SELECTED FIRST-INTERVIEW EFFECTS IN THE CONSUMER EXPENDITURE INTERVIEW SURVEY

Adriana R. Silberstein, U.S. Bureau of Labor Statistics

1. INTRODUCTION

The first interview is a critical element of panel survey methodology. Baseline information is gathered for the first time, to be "updated" during subsequent interviews. The sample is at its initial state prior to changes due to attrition and the birth/death process. Panel conditioning is not present. The quality of this initial contact with the respondent influences the reporting of subsequent interviews, so that research on the first interview is important even when these data are not used in the main estimation process.

The Consumer Expenditure Interview Survey (CE) is a panel survey of household expenditures comprising five "waves" of interviews with three month recall. The first wave is used to establish cooperation, to collect initial inventory data on household possessions and to bound the second wave. First-wave data are unbounded and subject to external telescoping, and, for this reason, are not used in the estimates. These data, on the other hand, have only a one month recall and are not affected by panel conditioning.

This paper analyzes the comparability of first-wave data to the rest of the survey and presents estimates of external telescoping. The implications of these results for shortening the recall period of certain expenditures are explored. The reporting of apparel expenses is used as the basis of comparison; this commodity group includes expenditures of various degrees of saliency and is collected by month of expenditure. Estimates of apparel and other frequently purchased items are known to be affected by underreporting as a result of recall length bias and other types of omissions. These response errors in the Interview Survey have been analyzed in two statistical studies (Silberstein & Jacobs, 1986, and Silberstein,1987). Another study has concentrated on cognitive issues of the reporting of expenditures (Lessler,1988).

Since this is the first study dealing with first-wave respondents in the CE, the paper includes information on panel response starting from the first wave. Section 2 summarizes the response experience of a complete sample and for the year 1984. Section 3 presents the analysis of apparel data, also from the 1984 survey; this section includes a comparative analysis by wave, estimates of telescoping effects in the first wave, and an initial look at the effect of unbounded interviews within the panel. Conclusions can be found in section 4.

2. PANEL RESPONSE

2.1 Background

Concerns over nonresponse are universal in survey design and administration. Bailar (1986) cites specific examples of demographic groups that historically tend to have higher nonresponse. Issues specific to panel surveys deal with attrition and the potential "aging" of the sample (Duncan et al.,1984), or the changing composition of the sample as a result of differential nonresponse through time (Williams & Mellows, 1970). Other issues surround the methodology of computing nonresponse rates, e.g., whether weighted or nonweighted (Platek & Gray, 1986), and the nonresponse adjustment process. Patterns of nonresponse and the effect of missing waves are investigated in panel surveys. (See: Kasprzyk & Mcmillen, 1986, Kalton et.al, 1986, and Huggings, 1987 for the Survey of Income and Program Participation (SIPP); Biderman & Cantor, 1984 for the National Crime Survey (NCS).)

Nonresponse rates are known to vary greatly: between 4% and 25% for the 25-30 demographic surveys conducted by the Census Bureau (Chapman et al.,1986). The Interview Survey, conducted by the Census Bureau for the Bureau of Labor Statistics, has averaged a 15% nonresponse rate for the interviews used in the estimates. Nonresponse adjustment is done on a monthly basis with the use of weight adjustments by geographic and demographic characteristics of the sample within each of the four rotations.

The reporting unit is the "consumer unit" (CU) which includes household members that are either related and/or pool their income to make joint expenditure decisions. Separate CU's may become panel respondents at a given address, taking on the selection probability and weight of the sampled address. "In-scope", or eligible, are units that respond ("interviews") and units that refuse or cannot be contacted at the time of the survey ("Type A noninterviews"). New CU's may become eligible after the first wave, as a result of three possible changes: 1) a vacant dwelling becomes occupied, or a dwelling under construction becomes ready and occupied, 2) additional consumer units become part of a sampled household, or 3) a mover is replaced by a new owner or tenant. Dwellings that are either vacant or under construction are part of "Type B noninterviews", whereas movers out of the selected addresses are part of "Type C noninterviews"; both type B and C noninterviews are not in-scope.

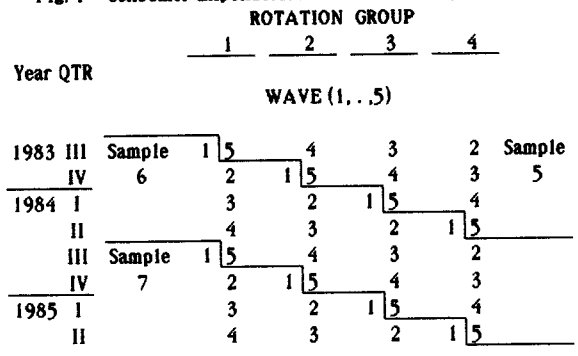
Nonresponse rates are defined as the percent ratio of Type A noninterviews over the CU's in-scope at a given time. Contacts are made at each wave of interview regardless of the interview status of the previous wave. Movers are not followed at new addresses, and units with usual residence elsewhere are not interviewed.

2.2 Sample 6 Response

The sample design has four rotations which stagger the survey initiation throughout the year; new panels initiated for all four rotations constitute a "sample". Figure 1 illustrates how portions of three samples contribute to the annual expenditure estimates, samples 5 to 7 in 1984. The first wave of new panels is overlapping the fifth wave of old panels.

Table 1 shows the number of units in scope and

Fig. 1 - Consumer Expenditure Interview Survey Design



the nonresponse at each wave of sample 6. These nonresponse rates are considered longitudinal since they pertain to the same units throughout their participation in the panel. Of the 5396 cases initially in-scope (col.2), 4210 cases (78%) were still in-scope at the fifth wave and 1186 cases (22%) had left the sample. Nonresponse rates were 10% for the first wave and between 15% and 17% in the other waves (col.2). A net attrition of 5% between the first and second wave was the result of 7.4% new nonrespondents in the second wave and 2.5% nonrespondents in the first wave that responded in the second wave. About 5% of the CU's refused in all five waves.

New CU's become eligible during the course of the panel; at the second wave, for instance, 448 units became part of the panel and about 90% of them responded (col.3). These CU's had lower nonresponse rates then the rest of the wave they joined, and this had a positive effect on the overall rates by wave (col.1); these reporters also experienced attrition as they progressed in the interviewing cycle.

Response patterns are the combinations of the response status in each of the five waves and this results in a great number of possible patterns. Only the major types for respondents in the first wave are shown in Table 2: 64% of sample 6 respondents reported in each wave, 7% were attrition cases (patterns 2 to 5), and 6% had other combinations of response and nonresponse in the five waves (patterns 6 to 9). CU's that only participated in the first wave were 11.5% of first wave respondents; this included CU's that refused (pattern 5) or moved out after the first wave (part of pattern 10).

2.3 1984 Response

The CE estimates are derived on a cross-sectional basis by using only the expenses reported for a given calendar (or expenditure) year. Some of these expenses are reported during interviews conducted in the first quarter of the following year. Nonresponse rates computed for an expenditure year are the official rates and are more relevant when weighted. Weights adjust for unequal sampling ratios and attribute different importance to the interviewing months according to the number of months contributed to the estimates.

The overall nonresponse rate for 1984 was 15% for waves 2 to 5 combined. Rates by wave were: 11.2% for CU's in the first wave, 15.3% in wave 2, 15.6% in wave 3, 16.5% in wave 4, and 14.5% in

TABLE 1 - NONRESPONSE RATES FOR SAMPLE 6

(URBAN CU's)

WAVE	All Sample In-Scope at Given Wave	Sample In-Scope at First Wave	Sample In-Scope After First Wave Joined Panel at Wave: 2	3	4	5
	SAMPLE CASES					
1	5396	5396				
2	5402	4954	448			
3	5431	4637	365	429		
4	5463	4394	309	349	411	
5	5424	4210	219	275	308	412
	NONRESPONSE RATES (Unweighted)					
1	10.0	10.0				
2	14.7	15.1	10.5			
3	15.6	16.1	13.7	11.0		
4	16.2	17.1	14.6	14.6	8.5	
5	15.0	16.3	16.4	9.8	11.0	7.8

TABLE 2 - RESPONSE PATTERNS FOR SAMPLE 6

Percent of first-wave respondents

(URBAN CU's)

PATTERN	Number of Respondents:	4859
		100.0
1	XXXXX	64.4
2	XXXX0	1.3
3	XXX00	1.0
4	XX000	1.3
5	X0000	3.6
6	X0XXX	1.5
7	XX0XX	1.0
8	XXX0X	1.0
9	Other response/nonresponse	2.2
10	OTHER (a)	22.7

X Indicates response. 0 Indicates nonresponse.

(a) Combinations of response/nonresponse and movers out of the panel during waves 2 to 5.

wave 5. These rates are very similar to the nonweighted longitudinal rates shown in Table 1, as levels remain approximately the same from one sample to the next.

The distribution of original and new units for waves 2 to 5 in 1984 shows that 83% of the interviews were conducted with CU's in-scope at the first wave and 17% with CU's that joined the panel after the first wave. These results indicate that the survey procedures succeeded in keeping the panel sample balanced in terms of sample deaths and births, as respondents entering the panel compensated for respondents leaving the sample for reasons other than attrition; about 50% of both inmovers and outmovers were one-person CU's, not surprisingly.

Panel participation varies according to the response from one wave to the next and due to sample eligibility, as discussed earlier. Some CU's are nonrespondents in one wave and respondents in the next; other CU's reside elsewhere for a period of time and return at a later time. These CU's with one or more missing wave have unbounded interviews. In 1984, 88.7% of

the interviews in waves 2 to 5 were bounded, 8% were unbounded as a result of being out-of-scope in the previous interview (including "new" and other ineligible CU's) and 3.3% were unbounded resulting from a previous refusal or other Type A noninterview.

3. TELESCOPING AND RECALL EFFECTS

3.1 Background

Unbounded interviews are known to yield higher estimates than bounded interviews. This results from a net effect of misdating events in a forward direction by including earlier events in the reporting period. An explanation for this "external telescoping" phenomenon is advanced by Sudman & Bradburn (1974, p.69):

<<..This is due to the respondent's wish to perform the task required of him. When in doubt, the respondent prefers to give too much information rather than too little. >>

Telescoping effects are present also within "bounded" interviews, and the net effect of this "internal" telescoping is believed to be in the forward direction more often than in the backward direction, i.e., in the direction of the first recall month (the month prior to the interview). Omission errors increase as the time of occurrence of the event is more distant from the interview, and this "recall length" bias produces a decreasing distribution of reports. The relationship of these effects suggests that, as time increases, smaller expenses are forgotten at a higher rate and telescoped at a lower rate; vice-versa for larger more salient expenditures. (See Neter & Waksberg,1965).

Studies of recall bias and telescoping effects from survey data attempt to analyze these relationships even though the two effects cannot be properly separated. Murphy & Cowan (1976) developed comprehensive comparisons of bounded and unbounded interviews in NCS. Cantor (1985) found the level of telescoping to be positively related to the level of reporting, using data from NCS. Biderman & Cantor (1984) studied the potential bias of unbounded interviews of inmovers into the NCS sample. Silberstein (1987) introduced the hypothesis that internal telescoping effects are relatively greater for reporters that "try harder" to report more completely in the CE. Mathiowetz (1985) found <<..the dating of unemployment spells was equally as likely to be telescoped backward as well as forward>>, using a study of unemployment which included record validation.

3.2 Method of Analysis

The subset of CU's that participated in all five waves was selected for the statistical analysis (a cross section of about 3200 reporters per wave in 1984). Apparel expenditures from section 9 of the questionnaire were grouped into eight item groups, after a preliminary analysis in greater detail (1). The first wave was processed similarly to the production data for other waves, but weights used in the study (for all waves) did not include the final adjustment factors for population controls, since they were not available for the first wave.

The first wave was compared to bounded interviews in subsequent waves to investigate whether telescoping internal to the three-month reporting period affects the first recall month of bounded interviews in a manner similar to the external telescoping in the unbounded first wave.

The Hotelling T^2 was used to test differences in the item groups simultaneously. Given two vectors of means in a repeated-measures design, a two-tailed .05-level test of H_0: $\mathbf{C}\mu = \mathbf{0}$ (equality of means) versus H_1: $\mathbf{C}\mu \neq \mathbf{0}$ is:

Reject H_0 if

$$[(C\bar{x})'(CSC')^{-1}C\bar{x}] \,/\, [np/(n-(p-1))] > F_{p,n-p+1}(.05)$$

where $\bar{x}$ is a vector of sample means by item group, $\mathbf{C}$ is a contrast matrix (2), p is the number of contrasts in $\mathbf{C}$, $\mathbf{S}$ is the covariance matrix for $\bar{x}$, and n=20 is the number of replicates used to compute $\mathbf{S}$. Simultaneous confidence intervals for individual comparisons by item group were derived using the Bonferroni method, with percentile $t_n(.05/2p)$: for p=8, t_{20}=3.36, for p=5, t_{20}=2.85 (Johnson & Wichern,1988).

3.3 First-Wave Effects

The hypothesis of equality of means theorizes the level of difficulty in the first wave is similar to the one experienced for the first recall month in subsequent waves; memory plays a large role in the reporting of apparel, and many of the would-be telescoped expenses in prior months are not remembered, regardless of the wave. Two differences, however, should be pointed out. First, it is less likely that expense records are used in the first wave than in the next ones, and this factor tends to increase telescoping in the first wave. Second, there is a much greater reporting load effect in subsequent waves due to the three-month reference period, and this factor tends to affect both uncertainty on dates of expenses and levels of reporting.

A preliminary review of the data showed the following relationships. The mean expenditure for "Total Apparel" was 40% higher in the first wave when compared to the mean for waves 2 to 5, and 15% higher than the mean for waves 2 to 5 derived using only the first recall month; these differences were significant.

Percent differences between the first wave mean and the means for wave 2 and waves 2 to 5 combined are displayed in Table 3. They indicate the first wave had higher means in nearly all item groups in both comparisons, but the test was significant only for the combined waves; higher variances were a factor in the test for wave 2. The individual tests revealed that two item groups had significant differences: "Coats,Jackets,etc." and "Sweaters,Dresses,etc.". These groups accounted for 33% of the apparel expenses in wave 1 and for 30% of the apparel expenses in waves 2 to 5 for this selected group of reporters(month 1).

Reporting rates by item group for the first and second waves were also tested; they are displayed in Table 4. These rates are the weighted percent of CU's reporting an item at least once in a given month. Note the similarity of the overall percent reporting (Any Apparel): 71.2% for wave 1 and 70.7% for wave 2 (recall month 1). This contrasts

TABLE 3 - PERCENT DIFFERENCE IN MEAN EXPENDITURES (a)

1984	% Difference Wave 1 and 1st Recall Month of Wave 2		% Difference Wave 1 and 1st Recall Month of Waves 2 to 5	
	% (b)	s	% (c)	s
APPAREL GROUP :				
Coats, Jackets, Furs, Suits	39.0	15.7	39.6 *	12.9
Trousers, Slacks, Jeans	7.6	12.0	13.6	9.5
Shirts, Blouses, Tops	11.2	8.0	9.7	5.6
Sweaters, Dresses, Skirts	16.2	8.7	16.4 *	4.7
Undergarments, Hosiery	6.2	7.3	6.9	5.4
Misc. & Combined Clothing	8.6	10.4	-2.5	7.3
Footwear	5.5	7.6	2.1	6.1
Other Items and Services	25.9	29.1	27.4	25.4
Simultaneous test value:	1.25		3.49 *	
Critical value: F (.05) = 2.77				

(a) Urban CU's that reported in waves 1 to 5
(b) Base: Wave 2; (c) Base: Waves 2 to 5 combined
s Standard error of percent difference

TABLE 4 - MONTHLY REPORTING RATES BY ITEM GROUP

1984	Percent of Consumer Units (a) WAVE 1	WAVE 2 Recall Month 1	2	3
APPAREL GROUP :				
Any Apparel Expenses (b)	71.2	70.7	62.1	54.2
Coats, Jackets, Furs, Suits	23.4	19.7	16.5	14.6
Trousers, Slacks, Jeans	27.5	24.0	18.3	14.7
Shirts, Blouses, Tops	29.0	25.9	19.8	16.1
Sweaters, Dresses, Skirts	27.9	24.7	19.5	17.5
Undergarments, Hosiery	33.6	32.6	26.2	20.9
Misc. & Combined Clothing	30.1	30.8	23.9	19.1
Footwear	31.6	29.9	21.7	18.7
Other Items and Services	25.3	24.6	17.3	15.3
Comparison of Wave 1 to 1st Recall Month of Wave 2				
Simultaneous test value:	2.70			
Critical Value: F (.05) = 2.77				

(a) Urban CU's that reported in waves 1 to 5
(b) Overall reporting rate, excluded from test

with 62.1% for recall month 2 and 54.2% for recall month 3. The rates by item group were always higher for the first wave compared to the first recall month of the second wave, but the simultaneous test (which excludes the "Any Expense" category) was not significant.

The tests described, so far, showed that significant differences pertained to selected apparel groups, specifically, to the ones including more salient, less frequently purchased items (e.g., coats and suits). Another test confirmed this finding: a comparison of first wave and first recall month of the second wave according to the dollar value of the expenses.

Reporting rates by expenditure size in waves 1 and 2 are given in Table 5. Note that CE records reflect individual purchases, with the exception of purchases for the same item, month and person in the family; these are usually reported as combined totals and counted as one record.

TABLE 5 - MONTHLY REPORTING RATES BY EXPENSE SIZE

APPAREL - 1984 Dollar value of reported expenses	Percent of Consumer Units (a) WAVE 1	WAVE 2 Recall Month 1	2	3
No Apparel Expense (b)	28.8	29.3	37.9	45.8
Less than $ 10	38.4	38.3	27.9	25.2
$ 10 to $ 40	57.9	54.7	48.0	40.5
$ 40 to $100	35.1	31.3	26.6	21.4
$100 and over	17.0 *	14.2	11.3	9.0
Comparison of Wave 1 to 1st Recall Month of Wave 2				
Simultaneous test value:	11.14 *			
Critical Value: F (.05) = 2.85				

(a) Urban CU's that reported in waves 1 to 5
(b) Category included in test

The "No expense" category was included in the simultaneous test, in this case. The test value was significant and the individual comparisons showed that significantly more CU's reported $100 or more "purchases" in the first wave; the other expense sizes were not significantly different. The data did not support the hypothesis, therefore.

3.4 Telescoping Effects

Monthly telescoping rates are the percent difference between unbounded one-month recall and bounded one-month recall. Estimates of bounded one-month recall could be derived by simply dividing the bounded three-month recall by a factor of three. This was not acceptable, however, considering the recall loss evident in the third recall month of the CE data. It was assumed that recall bias in the second month was small, and telescoping into the first month was mostly from expenses incurred in the second month.

It was further assumed that some conditioning loss at the item level was present from one wave to the next. (Panel conditioning refers to changes in the quality of reports, commonly in a downward trend, with time-in-sample (TIS); improvements in reporting quality of certain items can also be experienced, however, as respondents become more confident and knowledgeable about the reporting process (Silberstein & Jacobs,1986)). Four of the eight item groups showed some decline from the second to the third wave and this decline, while not significant (.05 level), was assumed to be the conditioning loss (a) between the first and the second wave (Table 6,col.5).

Estimates of telescoping effects in the first wave, developed with the use of the above assumptions, are an adaptation of the Neter/Waksberg model; the model implies that conditioning effects "compound" with time-in-sample. An outline of the method can be found in footnote (3).

The results are given in Table 6. Telescoping effects of 40% or higher were estimated for "Coats,etc." and "Other Items and Services" when no conditioning effects were taken into account; lower levels of telescoping were estimated for the other item groups; (col.1). When conditioning effects were taken into account, the telescoping

TABLE 6 - TELESCOPING ESTIMATES BASED ON EXPENSES

1984 APPAREL GROUP:	Telescoping Effects % Difference (a) If a = 0 %	s	If a > 0 (b) %	s	TIS Effect 1-(M3/M2) a
Coats,Jackets,Furs,Suits	46.2	14.2	-	-	-0.01
Trousers, Slacks, Jeans	30.3	8.6	12.3	11.8	0.10
Shirts, Blouses, Tops	27.7	7.8	17.6	16.7	0.05
Sweaters,Dresses,Skirts	28.3	5.9	8.7	15.0	0.11
Undergarments, Hosiery	22.2	6.9	7.2	12.7	0.08
Misc. & Combined Clothing	5.2	9.5	-	-	-0.18
Footwear	18.1	7.1	-	-	-0.08
Other Items and Services	54.9	35.8	-	-	-0.15

(a) Base: (M2+M3)/2 using recall months 1 and 2
(b) Time-in-sample (TIS) effect when positive
s Standard error of percent difference

estimates decreased considerably, (col.3). No change in conditioning from one wave to the next was assumed, since the data pertained to respondents in all five waves; lower telescoping estimates would have resulted if higher conditioning levels were assumed between wave 1 and wave 2.

The percent differences, shown in Table 6, give indications of the increase that would occur in the estimates in the absence of bounding. The results are consistent with the findings reported for home improvement expenditures in the experiment conducted by Neter & Waksberg.

The comparisons between first-wave means and the monthly estimates from other waves (using all three recall months) showed greater differences than telescoping alone would imply. Telescoping estimates were used to deduct these effects from the first-wave means; the remaining effects were assumed to be produced by a shorter recall period.

One-month "bounded" recall means were computed for the two conditioning assumptions and then compared to the bounded estimates for the second wave. See footnote (4). The first-wave means were at least 10% higher than means for the second wave, with the exception of the "Coats etc." group, which showed no potential benefits from the monthly recall. Larger differences (20% or higher) were found when conditioning effects were considered.

3.5 Unbounded Interviews Within the Panel

The findings of the study indicate telescoping is a factor in reporting certain expenditures in unbounded interviews, and there is variation in the extent to which this phenomenon takes place. Unbounded interviews within the panel may be affected by telescoping as well, but an initial analysis did not highlight this type of error.

The reporting of CU's entering the panel after the first wave was analyzed, and the actual interview cycle was determined disregarding the wave in which they entered. There were about 750 CU's that joined the panel in waves 2, 3 and 4 and reported until the end of the panel. (No comparisons between first and second interview can be made for CU's joining the panel at wave 5.)

The unbounded mean for "Total Apparel" was 20% lower in the first interview compared to the mean for the second interview. The third recall month in the first interview, the month most affected by external telescoping, was 35% lower than the third recall month in the second interview. These findings suggest that these reports may be more affected by recall bias than telescoping.

4. CONCLUSIONS

This study examined the magnitude of telescoping effects in the first wave reporting of Apparel. The results indicate salient high-ticket expenses, such as coats, are affected by telescoping levels of 40% or higher if reported in unbounded interviews; lower telescoping levels may be present in the reporting of other items.

The first wave exhibited higher reporting levels than other waves even after telescoping effects were deducted, and this could be a direct result of the shorter recall period. The analysis concluded that substantial gains in reporting levels can be expected from reducing the recall period to one month. These gains would become marginal as the size of the expenditure increases.

Previous research findings in CE are brought into greater focus because of this study's attempt to separate the effects of recall bias and telescoping on the estimates. The relationship of these response errors should be further examined to generalize the results to other commodities. Additional research should address the variation of these errors according to seasonal expense patterns and personal buying habits.

FOOTNOTES
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(1) APPAREL ITEM GROUPS:

COATS, JACKETS, FURS, SUITS
  Coats, jackets, and furs
  Sport coats and tailored jackets
  Suits
  Active sportswear
TROUSERS, SLACKS, JEANS
  Trousers, slacks, jeans, dungarees
SHIRTS,BLOUSES,TOPS
  Shirts, blouses, and tops
SWEATERS, DRESSES, SKIRTS
  Vests
  Sweaters and sweater sets
  Shorts and short sets
  Dresses
  Skirts and culottes
UNDERGARMENTS, HOSIERY
  Undergarments
  Hosiery
MISC. & COMBINED CLOTHING
  Nightwear and loungewear
  Accessories
  Uniforms (when cost not reimbursed)
  Other clothing
  Clothing items for infants under 2
FOOTWEAR
  Footwear

OTHER APPAREL ITEMS & SERVICES
- Watches
- Jewelry
- Hairpieces, wigs, or toupees
- Sewing materials for making clothes
- Sewing notions
- Repair & alterations to clothing
- Shoe repair and services
- Watch or jewelry repair
- Clothing rental
- Clothing storage

(2) CONTRAST MATRIX:

$$\mathbf{C}_{(px2p)} = \left[\begin{array}{cccc|cccc} 1 & 0 & \cdots & 0 & -1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 & 0 & -1 & \cdots & 0 \\ \vdots & \vdots & & \vdots & \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & 1 & 0 & 0 & \cdots & -1 \end{array}\right]$$

(3) METHOD FOR COMPUTING TELESCOPING ESTIMATES:

Let: MU unbounded mean, MB bounded mean, M2 bounded 2nd wave mean, and M3 3rd wave mean. M2 and M3 computed using recall months 1 and 2.

Assume:

Telescoping effect (b)

(1) MU = (1 + b) MB

(2) b = (MU / MB) - 1

Conditioning (a) is multiplicative

(3) M3 = (1 - a) M2

With no telescoping

(4a) M2 = (1 - 1.5 a) MU

Telescoping compounds on conditioning

(4b) MU = (M2 / (1 - 1.5 a)) (1 + b)

(5) b = (MU (1 - 1.5 a) / M2) - 1

Estimate MB:

MB = (M2 + M3) / 2
= (M2 + (1 - a) M2) / 2

(6) = M2 (1 - (a / 2))

Then:

(7) M2 = MB / (1 - (a / 2))

Estimate b, using (5) and (7):

(8) b = ((MU/MB) (1-1.5 a) (1-(a/2))) - 1

Adapted from: Neter & Waksberg (1965), 33-37.
Conditioning factor (1.5 a) was substituted with (1.0 a).

(4) Let: MB1 "bounded" first-wave mean,
MU1 unbounded first-wave mean.
MB1 = MU1 / (1 + b).

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