller; and P. Cantwell (1994). "Composite Weights for the Current Population Survey." *Proceedings of the Section on Survey Methods, American Statistical Association, 867-872*

Lent, J.; S. Miller; and P. Cantwell (1996). "Effect of Composite Weights on Some Estimates from the Current Population Survey." *Proceedings of the Section on Survey Methods, American Statistical Association, 130-139*

Mansur, K. (1995). Internal memorandum for Documentation, dated May 9, 1995, " Results of CPS Month-in- sample Bias Research (ESTWGT90-21)," Bureau of the Census, Washington, D.C.

Table 3.1: Uncomposited Estimates of TOTAL UE

TIS	1	2	3	4	5	6	7	8
1987 estimate (standard error)	106.96 (1.34)	100.35 (1.28)	98.82 (1.17)	100.23 (1.16)	100.39 (1.52)	95.56 (1.09)	96.47 (1.14)	101.22 (1.23)
1998 estimate (standard error)	109.50 (1.69)	102.98 (1.48)	101.32 (1.48)	97.83 (1.45)	100.33 (1.57)	94.57 (1.47)	95.72 (1.43)	97.75 (1.59)
Difference (87-98)	-2.54	-2.63	-2.50	2.40	0.06	0.99	0.75	3.47
t-statistic	1.18	1.34	1.33	1.29	0.03	0.54	0.41	1.72

Table 3.2: Uncomposited Estimates of MALE UE

TIS	1	2	3	4	5	6	7	8
1987 estimate (standard error)	103.17 (1.58)	101.10 (1.86)	98.65 (1.61)	101.00 (1.64)	99.90 (1.52)	95.10 (1.48)	99.17 (1.82)	101.93 (1.67)
1998 estimate (standard error)	108.59 (2.26)	101.60 (1.93)	100.87 (2.08)	97.10 (2.02)	101.62 (2.21)	95.64 (2.14)	95.41 (2.04)	99.17 (2.24)
Difference (87-98)	-5.42	-0.50	-2.22	3.90	-1.72	-0.54	3.76	2.76
t-statistic	1.97	0.17	0.84	1.50	0.64	0.15	1.37	1.00

Table 3.3: Uncomposited Estimates of FEMALE UE

TIS	1	2	3	4	5	6	7	8
1987 estimate (standard error)	111.28 (2.16)	99.35 (1.62)	99.21 (1.77)	99.30 (1.69)	101.06 (2.20)	96.09 (1.73)	93.27 (1.68)	100.43 (1.64)
1998 estimate (standard error)	110.51 (2.35)	104.51 (2.21)	101.81 (2.15)	98.64 (2.25)	98.91 (2.22)	93.39 (1.91)	96.06 (2.00)	96.18 (1.96)
Difference (87-98)	0.77	-5.16	-2.60	0.66	2.15	2.70	-2.79	4.25
t-statistic	0.24	1.89	0.93	0.23	0.69	1.05	1.07	1.66

Table 3.4: Uncomposited Estimates of BLACK UE

TIS	1	2	3	4	5	6	7	8
1987 estimate (standard error)	110.13 (3.21)	104.34 (2.61)	98.45 (2.60)	96.60 (2.54)	98.60 (2.90)	93.53 (2.18)	95.65 (2.60)	102.71 (2.88)
1998 estimate (standard error)	113.53 (3.71)	106.09 (3.62)	103.25 (3.09)	98.28 (3.36)	100.58 (3.50)	95.68 (3.45)	91.54 (3.16)	91.06 (3.60)
Difference (87-98)	-3.40	-1.75	-4.80	-1.68	-1.98	-2.15	4.11	11.65
t-statistic	0.69	0.39	1.19	0.40	0.43	0.52	1.00	2.52

Table 3.5 Uncomposited Estimates of TOTAL CLF

TIS	1	2	3	4	5	6	7	8
1987 estimate (standard error	101.62 (0.13)	100.21 (0.13)	99.65 (0.12)	100.19 (0.14)	99.83 (0.12)	99.22 (0.13)	99.31 (0.11)	99.95 (0.13)
1998 estimate (standard error)	101.67 (0.15)	100.49 (0.15)	100.24 (0.15)	99.94 (0.14)	99.69 (0.13)	99.31 (0.15)	99.10 (0.16)	99.36 (0.14)
Difference (87-98)	-0.05	-0.28	-0.59	0.25	0.14	-0.09	0.21	0.59
t-statistic	0.25	1.41	3.07*	1.26	0.79	0.45	1.08	3.08*

* Significant at 10 percent level.

Table 4.1 Average Correlations Within the Same Rotation Group
(January 1987-January 1988 and January 1996-January 1997)

	Lag	1	2	3	9	10	11
	No. Of Obs.	66	40	18	3	4	3
Unemployed	1987-88 (standard error)	0.44 (.011)	0.30 (.014)	0.21 (.023)	0.03 (.002)	0.10 (.005)	0.03 (.002)
	1996-97 (standard error)	0.39 (.010)	0.21 (0.10)	0.10 (.011)	0.08 (.006)	0.08 (.004)	0.05 (.003)
	Difference (88-97)	0.05*	0.09*	0.11*	-0.05	0.02	-0.02
Employed	1987-88 (standard error)	0.67 (.011)	0.47 (.019)	0.31 (.012)	0.16 (.012)	0.28 (.013)	0.28 (.016)
	1996-97 (standard error)	0.67 (.011)	0.47 (.019)	0.30 (.031)	0.13 (.009)	0.15 (.007)	0.19 (.011)
	Difference (88-97)	0.00	0.00	0.01	0.03*	0.13*	0.09*
CLF	1987-88 (standard error)	0.68 (.011)	0.48 (.019)	0.34 (.009)	0.12 (.009)	0.30 (.014)	0.34 (.018)
	1996-97 (standard error)	0.66 (.011)	0.47 (.019)	0.31 (.032)	0.12 (.009)	0.17 (.008)	0.22 (.013)
	Difference (88-97)	0.02	0.01	0.03	0.00	0.13*	0.12*

* Significant at 10 percent level.