

WEIGHTING ADJUSTMENTS FOR PARTIAL NONRESPONSE IN THE 1984 SIPP PANEL

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1. INTRODUCTION

The Survey of Income and Program Participation (SIPP) is an ongoing nationally representative household survey program of the U.S. Bureau of the Census that provides comprehensive information on the economic resources of the American people and on how public transfer and tax programs affect their financial circumstances. The SIPP is a panel survey in which sample members are interviewed every four months for a period of 32 months. A new SIPP panel is introduced each year. Nelson, McMillen and Kasprzyk (1985) provide an overview of the SIPP program.

As with any panel survey, a concern with the SIPP is the increasing levels of missing data as the panel ages. Missing data in a panel survey can be classified into three types: total nonresponse occurs when a sampled unit is a nonrespondent on every wave of the survey; partial nonresponse occurs when the unit is a respondent on some but not all waves for which it is eligible; and item nonresponse occurs when a unit responds on a wave but fails to provide acceptable answers for one or more of the survey items. This paper is concerned with the patterns of partial nonresponse in the 1984 SIPP Panel, with the characteristics of the partial nonrespondents, and with methods of making weighting adjustments to compensate for the partial nonresponse.

There were nine waves of data collection in the 1984 SIPP Panel, that is, there were nine different questionnaires. Each questionnaire contained the same set of 'core' items covering labor force participation, earnings from jobs, receipt of income and program benefits, and demographic data. In addition the questionnaires contained topical modules that changed from wave to wave. One half of the 1984 Panel was assigned to be interviewed for all nine waves, and the other half was assigned to be interviewed for only eight waves (one quarter of the Panel was not assigned to be interviewed in wave 2 and one quarter was not assigned to be interviewed in wave 8). A subset of the 'core' data collected in the 1984 Panel has been merged together into a research file that can be used for longitudinal analysis.

The 1984 Panel Research File provides a set of monthly measures covering 32 months corresponding to eight interviews (discarding data collected at the ninth wave for sample members scheduled for interview on all nine waves). It contains every person ever in the sample who was interviewed on at least one occasion. It thus includes both original sample persons identified as members of sampled households at the time of first interview (100 level persons, in the SIPP jargon) and persons entering the sample after the first interview because they resided with one or more original sample persons (200+ level persons). The file was created by merging cross-sectionally processed wave files and subjecting the merged data to a limited set of edits designed to check the consistency of selected information collected in the eight interviews. The 1984 Panel Research File is a research product of the Census Bureau. Although the procedures used to construct the file have not yet been fully evaluated, the file has been released to the public to allow exploratory analyses and evaluation of the data.

The analyses reported in this paper all relate to the 1984 Panel Research File. They are confined to original sample persons (i.e., 100 level persons) aged 15 and over at the start of the panel. Persons entering the sample after the first interview and sample persons dropped from the panel during waves 5 and 6 because of budget constraints are excluded.

The next section of the paper examines the patterns of response/nonresponse across the eight interviews, and compares the characteristics of complete respondents with those of partial respondents. These comparisons are made by examining the distributions of each characteristic individually for complete and partial respondents, and by developing logistic regression and SEARCH models to predict complete or partial response status from a set of characteristics taken in combination. Section 3 of the paper employs these prediction models for developing weights to adjust for partial nonresponse in the 1984 Panel Research File. The two sets of weights derived from these models are then compared with the panel weights provided on the Panel Research File to determine how similar the three sets of weights are, and how effectively each set compensates for the partial nonresponse. The final section of the paper gives some concluding remarks.

2. PARTIAL NONRESPONSE IN THE 1984 SIPP PANEL

The examination of partial response in a panel survey involves a number of complications. In the first place, a distinction needs to be drawn between nonresponse at a given interview and having left the survey universe. The SIPP universe was defined to comprise the noninstitutional population of the United States. Sample members who subsequently die thus leave the SIPP universe. Similarly, sample members who enter an institution, move abroad, or move into Armed Forces accommodation leave the SIPP universe; such persons may, however, return to the survey universe again at a later point during the panel. Persons who leave the survey universe are not nonrespondents when they are not members of that universe.

A second complication is that, when an interview is not obtained, it is not always known whether the person is a nonrespondent or has left the universe. This is occasionally the case with one-person households whose status, whether moving away or into an institution, cannot be determined after the first interview. In Table 1, which summarizes the person response/nonresponse patterns for the 1984 SIPP Panel, some of those persons classified as nonrespondents (0) may in fact have left the SIPP universe, thus slightly inflating the true nonresponse rate.

Table 1 divides the SIPP sample into three broad categories: panel members, non-panel members and total nonrespondents. Panel members are original sample persons who responded for all interviews for which they were eligible (i.e., for which they were in the SIPP universe). Eligibility for interview is an important consideration, because original sample persons who responded in every wave prior to institutionalization, moving abroad, or moving into Armed Forces barracks are complete respondents who should be included in the category of panel members. This category also includes sample members who did not miss an interview prior to dying during the panel. Furthermore, it also includes individuals who did not miss any interviews prior to leaving and after rejoining the survey universe.

Table 1: Person Response (1)/Nonresponse (0) Patterns for the Eight Interviews in the 1984 SIPP Panel Research File

	%
PANEL MEMBERS	
Responded to all 8 interviews	67.0
Responded to all interviews prior to death	1.5
Responded to all interviews except when:	
in an institution	0.7
in the Armed Forces	0.4
abroad	0.6
Other panel members	<u>0.2</u>
	70.4
NON-PANEL MEMBERS	
Attrition nonresponse patterns:	
11111110	1.4
11111100	1.2
11111000	1.5
11110000	2.0
11100000	2.2
11000000	2.6
10000000	<u>3.1</u>
	14.0
Other patterns with only one missing interview	4.3
Other patterns with two or more missing interviews	2.9
Non-panel members with missing interviews who were known to have died, become institutionalized, entered the Armed Forces, or moved abroad	0.3
Non-panel members with missing interviews who left for other reasons	3.3
TOTAL NONRESPONDENTS*	4.9
	<u>100.0</u>
Total number of sample persons	35,027

*Estimated. See text.

Non-panel members are original sample persons who failed to respond to one or more interviews when they were eligible. Total nonrespondents failed to respond to any of the eight interviews. It should be noted that the number of total nonrespondents is not known; all that is available is the number of total nonresponding households, from which the number of persons has been crudely estimated by multiplying the average number of sample persons in responding households by the number of nonresponding households.

Table 1 shows that all eight interviews were obtained for about two-thirds of the original sample persons. Overall, data were obtained for all eligible interviews for about 70% of original sample persons: these are the panel members in Table 1. The majority of the non-panel members were attritors, that is, sample persons who responded for a certain number of interviews, then became nonrespondents, and remained nonrespondents for the rest of the panel. The losses from attrition were heaviest at the second interview (3.1%) and declined thereafter.

An appreciable percentage of non-panel members, 5.7%, provided responses for seven out of the eight interviews; this includes the attrition pattern of seven responses followed by a nonresponse for the eighth interview. The procedure adopted for the 1984 SIPP Research File to handle such cases in a longitudinal analysis of the full panel is to drop them from the analysis, and make a weighting adjustment for them. An alternative strategy might be to impute responses for the missing interview (Kalton, 1986; Lepkowski, 1989). Given that data are available for both prior and subsequent interviews in 4.3% and for the prior interview in the remaining 1.4% of these cases, it may be possible to develop an effective imputation procedure for them.

When panel analysis is restricted to those who provide data for all interviews for which they are eligible (i.e., the panel members), then weighting adjustments are needed to compensate for all other sample members (i.e., the non-panel members and the total nonrespondents). Since little is known about the total nonrespondents, weighting adjustments for them can be developed using the standard approaches employed for cross-sectional surveys. In contrast, a great deal is known about the non-panel members from the responses they gave in the one or more interviews in which they did participate. These responses are available for use in making weighting adjustments for them.

In the 1984 SIPP Panel, households that failed to respond at the first interview were not assigned for interview on subsequent waves. Thus, all nonrespondents at the first interview are total nonrespondents, and all non-panel members provided responses for the first interview. A simple approach to making weighting adjustments for the non-panel members is to base the adjustments only on the first interview responses, ignoring any other responses they may have provided. As an initial step in developing weighting adjustments based on the first interview responses, it is helpful to compare panel members and non-panel members in terms of their responses at the first interview. Variables that exhibit differences in distributions between panel and non-panel members are then candidates for inclusion in a weighting adjustment scheme.

Table 2 presents a comparison of panel and non-panel members for a range of characteristics collected at the first interview. The characteristics chosen are those that exhibit some of the larger differences between the two groups. Non-panel members are somewhat more likely to be male, Black, children (aged 15 or older) of reference persons, younger, never married, living in rental units that are not in a public housing project, living in the central city of an MSA, and without interest earnings.

Two forms of analysis have been conducted to extend the bivariate analyses of Table 2 into analyses in which panel membership is predicted by a combination of several characteristics. One used a binary splitting algorithm, SEARCH, to create a set of groups of persons that has as great a variation as possible in panel membership. Using an indicator of 1 for panel member and 0 for non-panel member as the dependent variable, the SEARCH analyses employed 20 characteristics which were considered to be possibly related to panel membership. The SEARCH analyses were conducted using cross-sectional weights for the first interview that incorporated adjustments for total nonresponse and adjustments to population controls. Two SEARCH analyses were performed. They differed only in the criterion of the minimum percentage of variance in the dependent variable explained by a split before it was accepted. One analysis set this criterion at 0.1% and the other at 0.05%.

Table 2: Comparison of Distributions on Selected First Interview Characteristics for Panel and Non-Panel Members

Characteristic	Panel %	Non-Panel %
Male	46.2	49.1
Black	9.5	13.6
White	88.0	83.1
Relationship to reference person:		
Reference person	36.1	32.6
Spouse of reference person	29.9	25.1
Child of reference person	15.4	20.8
Age 15-29	30.8	39.9
Age 30-44	26.8	26.1
Age 45-64	25.8	24.2
Married, spouse present	60.5	52.0
Widowed	7.9	5.1
Never married	22.7	31.1
House owned or being bought	72.0	64.3
Rental unit not in a public housing project	23.6	31.9
Central city of an MSA	32.1	39.5
MSA not central city	41.2	41.0
Household income:		
Under \$1000	22.5	24.5
\$1000 - \$5000 and over	69.4	67.0
\$5000 and over	8.1	8.5
With interest earnings	66.1	57.2
Recipient of food stamps	5.8	5.8
Number of respondents	24,662	8,657

The eight groups formed by the SEARCH analysis using the 0.1% variance explained criterion are shown in Table 3. The percentage of panel members in each group can be seen to vary between a low of 56.2% and a high of 79.5%. The group with the lowest percentage comprised persons under 45 who are an other relative or non-relative of the household reference person and who are married with spouse absent, separated, divorced, or never married. The group with the highest percentage comprised persons who are homeowners or live in public housing, married with spouse present or widowed, and who do not live in the central city of an MSA.

The second SEARCH analysis that used the less stringent 0.05% variance explained criterion produced 19 groups. The additional predictor variables giving rise to splits in this analysis were sex, race, and reciprocity of Social Security income.

The second form of analyses employed a logistic regression model to predict panel membership. The panel membership indicator was regressed on the same characteristics used as predictors in the SEARCH analysis. Again, the analyses were weighted by the first interview cross-sectional weights. Variables whose effects were not significantly different from zero at the 5% level were dropped from the model. The important variables for predicting panel membership in the logistic regression are age, race, sex, marital status, living in an urban area, living in nonpublic rental accommodation, income, earning interest, and receiving food stamps. The estimated model coefficients for the final model are as follows:

$$\text{Ln} \left[\frac{\text{Pr}(\text{Member})}{1 - \text{Pr}(\text{Member})} \right] = 0.8954$$

- 0.0996 (MALE)
- + 0.1698 (WHITE)
- 0.0485 (BLACK)
- 0.3950 (AGE 15-44)
- 0.3131 (AGE 45-64)
- + 0.3155 (WIDOW)
- + 0.0366 (NONPUBLIC RENTAL)
- 0.4033 (CENTRAL CITY)
- 0.2533 (MSA, NOT CENTRAL CITY)
- + 0.1841 (HOUSEHOLD INCOME < \$5,000)
- + 0.3029 (INTEREST EARNED)
- + 0.2878 (FOOD STAMPS)

The SEARCH and logistic regression analyses employed broadly similar sets of characteristics to predict panel membership. Some differences are to be expected in view of the different underlying models. The SEARCH analysis identifies groups that in a linear model can only be represented by complex interaction terms. The logistic regression model employed allowed only for main effects, not interaction terms, in developing the panel membership prediction equation.

3. WEIGHTING ADJUSTMENTS FOR NON-PANEL MEMBERS

The panel weights in the 1984 Panel Research File have two components (Singh and Petroni, 1988): a first level of adjustment to compensate for total nonresponse and a second level of adjustment intended to account for panel nonresponse. Singh and Petroni identify the following variables as used in the second level:

- (a) An average monthly household income (<\$1,200; \$1,200-\$3,999; and \$4,000 or more)
- (b) Employment status (self-employed, other)
- (c) Type of income (welfare, unemployment compensation, other)
- (d) Asset ownership (bonds, other)
- (e) Completed education (<12 years, 12 years, 12-15 years, 16 or more years)
- (f) Race and origin (white and not Spanish, other)
- (g) Labor force status (in labor force, not in labor force).

These variables are used to create cells for reweighting. Cells with less than 30 cases and cells where the adjustment factor is greater than 2 are collapsed with adjacent cells.

The SEARCH and logistic regression analyses described in the previous section can be used to develop two alternative weighting adjustments to compensate for non-panel members. In the case of the SEARCH analyses, the weights to adjust for non-panel members can simply be taken as the inverses of the proportions of panel members in each of the groups created by the analysis.

Table 3: Summary of SEARCH Analysis to Predict Panel Membership

Characteristics	Group	%	Sample Size
Married with spouse absent, separated, never married, or divorced			
Age under 45			
Reference person or child of ref. person			
Resident of an MSA			
With interest earnings	1	68.9	3,307
Without interest earnings	2	61.7	3,260
Not a resident of an MSA	3	73.5	1,746
Other relative or nonrelative	4	56.2	1,275
Age 45 and over	5	76.0	1,894
Married with spouse present or widowed			
Home owner or public housing			
Resident of central city of an MSA	6	75.1	4,812
Resident of an MSA but not in central city or not a resident of an MSA	7	79.5	12,591
Renter, but not public housing	8	71.7	4,434

The final weight for a panel member is then the product of the member's first level adjustment factor and the inverse of the weighted proportion of panel members in the group in which the member falls. In the subsequent discussion, the SEARCH weights are based on the first SEARCH analysis, i.e., the analysis summarized in Table 3.

In the case of the logistic regression, the weight assigned to a particular panel member may be taken as the inverse of the predicted probability of panel membership from the logistic regression. The final weight for a panel member is the product of the first level adjustment factor and the inverse of the predicted probability of panel membership.

The SEARCH and logistic regression weighting procedures fail to mirror the panel weighting procedure in one respect. The first level adjustment factor used for the SEARCH and logistic regression procedures includes a poststratification or population control adjustment computed at the last step of adjustment. However, this poststratification adjustment is not included in the first level adjustment factor when constructing the panel weight. We did not have access to the poststratification factor, and hence could not remove it from the first level adjustment factor before running the SEARCH and logistic regression analyses. Hence, the SEARCH and logistic regression weights are not strictly comparable with the panel weights. We believe, however, that this difference will not substantially affect the comparisons presented below.

One way to compare the three weighting procedures is to examine how highly correlated they are with each other. Table 4 presents the simple correlations between the three sets of weights and the correlation of the SEARCH and logistic regression weights with the cross-sectional weights (i.e., the weights for the first level adjustment). Not surprisingly, given the way they were created, the SEARCH and logistic regression weights are highly correlated with each other, and also with the cross-sectional weights. The correlations of the SEARCH and logistic regression weights with the panel weights are not so high, indicating that the panel weights are somewhat different from the other two sets of weights.

Table 4: Correlations Between Panel, SEARCH, Logistic Regression and Cross-Sectional Weights

Weight	Panel	SEARCH	Logistic
SEARCH	0.70		
Logistic	0.72	0.96	
Cross-sectional		0.93	0.93

Another way to compare the three weighting procedures is to compare survey estimates produced with each set of weights. In general, such comparisons will show only whether the estimates are similar or not; if they are dissimilar, there is no means of knowing which weighting procedure is to be preferred. However, in the present situation, there is a benchmark for comparison for some estimates. If a weighting adjustment for non-panel members is effective, a weighted analysis of first interview variables for panel members should produce very similar estimates to those produced by a cross-sectional analysis of panel and non-panel members weighted by the cross-sectional weights.

A preliminary set of analyses of this type is given in Table 5. The table presents weighted distributions of characteristics at the first interview using the panel members only weighted by the three different panel weighting procedures, and using both panel and non-panel members weighted by the cross-sectional weights. If a characteristic is employed in the non-panel member adjustment process, the weighted distribution for panel members for that characteristic should conform closely to the cross-sectional distribution. Similarly, if the same characteristic is employed in alternative weighting adjustment procedures, the distribution of that characteristic should be similar for those procedures.

For these reasons, it is not surprising that the distributions of many of the characteristics in Table 5 are very similar to one another. Even for other characteristics, the distributions in Table 5 closely resemble one another. From these analyses, it does not appear that the inclusion of sets of variables in the SEARCH and logistic regression procedures that were not used in forming panel weighting classes has an appreciable effect on the survey estimates.

**Table 5: Comparison of Distributions on Selected
First Interview Characteristics Under Four Weighting Schemes**

Characteristic	Estimate (%)			
	Cross-Section Weight	Panel Weight	SEARCH Weight	Logistic Weight
<u>Sex</u>				
Male	47.7	47.7	46.9	47.6
<u>Race</u>				
White	86.3	86.2	87.1	86.4
Black	10.9	11.1	10.3	10.9
<u>Relationship to Reference Person (RP)</u>				
RP with other relatives	34.6	34.9	34.5	34.9
RP living alone	13.0	12.8	13.5	13.4
Spouse of RP	28.1	28.6	28.0	28.0
Child of RP	17.2	17.5	17.2	17.4
<u>Age</u>				
15-19	10.3	10.6	10.7	10.6
20-24	11.7	11.5	11.4	11.2
25-29	11.6	11.6	11.5	11.5
30-34	10.6	10.6	10.7	10.8
35-39	9.1	9.0	9.1	9.2
40-44	7.4	7.4	7.3	7.4
45-49	6.2	6.3	5.9	6.0
50-54	6.1	6.1	6.2	6.1
55-59	6.4	6.3	5.9	6.4
60-64	5.9	5.9	5.3	6.1
<u>Marital status</u>				
Married, spouse present	57.2	58.0	56.8	57.2
Widowed	7.2	7.2	7.6	7.2
Divorced	6.9	6.6	6.9	6.9
Never married	25.7	25.4	26.0	25.8
<u>Family type</u>				
Primary family	81.6	82.5	81.5	81.9
Other relative of RP	13.0	12.8	13.5	13.4
<u>Highest grade attended</u>				
0-11	27.3	27.7	27.7	27.5
12	36.0	36.3	35.7	35.8
1-3 years beyond high school	28.7	28.2	28.4	28.5
4+ years beyond high school	8.0	7.8	8.2	8.3
<u>Tenure, month 1</u>				
Owned or being bought	69.6	70.7	70.1	70.8
Rented for cash	28.0	26.9	27.5	26.8
<u>Not a resident in a public housing project</u>				
	26.1	24.8	25.5	24.7
<u>MSA status</u>				
Central city of an MSA	35.1	34.1	34.6	35.1
In an MSA/PSA not central	40.4	40.3	40.3	40.4
<u>Total person earnings</u>				
Zero or less	44.4	43.7	44.9	44.3
1-499	10.1	10.8	10.5	10.4
500-999	12.8	13.0	12.4	12.5
1000-1499	12.2	12.3	12.0	12.1
1500-1999	7.9	7.8	7.8	8.0
2000-2499	5.3	5.3	5.3	5.4

It should, however, be noted that these analyses are only preliminary. Further work is needed to examine the effects of these alternative weighting procedures on analyses of subclasses of the sample and on analyses of characteristics relating to later interviews.

A final consideration in comparing weighting procedures is to consider the distribution of weights that they produce. The more variable the weights are, the greater the loss of precision they cause in the survey estimates. Table 6 presents the distribution of weights for the three different weighting procedures. As can be seen from the table, the SEARCH and logistic regression weights have similar distributions. The panel weights are, however, slightly more variable, with a greater number of large weights. An index that provides a rough measure of the increase in variance of sample means and proportions caused by the variability in weights is $I = n\sum w_i^2 / (\sum w_i)^2$ (Kish, 1965, Section 11.7C). The value of this index for the three procedures is $I = 1.08$ for both the SEARCH and logistic regression weights and $I = 1.11$ for the panel weights. Thus, the SEARCH and logistic regression weights give rise to an 8% increase in variance while the panel weights give rise to an 11% increase.

Table 6: Distribution of Three Panel Nonresponse Adjusted Weights

Weight	Panel	SEARCH	Logistic
Under 5	4.5	5.7	6.8
5 -	88.2	89.8	88.5
10 -	5.7	3.8	3.9
15 -	1.2	0.5	0.6
20 and over	0.5	0.2	0.2
Total	100.0	100.0	100.0

Number of panel members: 24,662

4. CONCLUDING REMARKS

In conducting a longitudinal analysis from a panel survey like the SIPP, care needs to be taken to define the population of inference, the reference period for the analysis, and the set of sample cases that will provide the requisite data. Three reference periods are of particular interest for longitudinal analyses of a SIPP panel: the full duration of the panel and each of the two calendar years spanned by the panel. The current investigation has been concerned only with the full, 32 month, duration of the 1984 SIPP Panel. Although not studied here, the 1984 Panel Research File contains weights for each of the 1984 and 1985 calendar years as well as the panel weights for the 32 month reference period.

The aim of this study was to investigate weighting schemes that are alternatives to the panel weights currently being used for longitudinal analyses of the full duration of the 1984 SIPP Panel. The first part in the development of the alternative weighting schemes was to construct models that predicted panel membership. These models selected characteristics measured at the first interview that were good predictors of panel membership. As a result of this model construction, characteristics not included in the current panel weights were introduced in the alternative weighting schemes. The analyses conducted to date do not, however, show that the alternative weighting schemes are more effective in compensating for non-panel members than the current scheme.

The preliminary nature of this finding should be emphasized, and two factors in particular should be noted. First, the alternative weighting schemes were not developed as thoroughly in this exercise as they would be if they were to be implemented in practice. As indicated earlier, one aspect of this was the fact that, because the population control adjustment could not be readily identified separately, it was not removed from the cross-sectional weights before forming the alternative weighting adjustments for the non-panel members. Another aspect relates to the SEARCH analysis. For this exercise, the eight group SEARCH analysis reported in Table 3 was used as the basis of the non-panel member weighting adjustment. However, a SEARCH analysis that incorporated more variables, and hence created more groups, would probably be more effective in compensating for the non-panel members. Secondly, only a preliminary assessment of the three weighting schemes has been conducted at this time. Comparisons of subclass estimates and estimates for later interviews under the different weighting schemes are needed before a firmer conclusion can be reached.

The weighting schemes investigated here drop all the partial respondents from a longitudinal analysis of the panel, and compensate for them by weighting adjustments. This procedure discards data from as many as seven interviews for a sample person. An alternative approach would be to impute for the missing responses for some partial respondents, thus retaining their actual responses to the interviews in which they did participate. Effective, consistent, imputation for missing interviews in a panel is difficult, but in many cases the responses given in adjacent waves may serve as powerful predictors of the missing responses. Further investigation of this imputation approach for cases where only one or two of the eight interviews are missing appears warranted.

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