A COMPARISON OF A RANDOM DIGIT DIALING SURVEY AND THE CURRENT POPULATION SURVEY

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Using data collected by the U.S. Bureau of the Census, an investigation was made of the differential bias in the estimates of the unemployment rate from personal-interview and telephone-interview surveys. The approach required comparing estimates from data collected during the summer of 1982 in the Current Population Survey (CPS) and the Random Digit Dialing Employment and Health Survey (RDD I). From comparison of the demographic characteristics of the respondents in the two surveys, it can be claimed that the difference in the age distribution of respondents explains much of the differential bias. However, the two surveys were organized and administered differently, which could also be a source of differences.

CPS is a well-established household survey conducted by the Census Bureau every month to measure national employment and unemployment variables. The CPS sampling frame is based primarily on census address lists. Households are interviewed on eight occasions, some by personal visits and some by telephone when possible. However, comparisons in this study are restricted to first-time interviews which are always personal interviews. Thus, the CPS data used consist of approximately 7,200 interviews performed during the months of June, July, August, and September. The reference period for these interviews was the week containing the 16th of each month. The response rate was 95 percent.

RDD I was an experimental survey conducted by the Census Bureau to estimate the response rate for a Census Bureau survey using a Waksberg-Mitofsky random digit dialing survey design (Mulry-Liggan and Chapman 1982). The sampling frame for RDD I was all residential telehone numbers. RDD I was the first time the Census Bureau had conducted a national telephone survey from Census headquarters and employed a computer system for automated case management.

Interviewers were all inexperienced, and the procedures were essentially all new. RDD I data consist of 4,040 interviews performed during seven 2-week replicates. The questionnaire included labor force questions similar to those asked in the CPS, and the reference period was the week prior to the first week of the replicate. During the first four replicates, health questions followed labor force questions, but these health questions were eliminated during the last three replicates. The response rates and their standard errors are shown in Table 1. Response rates of 90 percent were achieved during Replicates 5 and 6. A decline during the last replicate of a survey is somewhat characteristic and has been observed by other survey researchers (e.g., Groves & Kahn 1979). The drop was probably due to lowered staff morale since their jobs were not continuing. The response rate for all seven replicates combined was 84 percent.

A secondary consideration during the design and implementation of RDD I was collecting data suitable for a study of the differential bias in estimates from it and the CPS. So that data for CPS households with telephones would be available, CPS respondents were asked, "Is there a telephone in this house/apartment?" According to the CPS data, 93 percent of the population has a telephone in their house or apartment; 94 percent of the whites and 86 percent of the nonwhites have telephones. Table 2 displays the best estimates of the unemployment rate and their standard errors for the entire population, the white population, and the nonwhite population from CPS and RDD I.

Estimates from RDD I and CPS households are independent estimates from the same population, namely the population with telephones in their house or apartment. Hence, the test of the hypothesis of no significant difference between the estimates of the unemployment rate from the two surveys is done using the t-test statistic,

$$(\hat{R}_{RDD} - \hat{R}_{CPS})/(\hat{V}_{RDD} + \hat{V}_{CPS})^{1/2}$$

where $\hat{R}_{RDD}$ = the estimated unemployment rate from RDD,
$\hat{R}_{CPS}$ = the estimated unemployment rate from CPS,
$\hat{V}_{RDD}$ = the estimated variance of the unemployment rate estimate from RDD,
$\hat{V}_{CPS}$ = the estimated variance of the unemployment rate estimate from CPS.

Table 1. Response Rates for the Random Digit Dialing Employment and Health Survey (RDD I)

Replicate	Response Rate	Standard Error
1	.82	.02
2	.81	--*
3	.80	.02
4	.79	.02
5	.90	.02
6	.90	.01
7	.85	.02

*Detailed call record data were accidentally erased from the computer.

Table 2. Unemployment Rate Estimates and Their Standard Errors Measured in RDD I and the First Month-In-Sample Interviews of the CPS

	Total Population			White Population			Nonwhite Population		
	RDD I	CPS Households w/tele.	CPS	RDD I	CPS Households w/tele.	CPS	RDD I	CPS Households w/tele.	CPS
All Replicates June-September	.102 (.005)	.089 (.002)	.100 (.002)	.087 (.005)	.079 (.002)	.087 (.002)	.195 (.019)	.158 (.007)	.187 (.007)
All Replicates except Rep. 6 June-September	.096 (.005)	.089 (.002)	.100 (.002)	.081 (.005)	.079 (.002)	.087 (.002)	.192 (.020)	.158 (.007)	.187 (.007)
Replicate 1 June	.085 (.016)	.087 (.003)	.099 (.004)	.074 (.014)	.074 (.003)	.082 (.004)	.150 (.062)	.182 (.015)	.217 (.015)
Replicates 2 & 3 July	.093 (.010)	.084 (.003)	.095 (.004)	.076 (.009)	.074 (.003)	.083 (.004)	.202 (.033)	.158 (.014)	.177 (.016)
Replicates 4 & 5 August	.100 (.009)	.090 (.004)	.100 (.004)	.081 (.008)	.083 (.004)	.090 (.004))	.206 (.033)	.139 (.014)	.166 (.014)
Replicates 6 & 7 September	.121 (.010)	.095 (.004)	.106 (.004)	.111 (.010)	.087 (.004)	.094 (.004)	.200 (.037)	.150 (.014)	.186 (.014)

The CPS variance estimator is discussed in Technical Paper 40 (U.S. Department of Commerce, Bureau of the Census 1978), and the RDD I variance estimator is based on the ultimate cluster technique (Stokes 1983). Normal distribution is used to determine the significance probabilities for the tests; these are shown in Table 3.

Table 3. Significance Probability of the Results of the Test of No Difference between the Unemployment Rate Measured in RDD I and CPS Households with Telephones

	Total Population	White Population	Nonwhite Population
All Replicates June-September	.02	.12	.06
All Replicates Except Rep. 6 June-September	.22	.76	.11
Replicate 1 June	.90	1.00	.65
Replicates 2 & 3 July	.39	.82	.22
Replicates 4 & 5 August	.32	.88	.07
Replicates 6 & 7 September	.02	.02	.22

The significance probabilities of the tests for all replicates combined are .02 for the entire population, .12 for the white population, and .06 for the nonwhite population. This leads to the conclusion that the estimates are different. However, the unemployment rate measured in Replicate 6 is unusually high, .135. Other indications that Replicate 6 was not routine include interviewer performance measures and monitoring scores which were somewhat out of line compared to the other replicates. When the data from Replicate 6 are removed, the significance probabilities of the tests increase to .22 for the total population, .76 for the white population, and .11 for the nonwhite population. The increased significance probabilities are not due to a loss in the power of the tests. Even assuming the same sample size, the significance probabilities increase almost as much.

Estimates of interviewer variance and simple response variance, which are not yet available, may give some insight as to why there was a relatively high unemployment rate observed in Replicate 6. The automated case management system interpenetrated the interviewers' assignments. Therefore, it is theoretically

possible to delete an interviewer's assignment without biasing the estimates. One possibility for correcting the data would be to delete the cases in assignments believed to be of inferior quality.

Even if the hypothesis tests do not appear to be detecting a significant difference in the estimates, there does seem to be a tendency for the RDD I unemployment rate estimates to be higher than the unemployment rate measured in the CPS households with telephones. Other researchers have observed a similar phenomenon. A comparison of a RDD health survey with the Health Interview Survey concluded that there was a tendency toward increased reporting of health events in the RDD survey (Cannell, Groves, et al 1982). However, the employment questions on the CPS questionnaire are very objective, and the RDD I questionnaire contained almost identical employment questions. The conjecture that a higher unemployment rate in RDD I was observed because of an increased tendency of the respondents to report being unemployed does not seem tenable. The CPS nonresponse adjustments are much more sophisticated than those currently available for a RDD survey. To assure that we are not merely comparing the quality of the nonresponse adjustments in each survey, the demographic characteristics of only the respondents were investigated.

The proportion of respondents in demographic categories are shown with their standard errors in Tables 4, 5, and 6 for RDD I, CPS households with telephones, CPS households without telephones, and all CPS households. Table 4 contains the proportion of the respondents in age, race, and gender categories. Table 5 displays the distribution of respondents aged 14 or over by marital status and by educational attainment. The proportion of the respondents aged 16 or over that are in the civilian labor force and the proportion of those in the civilian labor force who are unemployed are shown in Table 6.

Table 4. Proportion of Respondents in Demographic Categories and the Standard Errors

	RDD I	CPS with Telephones	CPS without Telephones	CPS
Age				
$0 \leq A \leq 15$	.248 (.006)	.235 (.003)	.335 (.008)	.242 (.002)
$16 \leq A \leq 24$	.154 (.005)	.153 (.002)	.223 (.007)	.159 (.002)
$25 \leq A \leq 34$	.176 (.005)	.162 (.002)	.188 (.006)	.164 (.002)
$35 \leq A \leq 44$	.134 (.004)	.123 (.002)	.083 (.004)	.120 (.001)
$45 \leq A \leq 64$	.189 (.006)	.208 (.002)	.102 (.007)	.201 (.002)
$65 \leq A$	.099 (.005)	.119 (.002)	.053 (.004)	.115 (.002)
Race				
White	.859 (.011)	.869 (.004)	.699 (.017)	.856 (.005)
Black	.099 (.009)	.102 (.004)	.258 (.016)	.113 (.004)
Other	.042 (.006)	.029 (.002)	.044 (.004)	.030 (.002)
Gender				
Male	.447 (.004)	.475 (.002)	.521 (.006)	.479 (.002)
Female	.523 (.004)	.525 (.002)	.497 (.006)	.521 (.002)

The respondents from the CPS households without telephones and the CPS households with telephones are very different. Those without telephones tend to be younger, are more likely to be male, and are more likely to be nonwhite than those with telephones. They also have less education and are less likely to be married. A lower proportion of the CPS respondents aged 16 or over without telephones is in the civilian labor force, and a higher proportion of the civilian labor force is unemployed.

To obtain an indication of how the differences in the demographic characteristics of the RDD I respondents and the CPS respondents with telephones occur, the hypothesis of no significant difference in the proportion of the respondents for each category was tested. These tests have the same form as those used for unemployment rate estimates.

Significance probabilities of the results of the tests of the hypothesis of no significant difference in the proportion for demographic categories are based on the normal distribution and are shown in Table 7. With a significance probability of .70, the surveys appear to be measuring a comparable proportion of males among the respondents. There are comparable proportions of whites and blacks, but a significance probability as low as .04 indicates that there is not a comparable proportion of

Table 5. Proportion of Respondents Aged 14 or over in Demographic Categories and the Standard Errors

	RDD I	CPS with Telephones	CPS without Telephones	CPS
Marital Status				
Married	.597 (.007)	.582 (.003)	.409 (.011)	.571 (.003)
Widowed, Divorced, or Separated	.143 (.007)	.155 (.002)	.239 (.009)	.161 (.002)
Never Married	.261 (.006)	.263 (.003)	.351 (.009)	.269 (.003)
Educational Attainment				
Elementary (0-8 yrs)	.100 (.005)	.141 (.003)	.281 (.011)	.150 (.003)
High School (9-12 yrs)	.546 (.008)	.541 (.003)	.591 (.012)	.545 (.003)
College (13-16 yrs)	.280 (.007)	.257 (.002)	.115 (.008)	.248 (.003)
Graduate School (18+ yrs)	.065 (.004)	.061 (.002)	.014 (.002)	.058 (.001)

Table 6. Proportion of Respondents Aged 16 or over in Civilian Labor Force, Proportion of Civilian Labor Force Unemployed, and the Standard

	RDD I	CPS with Telephones	CPS without Telephones	CPS
Civilian Labor Force	.674 (.007)	.661 (.003)	.618 (.011)	.658 (.003)
Unemployed	.102 (.005)	.091 (.002)	.024 (.011)	.099 (.002)
Employed	.898 (.005)	.909 (.002)	.758 (.011)	.901 (.002)

Table 7. Significance Probability of the Results of the Test of No Difference between the Proportions of Respondents in Demographic Categories in the RDD I and CPS Households with Telephones

Age	Significance Probability
$0 \leq A \leq 15$	.03
$16 \leq A \leq 24$	.83
$25 \leq A \leq 34$	.01
$35 \leq A \leq 44$	.01
$45 \leq A \leq 64$	.00
$65 \leq A$	.00
Race	
White	.37
Black	.80
Other	.04
Gender	
Male	.70
Female	.70
Marital Status	
Married	.08
Widow, Divorced, Separated	.00
Never Married	.75
Educational Attainment	
Elementary	.00
High School	.62
College	.00
Graduate School	.36
Labor Force	
Civilian Labor Force	.06
Employed	.04
Unemployed	.04

other races. These differences could be caused by classification errors. However, the proportions of whites and nonwhites are comparable. With the exception of the age category 16 to 24, all age categories have different proportions. The significance probability for the age category 16 to 24 is .83, while the highest significance probability for the others is .03.

The two surveys have a comparable proportion of persons who have never married among their respondents aged 14 or over. However, the proportion of those who are widowed, divorced, or separated is higher among the CPS respondents aged 14 or over in households with telephones. A significance probability of .08 implies that it is questionable that the surveys have the same proportion of respondents aged 14 or over who are married. Since the proportion never married appears definitely to be comparable and the proportion widowed, divorced, or separated appears to be definitely different, the proportion married is probably different also.

Educational attainment, which is an indicator of income, was examined because the different format of the income questions made them difficult to compare. A smaller proportion of the RDD I respondents aged 14 or over completed at most the eighth grade as compared to the CPS respondents with telephones. In addition, a greater proportion of the RDD I respondents aged 14 or over completed between one and four years of college as their highest level of educational attainment. However, the proportion of respondents aged 14 or over who completed at least one year of graduate school and the proportion who completed between one and four years of high school are comparable for the two surveys.

With a significance probability of .06, the proportion of the respondents aged 16 or over who are in the civilian labor force appears to be larger for RDD I than for CPS respondents with telephones. Also, a significance probability of .04 implies the unemployment rate among respondents in the civilian labor force is larger for RDD I than for CPS respondents with telephones.

Most of the difference in the labor force data appears to be explained by the difference in the age distribution of RDD I respondents and CPS respondents with telephones. The proportion of the respondents aged 65 or over is smaller in RDD I than it is in CPS households with telephones. Therefore, a potentially smaller proportion of respondents in RDD I are retired; this implies that a larger percentage of those aged 16 or over are in the civilian labor force.

Although not available, a cross tabulation of respondents by age and employment status would resolve the conjecture that much of the differential bias can be attributed to the difference betwen the age distribution of respondents in RDD I and in CPS respondents with telephones. However, data from CPS during the months of June through September are available from Employment and Earning published by the U.S. Department of Labor. Table 8 displays the average proportion of the population aged 16 or over in each age category in the civilian labor force and the average proportion of the civilian labor force in the age category who are unemployed. These estimates include nonresponse adjustments and are based on telephone and nontelephone households plus interviews other than first-time interviews.

Assuming the proportions shown in Table 8 apply for the population with telephones in their houses or apartments, the effect of the difference in the age distribution for RDD I respondents and CPS respondents with telephones has on the estimated rate of civilian labor force participation can be illustrated.

An estimate of the proportion of the respondents aged 16 or over in the civilian labor force can be obtained as follows:

$$\hat{P}_{CLF} = \sum_{i=1}^{5} \hat{P}_i \hat{P}'_i$$

where

$\hat{P}_i$ = estimated proportion of the respondents aged 16 or over in age category i and

P'_i = proportion of the population in age category i in the civilian labor force.

After this computation, $\hat{P}_{CLF}$ equal .640 for CPS respondents with telephones and .657 for RDD I respondents. The difference in these estimates of the proportion of respondents aged 16 or over in the civilian labor force is .017. The difference in the proportions calculated directly from the data is .013. These calculations demonstrate that the difference in the age distribution observed for the RDD I respondents and CPS respondents with telephones may explain most of the difference in the estimated rate of participation in the civilian labor force.

A possible explanation for the higher unemployment rate among respondents in the civilian labor force observed in RDD I as opposed to CPS respondents is the fact that a larger proportion of the respondents between the ages of 16 and 64 are in the 25-to-34 age category. There is also a higher proportion of respondents in the 35-to-44 age category for RDD I than for CPS respondents with telephones.

During the summer of 1982, there were many layoffs, and workers with the least seniority were always the first to be laid off. The worker in the 25-to-34 age group would be among those with the least seniority and the most likely to be unemployed.

An analysis using the data in Table 8 similar to that done for the civilian labor force is not possible for respondents who are unemployed because age distributions for the civilian labor force are not available from RDD I and CPS. However, the data shown in Table 8 demonstrate that the younger age groups did, if fact, have substantially higher unemployment rates during June through September.

Table 8. Average Proportion of the Population in Each Age Category in the Civilian Labor Force and the Average Proportion of the Civilian Labor Force Unemployed for the Months June through September 1982*

Age	CLF	Unemployed
$16 \leq A \leq 24$	.714	.174
$25 \leq A \leq 34$	.807	.097
$35 \leq A \leq 44$	.808	.065
$45 \leq A \leq 64$	.651	.051
$65 \leq A$	.120	.031

*U.S. Department of Labor, Employment and Earnings, Table A-3, June, July, August, September, 1982.

Adjusting the age distribution of the respondents in a random digit dialing survey like RDD I to match the distribution simultaneously measured for CPS respondents with telephones may alleviate the differential bias observed. Under other economic conditions, race and gender may appear more important in labor force estimates. Therefore, adjustments based on these demographic characteristics should also be considered in future studies of this nature.

There are other potential sources of differential bias that have not been explored. For example, the component of the differential bias arising solely from the difference in the interviewing mode -- namely, the effect of interviewing in person vs interviewing by telephone -- has not been isolated. Therefore, further research is required before the complete nature of the differential bias in estimates from a random digit dialing survey and a personal interview survey can be described conclusively.

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