

Chapter 6--SUMMARY OF RESULTS

A. LEVELS OF RESPONSE VARIANCE IN 1960 CENSUS STATISTICS

The estimates of response reliances¹ for selected 1960 census population items are shown by characteristic in the detailed tables in chapter 7. These estimates apply to an enumeration by one interviewer in an area having a population of 3,900. To determine the response reliances for areas having more than 3,900 persons (which were usually covered by more than a single interviewer), the response reliances shown in chapter 7 must be divided by an appropriate factor. This factor is the ratio of the population in the area of interest, say N , to 3,900. Thus, the reliances shown for different characteristics in chapter 7 should be divided by $N/3,900$.

For areas having less than 3,900 population, one should also take into account the fact that the value of ρ_d depends upon the size of the interviewer's assignment area, which had 3,900 population in the present experiment. For places smaller than 3,900, ρ_d increases as the size of the area decreases.

The response variance can be expressed as a multiple of the sampling variance. This multiple expresses the relative increase in variance due to the interviewers and crew leaders. The user of census data can then multiply the sampling variances shown in the 1960 census volumes by the appropriate multiplier to determine the combined effect of sampling and response variances.

The multiplier used is crude. For every item studied, the ratio of the response to the sampling variance was estimated for a 25-percent sample of households. Suppose a multiplier for school enrollment items is desired. There were 10 items studied, excluding the nonresponse category. The median value of the ratios of the response variance to the sampling variance was used as the multiplier. For a multiplier over all population characteristics studied, the median value of the ratios of the response variance to the sampling variance over all 75 population items was computed. The median was computed using the data with the crew leader effect and after allocation for nonresponse and inconsistencies. Since it is known that nonresponse categories exhibit very large interviewer variances, these items were not included in computing the median.

Because some of the estimates of response variance have large variances, the median ratio may be misleading as a multiplier. As explained in chapter 9, a

¹ As explained in chapter 4, the estimates of response variance presented in this chapter are understated by the amount of the first term in equation 4.16 on page 12. This is the simple response variance. Estimates of this term will be presented in a later report. However, it is believed that this term is small in comparison with the correlated component.

98-percent confidence interval was constructed for the response reliance for each of the 75 population items, 5 housing items, and 6 nonresponse items. We have used both endpoints of the confidence interval to construct median ratios. Therefore, for each characteristic, we have three median ratios--one for the lower endpoints of the confidence interval, one for the actual point estimates of the response variance, and one for the higher endpoints of the confidence interval.

Table 3 shows multipliers for each characteristic separately and for the selected set of population items as a whole. Extreme caution must be used in the application of these multipliers. The items in the sets listed in the table are heterogeneous. For example, only five housing items were studied, four relating to gross rent and one to year built. It is unrealistic to apply the multipliers derived to all housing characteristics.

Similarly, only two items are included under nativity. The estimates of the ratio of response variance to sampling variance were 0 for one of these items and 6.0 for the other. Table 3 shows the median value as 3.0 (the mean of the two estimates). Clearly, the median value should not be taken as more than a very rough indication of the magnitude of the ratio for a class of items.

In table 3, M_L refers to the smallest multiplier. This was the multiplier constructed by using the lower endpoints of the confidence intervals. M_U is the multiplier obtained by using the upper endpoints of the confidence intervals.

Care should be exercised in the use of table 3 and it should be applied only to places of 3,900 inhabitants or more.² For example, for labor force items, the multipliers given in the table appear to be small. However, if the specific item of interest is unemployment, the multiplier is really of the order of 2.0. Thus, the multipliers shown are only rough approximations and should be regarded as such.

Table 3 may be used as follows. Suppose a person is interested in getting a rough approximation of the variance of the percentage of the total population who were males receiving income other than from wage, salary or self-employment in an area of about 10,000 inhabitants. This group comprises about 10 percent of the total population. According to the census volume [17], the sampling variance is about .36. From table 3 we see that the proper multiplier is about .6. So the total variance is

$$.36 + (.6)(.36) = .58$$

Using the lower and upper multipliers, we find a range of .40 to .68 for the estimate of the variance.

² The value of ρ_d does not change for any place larger than the size of an interviewer's assignment area. For smaller places ρ_d increases with a decrease in the size of area.

Table 3.--MULTIPLIERS OF CENSUS SAMPLING VARIANCES FOR SELECTED GROUPS OF CHARACTERISTICS TO OBTAIN INCREASE IN VARIANCE DUE TO INTERVIEWERS AND CREW LEADERS

Characteristic ¹	Number of items	M _L	M	M _U
Selected housing characteristics.....	5	0.7	0.8	0.9
Selected population characteristics.....	75	0.2	0.4	0.6
Nativity.....	2	2.5	3.0	3.7
1955 residence.....	3	2.4	2.8	3.2
Educational attainment.....	8	0.4	0.5	0.7
School enrollment.....	10	0.4	0.7	1.0
Number of children.....	4	0.0	0.1	0.2
Labor force.....	6	0.1	0.2	0.4
Occupation.....	7	0.0	0.3	0.4
Wage and salary income (size groups).....	12	0.2	0.4	0.7
Self-employment income (size groups).....	11	0.1	0.5	0.6
Other income (size groups).....	11	0.1	0.6	0.9
Veteran status.....	1	0.2	0.3	0.3

¹See chapter 7 for the description of the characteristics and the list of items within each characteristic.

Notice that the range from M_L to M_U gives an indication of the variability in the estimates. For example, for labor force items, the range is 0.1 to 0.4 while for other income, it is 0.1 to 0.9; the estimates for other income categories had large variances.

B. LEVELS OF RESPONSE VARIANCE BY TYPE OF AREA

Three types of areas were defined for which estimates of the response variances were computed. Those areas were as follows:

Highly urban areas--These were places of 100,000 inhabitants or more and identified as urban in the census geographic identification code scheme. Ninety-six of the clusters of EA's with the crew leader effect and 94 of the clusters of EA's without the crew leader effect were included.

Other urban areas--These were places of 2,500 to 99,999 persons and listed as urban in the geographic identification code scheme. This group included 171 of the clusters with the crew leader effect and 167 of the clusters without the crew leader effect.

Rural areas--These were places listed as rural in the geographic identification code scheme. This group included 123 clusters of each type.

The results from this analysis showed that the estimates of response variance differed widely by type of area. Table 4 presents multipliers for the 12 characteristics studied, by type of area. The sampling variances of these estimates were not computed, so a range on the multipliers is not given. The multipliers shown in table 4 are those constructed from using the actual point estimates of the response variances. The multipliers for highly urban areas may be applied to any part of a highly urban area as long as the segment of interest has a population of 3,200 persons or more; the multipliers in other urban areas may be applied to the appropriate areas of 4,100 persons or more; and the multipliers for rural areas may be applied to the appropriate areas of 4,000 persons or more.

Notice first that there is great variability in the multipliers from area to area. For example, the multiplier for occupation categories is 1.2 in highly urban areas and only 0.3 in other urban areas and 0.2 in rural areas. The highly urban clusters produced extremely high response variances for the two farming categories in which less than 0.1 percent of the total population was classified, as shown in table 27 on page 61. A similar thing occurred with the nativity item in rural areas. While these may reflect great differences in type of area, undoubtedly the variances of these estimates are very large.

The detailed tables showing estimated response reliabilities by type of area for each of the 75 population items, 5 housing items, and 6 nonresponse items are not included in this report. However, the ratios of the response variances to the appropriate census variances are given in the detailed results in chapter 7.

C. COMPARISON OF LEVELS OF RESPONSE VARIANCE 1950-1960

The design of the 1960 Censuses of Population and Housing was greatly influenced by the findings of the 1950 Enumerator Variance Study. That study first measured the census interviewers' contribution to the total mean-square error of census statistics. For small areas, or small tabulation cells, this response variance had a large effect. Therefore, in 1960, as a device to reduce the response variance due to census interviewers, self-enumeration was used extensively. We now want to compare the 1950 and 1960 data on response variances to see if the response variance was in fact reduced in 1960. We will make comparisons in two ways. First, we shall compare the overall levels of response variance in the two censuses, and then we shall compare response reliabilities for identical items in the two censuses. Since the 1950 and 1960 experiments were based on different sampling units, direct comparisons will reflect things other than changes in the interviewer effect. For that reason we cannot compare the data directly.

Because the experiments designed to measure response variance in 1950 and 1960 were different, a brief description of the 1950 Enumerator Variance Study (EVS) follows.

Table 4.--MULTIPLIERS OF CENSUS SAMPLING VARIANCES FOR SELECTED GROUPS OF CHARACTERISTICS TO OBTAIN INCREASE IN VARIANCE DUE TO INTERVIEWERS AND CREW LEADERS IN HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Characteristic	Number of items	Multiplier (M) of sampling variance in--		
		Highly urban areas	Other urban areas	Rural areas
Selected housing characteristics.....	5	0.9	0.8	0.5
Selected population characteristics.....	75	0.6	0.3	0.4
Nativity.....	2	0.2	0.7	23.8
1955 residence.....	3	0.6	1.6	5.1
Educational attainment.....	8	0.8	0.6	0.9
School enrollment.....	10	0.5	0.6	0.1
Number of children.....	4	0.5	0.0	0.2
Labor force.....	6	0.9	0.1	0.2
Occupation.....	7	1.2	0.3	0.2
Wage and salary income (size groups)...	12	0.7	0.2	0.4
Self-employment income (size groups)...	11	0.3	0.4	0.6
Other income (size groups).....	11	0.3	0.4	0.6
Veteran status.....	1	0.7	0.0	0.6

The 1950 EVS was conducted in 21 purposively selected counties in Ohio and Michigan. A total of 200 strata, with an average population of about 6,500 persons each, were formed. Within each stratum, the ED's were paired at random, and each pair was assigned to an interviewer by a random method. The variances between the results of ED's completed by different interviewers were compared with the variances between the pairs of ED's completed by the same interviewers to give estimates of the response variability. (See [8] for a complete description of the 1950 EVS.)

In the tables which follow, we have made extensive use of a sampling variance model. The terms labelled "sampling variance" are not actual census sampling variances but theoretical variances derived from this sampling variance model. This sampling variance model assumes a 25-percent simple random sample of housing units without replacement in an area of N persons. A simple random sample of households is a cluster sample of persons. We have assumed that the intraclass correlation on personal characteristics in households is 0.1 for all population characteristics and that the average household has 3.5 persons. The assumption of an intraclass correlation of 0.1 for all characteristics is contrary to fact for a few characteristics. For example, characteristics such as mobility, race, etc., are usually the same for all persons in a household and the intraclass correlation is close to 1.0. However, we are using the value 0.1 only for illustration of the comparison. The reader who is concerned with other values of the intraclass correlation can easily make the appropriate modifications in the tables which follow.

In the model specified, the formula used to derive the sampling relvariances was:

$$V_s^2 = \frac{N-n}{N-1} \cdot \frac{1}{n} \cdot \frac{Q}{P} [1 + \delta (\bar{n}-1)] \quad (6.1)$$

$$\doteq [1 - \frac{n}{N}] \cdot \frac{1}{n} \cdot \frac{Q}{P} [1 + \delta (\bar{n}-1)]$$

where N = number of persons in the population

n = number of persons in the sample

P = proportion of population having characteristic

Q = 1-P

δ = intraclass correlation within households

\bar{n} = average number of persons per household.

We have assumed a 25-percent sample, so $n/N = 1/4$. Also, $\delta = 0.1$ and $\bar{n} = 3.5$. Then

$$V_s^2 \doteq \frac{3}{4} \cdot \frac{1}{n} \cdot \frac{Q}{P} [1 + 0.1 (2.5)]$$

$$\doteq \frac{1}{4n} \cdot \frac{Q}{P} \cdot 3(1.25)$$

$$\doteq \frac{3.75}{4n} \cdot \frac{Q}{P}$$

$$\doteq \frac{3.75}{N} \cdot \frac{Q}{P} \quad (6.2)$$

For 1950, N = 6,500; for 1960, N = 3,900.

Table 5 shows the response variances for selected 1950 population characteristics. The sampling relvariances shown in column 4 were obtained by using equation 6.2. A table similar to this was presented in *The Accuracy of Census Statistics With and Without Sampling*, Bureau of the Census, Technical Paper No. 2. In that paper, it was concluded that the median ratio of the ratios of response variance to sampling variance for the various types of items in the table was about 1, if the age items were excluded.

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Table 5.--1950 EVS: ESTIMATED RESPONSE RELVARIANCES FOR AN ENUMERATION BY SEVEN INTERVIEWERS OF AN AREA OF 6,500 POPULATION; AND SAMPLING RELVARIANCES OF A 25-PERCENT HOUSEHOLD SAMPLE OF SAME AREA

Characteristics	Average census results		Relvariance		Relative standard error (coefficient of variation)		Ratio of response to sampling variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling	
Total population.....	6,559	100.0	-	-	-	-	-
Nativity:							
Native white.....	5,939	90.5	.00004	.00006	.006	.008	.6
Foreign born white.....	239	3.6	.01103	.01514	.105	.123	.7
Residence 1 year earlier: ¹							
Same house.....	5,264	80.3	.00029	.00014	.016	.012	2.0
Different house, same county....	750	11.4	.01114	.00443	.106	.066	2.5
Different county or abroad.....	307	4.7	.01268	.01163	.113	.108	1.1
Age, males:							
Under 5 years.....	376	5.7	.00102	.00940	.032	.097	.1
15 and older.....	2,314	35.3	.00010	.00105	.010	.032	.1
35 and older.....	1,360	20.7	.00048	.00219	.022	.047	.2
55 and older.....	554	8.4	.00041	.00619	.020	.079	.1
Highest grade of school attended: ²							
Grade 5 or over.....	3,539	54.0	.00001	.00049	.004	.022	.03
Grade 9 or over.....	2,103	32.1	.00070	.00121	.026	.035	.6
Grade 13 or over.....	446	6.8	.02464	.00784	.157	.089	3.1
Income: ³							
Wage and salary--							
None.....	2,284	34.8	.00128	.00107	.036	.033	1.2
Under \$2,500.....	1,209	18.4	.00392	.00253	.063	.050	1.6
\$2,500 and over.....	1,081	16.5	.00097	.00290	.031	.053	.3
From own business--							
None.....	4,172	63.6	.00061	.00033	.025	.018	1.9
Under \$2,500.....	265	4.0	.01772	.01357	.133	.116	1.3
\$2,500 and over.....	128	2.0	.01794	.02863	.134	.169	.6
Other income--							
None.....	3,777	57.6	.00133	.00042	.036	.020	3.2
Under \$2,500.....	751	11.4	.01991	.00442	.141	.066	4.5
\$2,500 and over.....	30	.5	(⁴)	.12556	(⁴)	.354	(⁴)
Major occupation group: ⁵							
Craftsmen, foremen, etc., males..	400	6.1	.00394	.00880	.063	.094	.4
Farmers and farm managers, males.	146	2.2	.03035	.02515	.174	.159	1.2
Farm laborers, unpaid family workers, males.....	18	.3	.18518	.20370	.430	.451	.9
Farm laborers, paid males.....	30	.5	.03600	.12667	.190	.356	.3
Industry group: ⁵							
Manufacturing.....	1,000	15.2	.00175	.00318	.042	.056	.5

¹Persons 1 year of age and over.

²Persons 25 years of age and over.

³Persons 14 years of age and over.

⁴Estimate of response variance negative.

⁵Employed workers 14 years of age and over.

Figure 4 shows the response and sampling coefficients of variation plotted for the 1950 data. Approximately half of the points representing response coefficients of variation are above and half below the curve representing the sampling coefficient of variation as a function of the size of the class being estimated.

In order to make comparisons of the overall level of the 1960 response variance with that of 1950 we shall express the 1960 data in terms of a 25-percent sampling variance function, just as we did with the 1950 data. Thus, we use equation 6.2 to derive sampling relvariances.

**Figure 4. Response Coefficient of Variation for Population Characteristics
in Places of 6,500 Persons: 1950 Census**

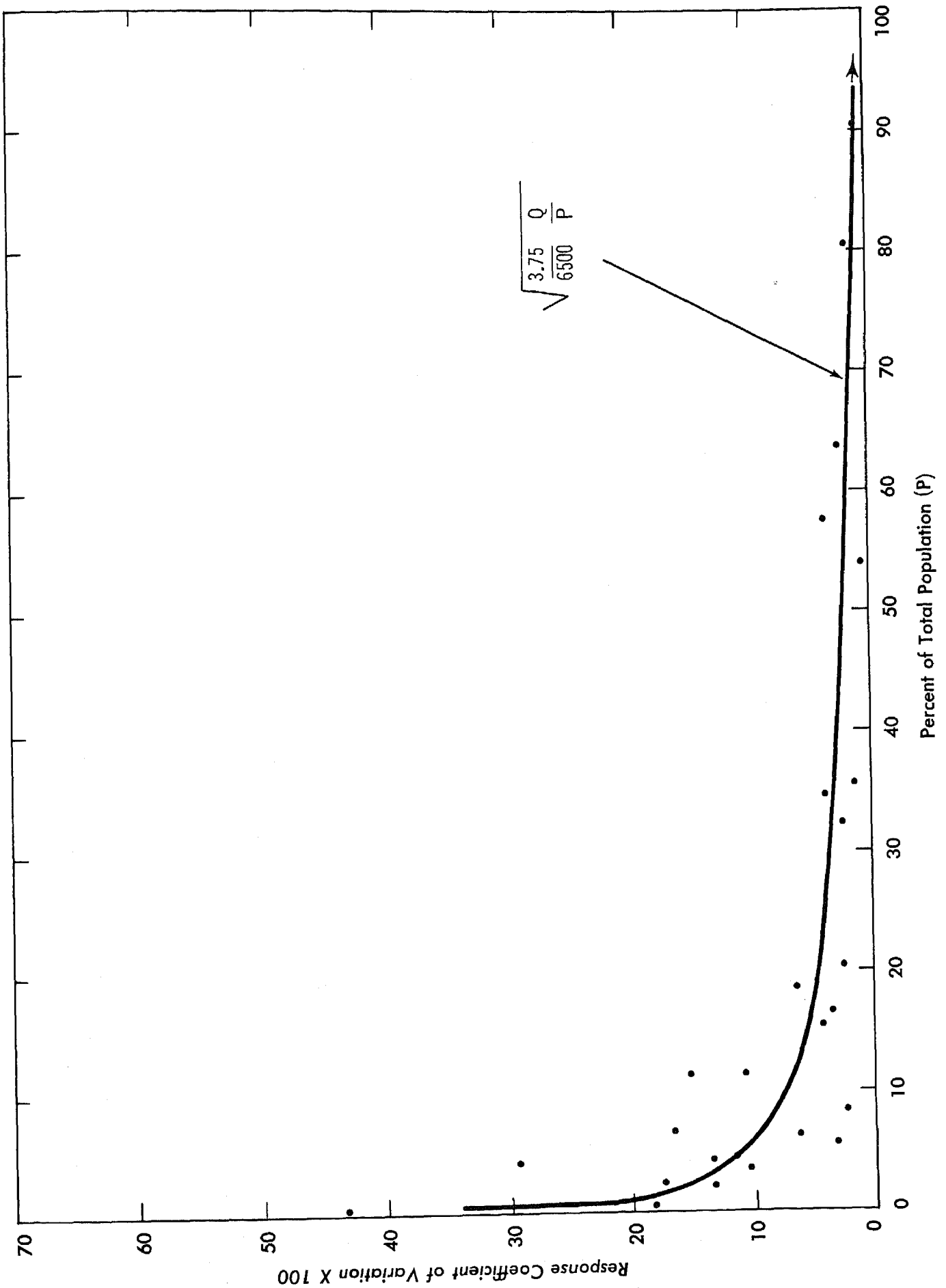


Table 6 shows the estimates of response reliabilities and the theoretical sampling reliabilities. The data are taken from the estimates without the crew leader effect and after allocation. Column 7 gives the ratios of the response variance to the theoretical sampling variances.

The median ratio of response to sampling variance from this set of data was .24 or approximately 1/4. On this basis, the level of response variance in 1960 is about 1/4 of the 1950 level.

In order to visualize this decrease in response variance, figure 5 is presented. A 25-percent sampling variance function, $\sqrt{\frac{3.75}{3,900} \cdot \frac{Q}{P}}$, is shown with the co-

efficients of response variation plotted on the same chart. It is obvious that that function is not a good fit to the data. A sampling variance of 1/4 of the variance of a 25-percent sample provides a much better fit, as is shown on Figure 5.

Table 6.--1960 ESTIMATED RESPONSE RELIABILITIES FOR AN ENUMERATION BY ONE INTERVIEWER IN AN AREA OF 3,900 PERSONS; AND THEORETICAL SAMPLING RELIABILITIES OF A 25-PERCENT HOUSEHOLD SAMPLE OF SAME AREA

Characteristic	Average census results		Reliability		Coefficient of variation		Ratio of response to sampling variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling	
Total population.....	3,900	100.0	-	-	-	-	-
Nativity:							
Native born.....	3,705	95.0	.00024	.00005	.015	.008	4.8
Foreign born.....	195	5.0	.00760	.01827	.087	.135	0.4
1955 residence:							
Same house.....	1,786	45.8	.00013	.00114	.011	.034	0.1
Different house, same county.....	885	22.7	.00351	.00327	.059	.057	1.1
Different county or abroad.....	757	19.4	.00385	.00399	.062	.063	1.0
Educational attainment:							
Highest grade not completed.....	480	12.3	.01438	.00686	.120	.083	2.1
Elementary, 1-2.....	23	0.6	.05840	.15929	.242	.399	0.4
Elementary, 8.....	394	10.1	.00296	.00856	.054	.093	0.3
Grade 9 or more.....	1,353	34.7	.00030	.00181	.017	.043	0.2
High school, 4.....	569	14.6	.00208	.00562	.046	.075	0.4
College 1.....	66	1.7	.00667	.05560	.082	.236	0.1
College 1 or higher.....	394	10.1	.00192	.00856	.044	.093	0.2
College 5 or higher.....	66	1.7	.01599	.05560	.126	.236	0.3
School enrollment:							
Kindergarten or first grade.....	144	3.7	.00122	.02503	.035	.158	0.05
Elementary 8.....	74	1.9	.00000	.04965	.000	.223	0.0
High school 1.....	55	1.4	.01875	.06772	.137	.260	0.3
High school 4.....	55	1.4	.01865	.06772	.137	.260	0.3
College 1.....	20	0.5	.14344	.19135	.379	.437	0.8
College 5 or more.....	(¹)	(¹)	.44102	(¹)	.664	(¹)	(²)
Public elementary.....	597	15.3	.00000	.00532	.000	.073	0.0
Private elementary.....	109	2.8	.04042	.03338	.201	.183	1.2
Public high school.....	179	4.6	.00675	.01994	.082	.141	0.3
Private high school.....	20	0.5	.06761	.19135	.260	.437	0.4
Number of children:							
None.....	195	5.0	.00274	.01827	.052	.135	0.1
1-3 children.....	706	18.1	.00040	.00435	.020	.066	0.1
3 or more children.....	464	11.9	.00081	.00712	.028	.084	0.1
5 or more children.....	152	3.9	.00548	.02369	.074	.154	0.2
Labor force:							
Total.....	1,529	39.2	.00028	.00149	.017	.039	0.2
Males.....	1,041	26.7	.00073	.00264	.027	.051	0.3
Females.....	480	12.3	.00000	.00686	.000	.083	0.0
Females, 14-19, attending school.....	20	0.5	.03090	.19134	.176	.437	0.2
Unemployed.....	78	2.0	.07552	.04711	.275	.217	1.6
Worked less than 35 hours last week.....	242	6.2	.00281	.01455	.053	.121	0.2

Table 6.--1960 ESTIMATED RESPONSE RELVARIANCES FOR AN ENUMERATION BY ONE INTERVIEWER IN AN AREA OF 3,900 PERSONS; AND THEORETICAL SAMPLING RELVARIANCES OF A 25-PERCENT HOUSEHOLD SAMPLE OF SAME AREA--Continued

Characteristic	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling	
Occupation groups:							
Professional, technical.....	160	4.1	.00026	.02249	.016	.150	0.01
Farmers, farm mgrs., male.....	43	1.1	.00868	.08645	.093	.294	0.1
Clerical.....	218	5.6	.00247	.01621	.050	.127	0.2
Sales workers.....	117	3.0	.00000	.03109	.000	.176	0.0
Craftsmen, foremen.....	218	5.6	.00408	.01621	.064	.127	0.3
Operatives.....	277	7.1	.00281	.01258	.053	.112	0.2
Farm laborers, paid workers, male	20	0.5	.04845	.19134	.220	.437	0.3
Wage and salary income:							
None.....	1,248	32.0	.00090	.00204	.030	.045	0.4
2,500 or more.....	920	23.6	.00026	.00311	.016	.056	0.1
Males, less than \$3,000.....	246	6.3	.00745	.01430	.086	.120	0.5
Females, less than \$3,000.....	367	9.4	.00322	.00927	.057	.096	0.3
Males, \$3,000 to \$4,999.....	261	6.7	.00425	.01339	.065	.116	0.3
Females, \$3,000 to \$4,999.....	140	3.6	.01060	.02575	.103	.160	0.4
Males, \$5,000 to \$6,999.....	261	6.7	.00320	.01339	.057	.116	0.2
Females, \$5,000 to \$6,999.....	27	0.7	.02848	.13640	.169	.369	0.2
Males, \$7,000 to \$9,999.....	117	3.0	.01118	.03109	.106	.176	0.4
Females, \$7,000 to \$9,999.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	0.0
Males, \$10,000 or more.....	51	1.3	.00256	.07300	.051	.270	0.04
Females, \$10,000 or more.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	0.0
Self-employment income:							
\$2,500 or more.....	136	3.5	.00704	.02651	.084	.163	0.3
Males, less than \$3,000.....	105	2.7	.01235	.03465	.111	.186	0.4
Females, less than \$3,000.....	27	0.7	.07884	.13640	.281	.369	0.6
Males, \$3,000 to \$4,999.....	39	1.0	.00000	.09519	.000	.309	0.0
Females, \$3,000 to \$4,999.....	(¹)	(¹)	.16999	(¹)	.412	(¹)	(¹)
Males, \$5,000 to \$6,999.....	27	0.7	.04805	.13640	.219	.369	0.4
Females, \$5,000 to \$6,999.....	(¹)	(¹)	.38484	(¹)	.620	(¹)	(²)
Males, \$7,000 to \$9,999.....	12	0.3	.00000	.31955	.000	.565	0.0
Females, \$7,000 to \$9,999.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	0.0
Males, \$10,000 or more.....	27	0.7	.02354	.13640	.153	.369	0.2
Females, \$10,000 or more.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	0.0
Other income:							
\$2,500 or more.....	55	1.4	.02865	.06772	.169	.260	0.4
Males, less than \$3,000.....	402	10.3	.00003	.00837	.005	.091	0.0
Females, less than \$3,000.....	296	7.6	.00709	.01169	.084	.108	0.6
Males, \$3,000 to \$4,999.....	12	0.3	.05200	.31955	.228	.565	0.2
Females, \$3,000 to \$4,999.....	16	0.4	.13785	.23942	.371	.489	0.6
Males, \$5,000 to \$6,999.....	(¹)	(¹)	.02590	(¹)	.161	(¹)	(²)
Females, \$5,000 to \$6,999.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	0.0
Males, \$7,000 to \$9,999.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	0.0
Females, \$7,000 to \$9,999.....	(¹)	(¹)	1.18107	(¹)	1.087	(¹)	(³)
Males, \$10,000 or more.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	0.0
Females, \$10,000 or more.....	(¹)	(¹)	2.44674	(¹)	1.564	(¹)	(³)
Veteran status:							
World War II veterans.....	324	8.3	.00304	.01062	.055	.103	0.3

¹The number of persons in this category was less than .1 percent of the total population.

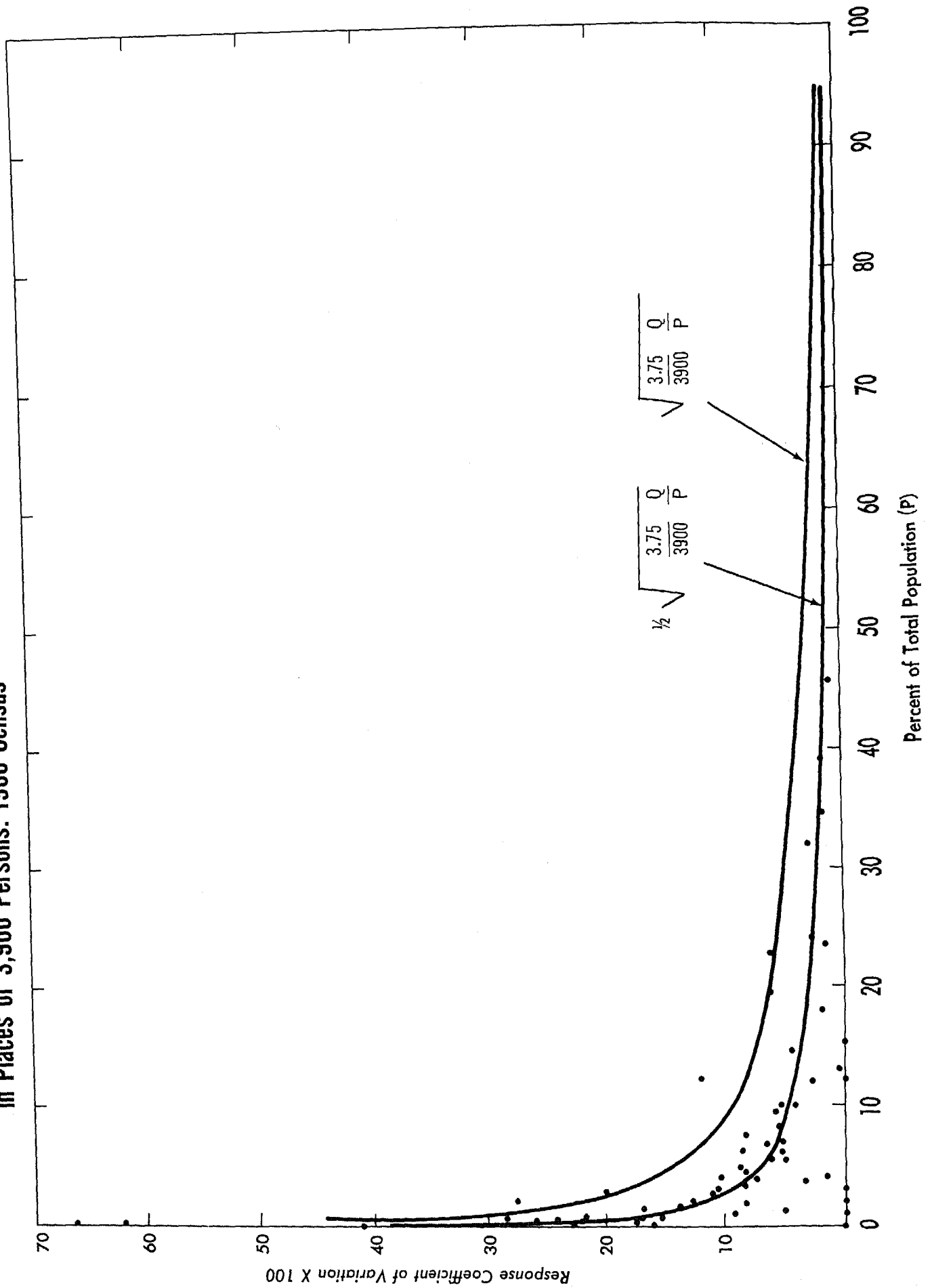
²On the basis of .1 percent of the total population, this ratio would be less than 1.0.

³On the basis of .1 percent of the total population, this ratio would be greater than 1.0.

From the paragraphs above, it is evident that the overall level of response variance decreased from 1950 to 1960. We are also interested in observing whether the response variance decreased for identical items from 1950 to 1960. We cannot compare the estimates of response variance since the response variances are functions of the size of the interviewers' assignment area.

The value of ρ_d goes down as the size of the assignment area increases. The ρ_d of 1950 was evaluated in an area of 6,500 persons; the ρ_d of 1960 was evaluated in an area of 3,900 persons. However, the estimates of $\rho_d V_d^2$ obtained in 1960 when multiplied by $\left(\frac{3,900}{N}\right)$ is a valid multiplier for a place of N persons, as long as the area is larger

**Figure 5. Response Coefficient of Variation for Population Characteristics
in Places of 3,900 Persons: 1960 Census**



than the size of an interviewer's assignment area. Therefore, if we multiplied the 1960 estimates by $3,900/6,500$, we should adjust for the difference in sizes of area, and would then be able to compare these estimates directly.

In comparing the 1950 and 1960 data it is important to take into account the variability of both sets of estimates. Unfortunately, the variances of the 1950 estimates were never estimated. The variability of the 1960 estimates are taken into account. In chapter 9, the 98-percent confidence intervals for these estimates are derived and shown. The upper limits of these intervals are also compared with the 1950 estimates of the response relvariances in table 7 which follows.

Of the 20 identical items, the 1960 response relvariances were smaller for all but five items. Even the upper limits of the 1960 confidence intervals are smaller for all but five items.

Of these five items, two were "not reported" categories for educational characteristics. In 1950, interviewers were allowed to accept answers from neighbors if they could not get an interview in the household. This was not allowed in the 1960 procedures. This may explain

some interviewers getting a higher nonresponse rate. This did not occur for the three "not reported" categories for income characteristics. For those cases, the response relvariances of 1960 are about 80 percent of the 1950 variances.

The variances of the 1950 estimates were not computed, but it may well be that they were smaller than the variances of the 1960 estimates. For one thing, the 1950 study was concentrated in 21 counties which were very similar to each other, rather than spread over the United States. Also, the 1950 selection was a purposive one. These facts would lead to reductions in variability of the estimates. By the same token, however, they would lead to bias in the estimates. It seems likely, therefore, that the 1950 estimates are underestimates of the response relvariances.

In view of the evidence above, we conclude that the 1960 response variances were decreased considerably from the 1950 response variances. Since the introduction of self-enumeration on a large-scale basis was the principal change in the census procedure, it seems likely that self-enumeration was the prime cause of that decrease.

Table 7.--COMPARISON OF RESPONSE RELVARIANCES FOR IDENTICAL POPULATION ITEMS: 1950 AND 1960 CENSUSES

Characteristic	Estimates of response relvariance			Ratio to 1950 of--	
	1950	1960 X $\frac{3,900}{6,500}$	1960 upper limit X $\frac{3,900}{6,500}$	1960 X $\frac{3,900}{6,500}$	1960 upper limit X $\frac{3,900}{6,500}$
Educational attainment:					
Highest grade not completed.....	.04241	.00863	.00941	.20	.22
Grade 9 or higher.....	.00070	.00018	.00029	.26	.41
Grade 13 or higher.....	.02465	.00115	.00172	.05	.07
Highest grade completed, not reported.....	.13666	.14005	.15284	1.02	1.12
School enrollment:					
Now attending school, not reported..	.20858	.35133	.38081	1.68	1.83
Labor force:					
Total.....	.00035	.00017	.00025	.49	.71
Males.....	.00017	.00044	.00055	2.59	3.24
Females.....	.00200	.00000	.00028	.00	.14
Females, 14-19, attending school....	.04807	.01854	.02969	.39	.62
Occupation groups:					
Farmers, farm mgrs., male.....	.03035	.00521	.01687	.17	.56
Farm laborers, paid workers, male...	.03600	.02907	.04881	.81	1.36
Craftsmen, foremen.....	.00394	.00245	.00374	.62	.95
Wage and salary income:					
None.....	.00128	.00054	.00065	.42	.51
\$2,500 and over.....	.00010	.00016	.00025	1.60	2.50
Not reported.....	.14605	.11480	.12400	.79	.85
Self-employment income:					
\$2,500 and over.....	.01794	.00422	.00574	.24	.32
Not reported.....	.15257	.11833	.13085	.78	.86
Other income:					
\$2,500 and over.....	.00000	.01719	.02125	-	-
Not reported.....	.14699	.11119	.11939	.76	.81
Veteran status:					
World War II veterans.....	.00341	.00182	.00241	.53	.71

D. CREW LEADER EFFECT ON 1960 CENSUS STATISTICS

There were 75 population items for which estimates of the response variance were computed for both the clusters with and those without the crew leader effect. These estimates are shown in detail in chapter 7. In this part we are concerned with a comparison of the estimates after allocation for nonresponse.

For most of the items studied, the crew leader effect was close to zero. However, there were some items which showed a very strong crew leader effect. For all three of the mobility items the crew leader effect was very strong. It was relatively strong for at least one item in each characteristic studied. The effect of the crew leaders was particularly noticeable for some of the non-response items. Altogether, at least 15 items showed a strong crew leader effect.

E. RESPONSE VARIANCES FOR NONRESPONSE ITEMS

In the detailed results in chapter 7 of this report and in the summary, we see that the response variances for nonresponse categories are larger than the variances for other categories. This agrees with results found by other researchers in the field. Eckler and Hurwitz [2] point out that the most striking contribution from interviewer variability was in the "not reported" categories. The detailed results in chapter 7 show that the estimates of response variance for nonresponse items vary considerably by type of area.

F. CONCENTRATION OF RESPONSE VARIABILITY

The interviewer-pairs who contributed especially high estimates of response variance were identified for each item.

Over half of the interviewer-pairs had three or fewer high estimates for the 75 population items. Slightly under half had three or fewer high estimates when the five housing items were also considered. This indicates that most interviewers who produced a high estimate for one item did not do so consistently for all items.

About 10 percent of the interviewer-pairs produced high values for eight or more items. These interviewers were probably those who did not understand the training, or did not do their work carefully. It is this 10 percent which could probably benefit from retraining if there were a way to identify these interviewers early in the enumeration.

Similarly, only about 5 percent of the interviewer-pairs produced high values for four or more of the six nonresponse items.

From these results we can see that most interviewers may do badly on one, two, or three items but may not perform badly for the complete enumeration. Only about 10 percent of the interviewers do bad work consistently for many characteristics.

Chapter 7--DETAILED RESULTS BY SUBJECT

A. HOUSING ITEMS

There were very few housing items in the 1960 census asked of all sample housing units which were common to both the block and non-block schedules. (Block schedules were used in large cities for which statistics were published for blocks.) Though there were many items included in the housing census, most of them were asked

of a reduced sample (either 5 or 20 percent). From the list of available items, 10 were selected for analysis from among the 25-percent sample items. Of the items selected, eight referred to gross rent and four of these were quantitative items, not 0-1 variates. The remaining two items referred to the year the unit was built. The housing questions selected are shown in figure 6.

<p>H20. About when was this house originally built?</p> <p>In 1959 or 1960 ----- <input type="radio"/></p> <p>1955 to 1958 ----- <input type="radio"/></p> <p>1950 to 1954 ----- <input type="radio"/></p> <p>1940 to 1949 ----- <input type="radio"/></p> <p>1930 to 1939 ----- <input type="radio"/></p> <p>1929 or earlier ----- <input type="radio"/></p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top; padding: 5px;"> <p>H43. In addition to rent, does renter pay for--</p> <p>a. Electricity? Yes <input type="radio"/> No <input type="radio"/></p> <p>b. Gas? Yes <input type="radio"/> No <input type="radio"/></p> <p>c. Water? Yes <input type="radio"/> No <input type="radio"/></p> </td> <td style="width: 50%; vertical-align: top; padding: 5px;"> <p>H44. If "Yes" in H43 and if occupied-- What is the average monthly cost for--</p> <p>a. Electricity? \$ 0 1 2 3 4 5 6 7 8 9</p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>b. 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Water? \$ 0 1 2 3 4 5 6 7 8 9</p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> </td> </tr> <tr> <td style="width: 50%; vertical-align: top; padding: 5px;"> <p>H45. In addition to rent, does renter pay for--</p> <p>Oil, coal, wood or kerosene? Yes <input type="radio"/> No <input type="radio"/></p> </td> <td style="width: 50%; vertical-align: top; padding: 5px;"> <p>H46. If "Yes" in H45 and if occupied-- What is the total yearly cost for--</p> <p>\$ 0 1 2 3 4 5 6 7 8 9</p> <p>Hnd's <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> </td> </tr> </table>	<p>H43. In addition to rent, does renter pay for--</p> <p>a. Electricity? Yes <input type="radio"/> No <input type="radio"/></p> <p>b. Gas? Yes <input type="radio"/> No <input type="radio"/></p> <p>c. Water? Yes <input type="radio"/> No <input type="radio"/></p>	<p>H44. If "Yes" in H43 and if occupied-- What is the average monthly cost for--</p> <p>a. Electricity? \$ 0 1 2 3 4 5 6 7 8 9</p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>b. 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Water? \$ 0 1 2 3 4 5 6 7 8 9</p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p>	<p>H45. In addition to rent, does renter pay for--</p> <p>Oil, coal, wood or kerosene? Yes <input type="radio"/> No <input type="radio"/></p>	<p>H46. If "Yes" in H45 and if occupied-- What is the total yearly cost for--</p> <p>\$ 0 1 2 3 4 5 6 7 8 9</p> <p>Hnd's <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p>
<p>H43. In addition to rent, does renter pay for--</p> <p>a. Electricity? Yes <input type="radio"/> No <input type="radio"/></p> <p>b. Gas? Yes <input type="radio"/> No <input type="radio"/></p> <p>c. Water? Yes <input type="radio"/> No <input type="radio"/></p>	<p>H44. If "Yes" in H43 and if occupied-- What is the average monthly cost for--</p> <p>a. Electricity? \$ 0 1 2 3 4 5 6 7 8 9</p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>b. Gas? \$ 0 1 2 3 4 5 6 7 8 9</p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>c. Water? \$ 0 1 2 3 4 5 6 7 8 9</p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p>				
<p>H45. In addition to rent, does renter pay for--</p> <p>Oil, coal, wood or kerosene? Yes <input type="radio"/> No <input type="radio"/></p>	<p>H46. If "Yes" in H45 and if occupied-- What is the total yearly cost for--</p> <p>\$ 0 1 2 3 4 5 6 7 8 9</p> <p>Hnd's <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Tens <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p>Units <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p>				

Figure 6.--Questions H20, H43, H44, H45, and H46 on housing, 1960 Decennial Census schedule.

For item H20, the response variance was computed for the categories "1929 or earlier," and "year built not reported". The computed values were quite high. The interviewer was told that in cases where the respondent did not know the year built, he was to ask the owner, manager, or janitor for multiunit structures. In the training session it was stressed that the time referred to was the time of original construction, not of any remodeling, additions or any other work. It may be that a misunderstanding of some of these points contributed to the large response variances.

Item H43 consisted of three parts for occupants of rented housing units to complete on whether they paid for electricity, gas, and water, in addition to rent. H45 was a corresponding question on payment for fuel. Item H44 was the average monthly cost to the occupants for each utility they paid for. H46 was the annual cost of fuel if they paid for fuel. The instructions to the interviewers were fairly detailed.

Items H43-46 were edited in a sequence of operations. The editing was intended to correct careless marking

of the schedules by interviewers, and to correct inconsistencies. Several patterns of allocation were devised for blanks. (For a description of the interviewers' instructions and the editing and allocation processes for these items, see Bureau of the Census, *1960 Censuses of Population and Housing: Procedural History*, pp. 245-247.)

1. Estimates of response variance for selected 1960 census housing statistics

Table 8 shows the estimated response relvariances and coefficients of variation for the selected 0-1 items. The estimates of census sampling relvariances and coefficients of variation shown in columns 4 and 6 respectively, were computed from table III, page LXXIV, Bureau of the Census, *U.S. Census of Housing, 1960, Volume I, States and Small Areas, Part I: United States Summary*. Both the estimates of response relvariances and sampling relvariances apply to an enumeration by one interviewer in an area of about 1,300 housing units.¹

¹An area of 1,300 housing units was taken to correspond to an area of 3,900 population.

Table 8.--ESTIMATED RESPONSE RELVARIANCES FOR SELECTED HOUSING CHARACTERISTICS FOR AN ENUMERATION BY ONE INTERVIEWER IN AN AREA OF 1,300 HOUSING UNITS AND CENSUS SAMPLING RELVARIANCES FOR AREA OF SAME SIZE

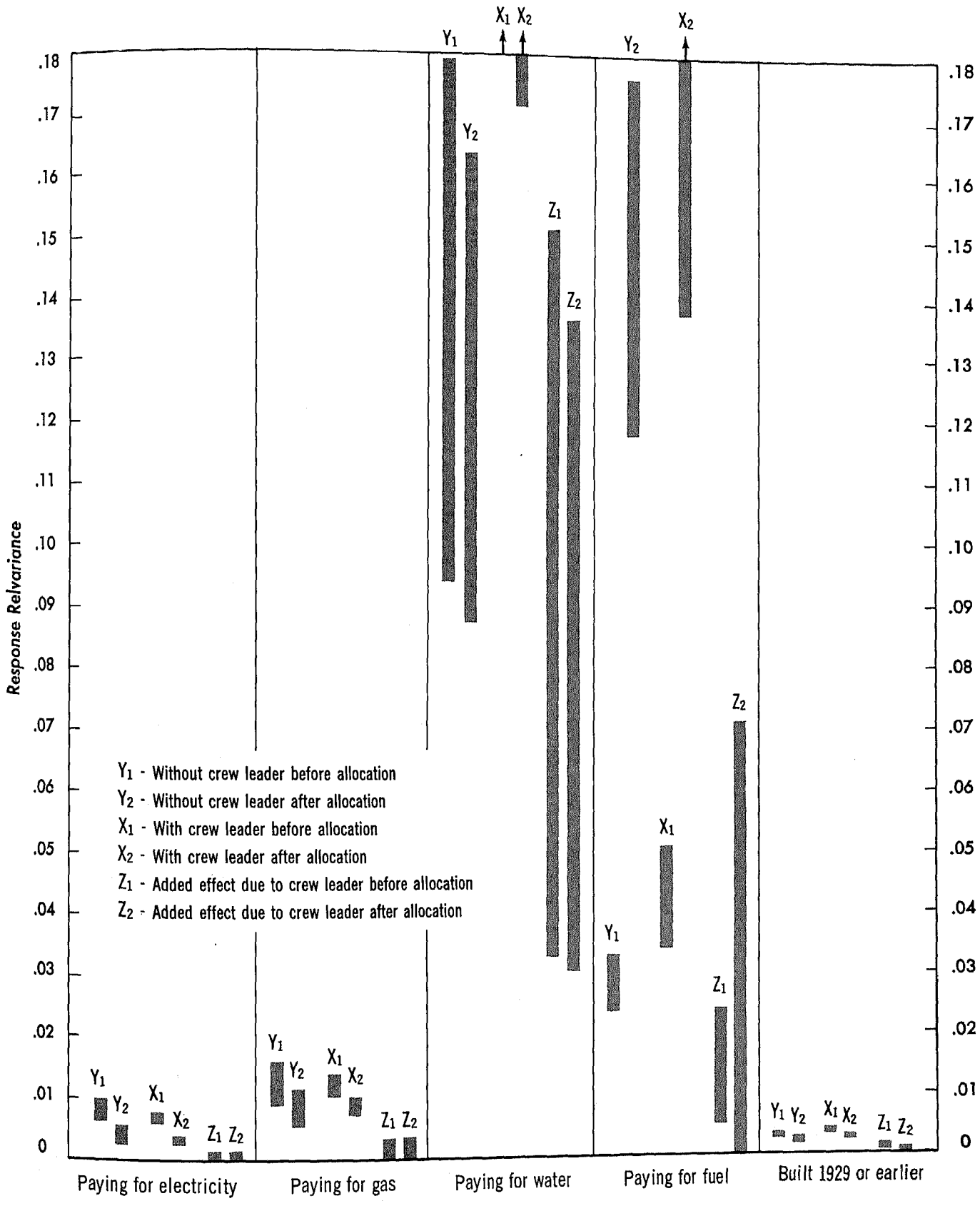
Housing characteristics	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of units	Percent of total	Response	Sampling	Response	Sampling		
Total dwelling units...	1,300	100.0	-	-	-	-	-	-
A. Without Crew Leader Effect								
Occupied, rented housing units paying for--								
Electricity:								
Before allocation.....	264	20.3	.00788	.01250	.089	.112	.63	.00081
After allocation.....	281	21.6	.00379	.01154	.062	.107	.33	.00068
Gas:								
Before allocation.....	218	16.8	.01276	.01592	.113	.126	.80	.00157
After allocation.....	235	18.1	.00848	.01437	.092	.120	.59	.00132
Water:								
Before allocation.....	78	6.0	.13669	.05523	.370	.235	2.47	.01836
After allocation.....	85	6.5	.12531	.05045	.354	.225	2.48	.01643
Fuel:								
Before allocation.....	83	6.4	.02790	.05133	.167	.227	.54	.00205
After allocation.....	91	7.0	.14710	.04715	.384	.217	3.12	.01257
Year built 1929 or earlier								
Before allocation.....	619	47.6	.00295	.00339	.054	.058	.87	.00018
After allocation.....	634	48.8	.00236	.00325	.049	.057	.73	.00019
Year built not reported.....	38	2.9	.48828	.10958	.699	.331	4.46	.02832
B. With Crew Leader Effect								
Occupied, rented housing units paying for--								
Electricity:								
Before allocation.....	272	20.9	.00689	.01201	.083	.110	.57	.00040
After allocation.....	290	22.3	.00313	.01110	.056	.105	.28	.00027
Gas:								
Before allocation.....	224	17.2	.01213	.01548	.110	.124	.78	.00075
After allocation.....	238	18.3	.00852	.01419	.092	.119	.60	.00067
Water:								
Before allocation.....	83	6.4	.22891	.05133	.478	.227	4.46	.01766
After allocation.....	88	6.8	.20915	.04801	.457	.219	4.36	.01606
Fuel:								
Before allocation.....	90	6.9	.04245	.04853	.206	.220	.87	.00355
After allocation.....	99	7.6	.17282	.04322	.416	.208	4.00	.01487
Year built 1929 or earlier								
Before allocation.....	593	45.6	.00394	.00361	.063	.060	1.09	.00017
After allocation.....	616	47.4	.00283	.00339	.053	.058	.83	.00013
Year built not reported.....	38	2.9	.74468	.10958	.863	.331	6.80	.03097

The estimates of response relvariances are generally higher than for most population characteristics. Notice, from column 7 that for only one item was the response variance less than one-half of the sampling variance. It is easy to see that if the response variances are ignored in the computation of the variability for these items, the total mean-square error of these statistics will be seriously underestimated.

Estimates of the variability of the response variances were calculated as described in chapter 9 and 98-percent confidence intervals were constructed. The estimates of

variability are shown in column 8 of table 8. Figure 7 shows the confidence intervals for the housing items, omitting the nonresponse item. The first block on the chart refers to "paying for electricity." The first bar is the confidence interval for the response relvariance without the crew leader effect and before allocation. The second bar shows the same item after allocation. The next two bars show the item with the crew leader effect, before and after allocation. The final two bars show the confidence intervals for the added effect due to crew leaders.

**Figure 7. 98-Percent Confidence Intervals for Response Relvariances
Housing Items**



The following observations are evident from this chart:

1. If the confidence interval encompasses the zero line, the estimate of response relvariance is within sampling variability of zero. Notice that not one estimate, with or without the crew leader effect, was within sampling variability of zero. In fact, the confidence intervals do not include zero and the lower endpoint is higher than zero for all the items. Notice the confidence interval for "paying for water" with the crew leader effect. The lower endpoint for the interval before allocation is so high it cannot be shown on the chart.

2. The confidence intervals for the added effect due to crew leaders occasionally include zero. This means that the crew leader added little or nothing to the response variance. This was true for paying for electricity, paying for gas, paying for fuel, after allocation, and built in 1929 or earlier, after allocation.

3. The longer the confidence interval, the larger is the variance associated with the estimate of response variance. While the intervals for paying for electricity and gas were fairly short, and the intervals for built in 1929 or earlier were very short, the ones for paying for water and paying for fuel were very long. Notice especially the long interval for the added effect due to crew leaders for the paying for fuel item after allocation.

4. Allocation tended to push the confidence interval in the direction of the zero line for all items except paying for fuel. For that item, the allocation process pushed the interval farther away from zero and increased the variability of the estimate of response relvariance. This may have been caused because fuel was edited separately from the other gross rent components since it was requested on a yearly basis.

Because there are only two housing characteristics--gross-rent components and year built--for which response variances are available, it is incorrect to apply the measures of response variance for those items to all housing items. However, as pointed out in the paragraphs above, these response variances were very large. We

have used the factor computed from the items studied to apply to all housing characteristics. However, readers who want to use a different factor can adjust the data accordingly.

Powell and Pritzker [15] show that the proportional increase in the variance of an estimate for any area larger than the interviewer's assignment area is $\rho_d \sigma_d^2 / \sigma_s^2$ (defined in chapter 4). These ratios are shown in column 7 of table 8. Because the ratios vary over the items, the median value of the ratios shown in the estimates with the crew leader effect is used to approximate the relationship between the sampling and response variances. This median ratio is .87. Therefore, the sampling variance should be multiplied by a factor of 1.87 to obtain a figure for the total variance that accounts for the increased variability due to the response variance. This reflects both the interviewer and the crew leader effect.

Table 8 shows estimates of 0-1 variates only. There were also four quantitative items for which response relvariances were computed. Table 9 shows the estimates for these gross rent items.

Since sampling variances for these items were not computed in the census, we do not show the ratio of response to sampling variance. An interesting result in table 9 is that, except for "yearly cost of fuel," all the estimates without the crew leader effect were larger than those with the crew leader effect. Of course, the crew leader must make a contribution to the response variance. The relationship observed in these estimates cannot be ascribed to sampling variability, but no other explanation has been found.

Figure 8 shows the confidence intervals for the response variances of these quantitative items. The following observations are evident from this chart:

1. The lower endpoints of the confidence intervals for the response relvariances did not include zero, except for the intervals showing the added effect due to crew

Table 9.--ESTIMATED RESPONSE RELVARIANCES FOR QUANTITATIVE GROSS RENT ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN AN AREA OF ABOUT 1,300 HOUSING UNITS

Item	Average value		Response relvariance		Response coefficient of variation	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
Monthly cost of electricity:						
Before allocation.....	\$7.49	\$7.27	.10016	.03296	.316	.182
After allocation.....	7.54	7.30	.06869	.03714	.262	.193
Monthly cost of gas:						
Before allocation.....	7.80	7.51	.08413	.04633	.290	.215
After allocation.....	7.82	7.55	.06497	.05409	.255	.233
Monthly cost of water:						
Before allocation.....	4.44	3.82	.69444	.25372	.833	.504
After allocation.....	4.48	3.83	.77750	.33115	.882	.575
Yearly cost of fuel:						
Before allocation.....	148.24	144.25	.05392	.05327	.232	.231
After allocation.....	142.38	138.63	.05239	.04736	.229	.218

Figure 8. 98-Percent Confidence Intervals for Response Relvariances

Quantitative Gross Rent Items

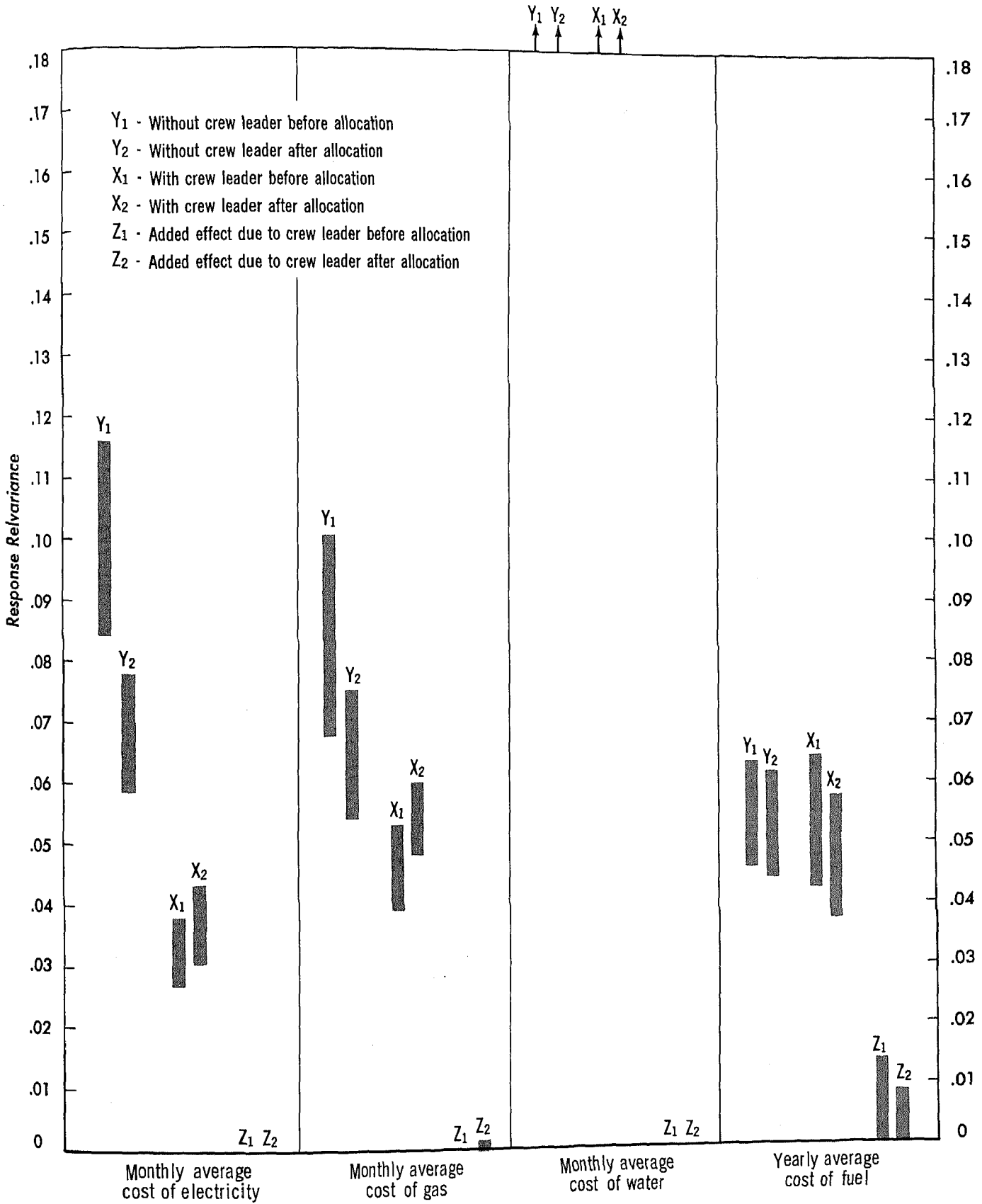


Table 10.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR HOUSING ITEMS FOR HIGHLY URBAN, OTHER URBAN AND RURAL AREAS

Housing items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
<u>OCCUPIED RENTED UNITS</u>						
Paying for electricity:						
Before allocation.....	1.52	.78	.40	.56	.04	.44
After allocation.....	1.12	.40	.00	.34	.03	.08
Paying for gas:						
Before allocation.....	1.54	.92	.48	.98	.40	.36
After allocation.....	1.24	.52	.24	.94	.41	.10
Paying for water:						
Before allocation.....	13.07	34.66	.79	.57	1.26	.75
After allocation.....	11.60	31.69	.78	.66	1.43	.50
Paying for fuel:						
Before allocation.....	1.53	.88	.38	.60	.44	1.31
After allocation.....	11.50	20.56	2.80	.81	.79	1.85
<u>YEAR BUILT</u>						
1929 or earlier:						
Before allocation.....	1.89	1.59	.65	1.10	.55	.99
After allocation.....	1.15	.89	.58	.92	.74	.83
Year built not reported.....	5.14	2.93	3.06	3.53	4.75	13.10

leaders. The response relvariances were large, but not as large as for "paying for water" as shown on figure 7.

2. The confidence intervals for the added effect due to crew leaders all include zero. This is, for at least two of the items--cost of electricity and cost of water--because of using a restricted estimate. (See page 15.) If the end-points of the confidence interval were negative, they were replaced by zero.

3. The confidence intervals are not especially long when compared with some of those for the 0-1 variates shown in figure 7. This indicates that the sampling variability of the estimates of response relvariance were not especially large.

4. Allocation tended to reduce the response relvariance for the data without the crew leader effect (with the exception of the item "cost of water"). It tended to increase the response relvariance for data with the crew leader effect except for "cost of fuel."

2. Estimates of response variance by type of area

A description of the basis for dividing the clusters into highly urban, other urban, and rural areas is given in chapter 6. The response relvariances were computed for the housing items for these three types of area. Table 10 shows the ratios of response to sampling variance for the housing items which are 0-1 variates.

Except for the highly urban areas, the estimates with the crew leader effect are generally the larger. All of these estimates are subject to sampling variability. The

estimates of sampling variability were not computed for the estimates of response variance by type of area. However, there were fewer clusters in the highly urban areas than in the other two areas, so the sampling variability for these estimates is larger. The other urban areas had the most clusters, so the estimates are probably subject to the least sampling variability.

Notice that the effect of allocation is generally to decrease the response variance except for the "paying for fuel" item. This same effect was noted in the previous section. From the results shown in table 10, it is obvious that in applying these estimates of response variance to a specific area, it is important to identify the type of area, and apply the estimates corresponding to that type of area. Medians of the ratios of the response to sampling variances were computed by type of area both with and without the crew leader effect. Table 11 shows these medians.

Table 11.--MEDIAN RATIOS OF RESPONSE TO SAMPLING VARIANCES FOR HOUSING ITEMS FOR HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Type of area	Median ratio of response to sampling variance	
	Without crew leader effect	With crew leader effect
Highly urban.....	1.54	.92
Other urban.....	.58	.81
Rural.....	.55	.75
All.....	.83	.87

The response variances were also produced for the quantitative gross rent items. These estimates also varied depending on the type of area. For almost every item, for each type of area, we find again the unexplained fact that the estimate without the crew leader effect was greater than the estimate with the crew leader effect.

3. Comparison of 1950-1960 levels of response variance

It is difficult to make a valid comparison of the levels of response variance for housing characteristics from 1950 and 1960 because none of the items studied were the same. The items selected in the 1950 EVS were asked of all housing units in 1960 (i.e., were not sample items) and so were not included in the 1960 RVS.

Table 12 shows the estimates of response relvariance for selected items from the 1950 EVS. The estimates of the sampling relvariance are theoretical and are not estimated from the census results. The estimates are theoretical relvariances derived from assuming a 25-percent simple random sample of housing units without replacement in an area of 1,992 housing units. For housing characteristics,

$$\begin{aligned}
 V_s^2 &= \frac{N-n}{N-1} \cdot \frac{1}{n} \cdot \frac{Q}{P} \\
 &= \frac{3}{4n} \cdot \frac{Q}{P} \\
 &= \frac{3}{1,992} \cdot \frac{Q}{P} \quad (7.1)
 \end{aligned}$$

The sampling relvariances shown were obtained by substituting the values of P and Q = 1-P shown in column 2.

It was assumed that the level of the response variance in 1950 was about equal to the sampling variance of a 25-percent household sample. Figure 9 shows the 25-percent sampling variance function of equation 7.1 with the response coefficients of variations plotted on the same graph. Approximately one-half of the points are above the sampling variance function and about one-half below.

To provide comparisons of 1950 data with 1960 data, similar estimates of sampling relvariance were derived from the same sampling variance model for the 1960 data. In this case, 4n was 1,300, so

$$V_s^2 = \frac{3}{1,300} \cdot \frac{Q}{P} \quad (7.2)$$

Only the estimates without the crew leader effect were used, since crew leader effect was not measured in 1950. The appropriate relvariances were found by substituting the values of P and Q = 1-P from table 8. A 25-percent sampling variance function was assumed to be correct for the 1960 data also. About one-half the points are above the curve, and half below as shown in figure 10. The 25-percent sampling variance function seems to provide as good a fit for the 1960 data as for the 1950 data.

Since the housing characteristics studied for 1950 were not the same ones as those studied for 1960, even though a 25-percent sampling variance function provided as good a description of the 1960 estimates as the 1950 estimates of response variance, it is not possible to say that the overall levels of response variance were the same in 1950 and 1960 for housing characteristics. At this point, all we can say is that the response variances for housing characteristics were high both in 1950 and in 1960.

4. Summary of data on housing items

- a. Large response variances were found for all housing items investigated. For only one of the 0-1 variates--paying for electricity, after allocation--was the response variance less than the sampling variance. In many cases, the contribution from the response variance to the total mean-square error of these housing statistics was greater than the contribution from the sampling variance.
- b. The crew leader effect for many of the housing items studied was within sampling variability of zero. Therefore, we may assume that, for these characteristics, the crew leader adds little or nothing to the variability of the statistics.

Table 12.--1950 EVS: ESTIMATED RESPONSE RELVARIANCES FOR AN ENUMERATION BY SEVEN INTERVIEWERS IN AN AREA OF 1,922 HOUSING UNITS AND SAMPLING RELVARIANCES OF A 25-PERCENT HOUSEHOLD SAMPLE OF SAME AREA

Characteristic	Average census result		Relvariance		Coefficient of variation		Ratio of response to sampling variance
	Number of units	Percent of total	Response	Sampling	Response	Sampling	
Total dwelling units:							
Occupied, total.....	1,897	95.2	.00000	.00008	.000	.009	0.0
Owner occupied.....	1,249	62.7	.00102	.00090	.032	.030	1.1
Renter occupied.....	648	32.5	.00372	.00313	.061	.056	1.2
Vacant, for sale or rent.....	20	1.0	.03422	.14910	.185	.386	0.2
Other vacant and nonresident.....	76	3.8	.00000	.03813	.000	.195	0.0
Condition and plumbing:							
No bath or dilapidated.....	652	32.7	.00518	.00310	.072	.056	1.7
No water or dilapidated.....	334	16.8	.02016	.00746	.142	.086	2.7
Persons per room:							
1.5 or more persons per room.....	76	3.8	.02690	.03813	.164	.195	.7
Number not reported.....	27	1.3	.08762	.11434	.296	.338	.8

**Figure 9. Response Coefficient of Variation for Housing Characteristics
in Places of 1,992 Housing Units: 1950 Census**

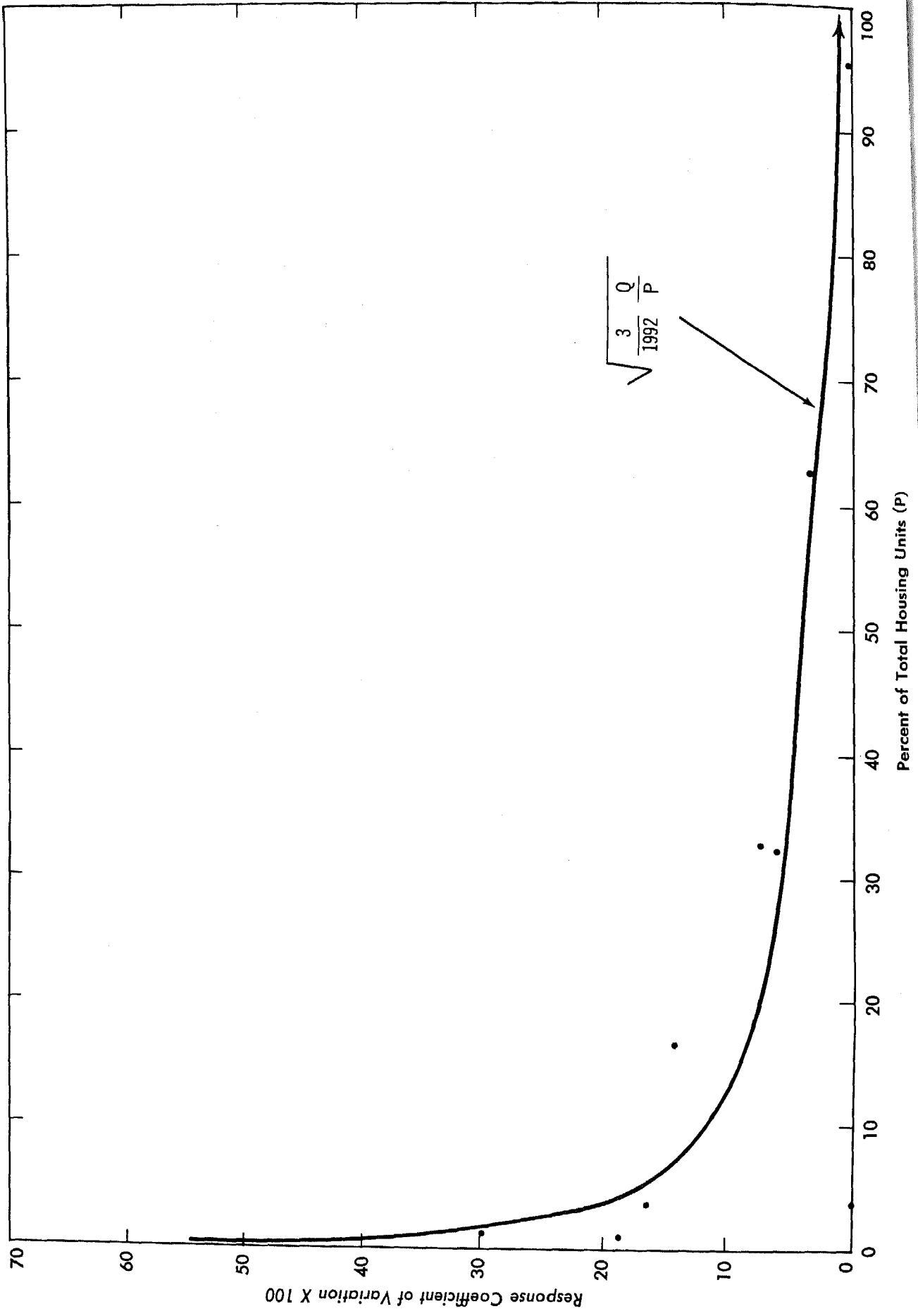
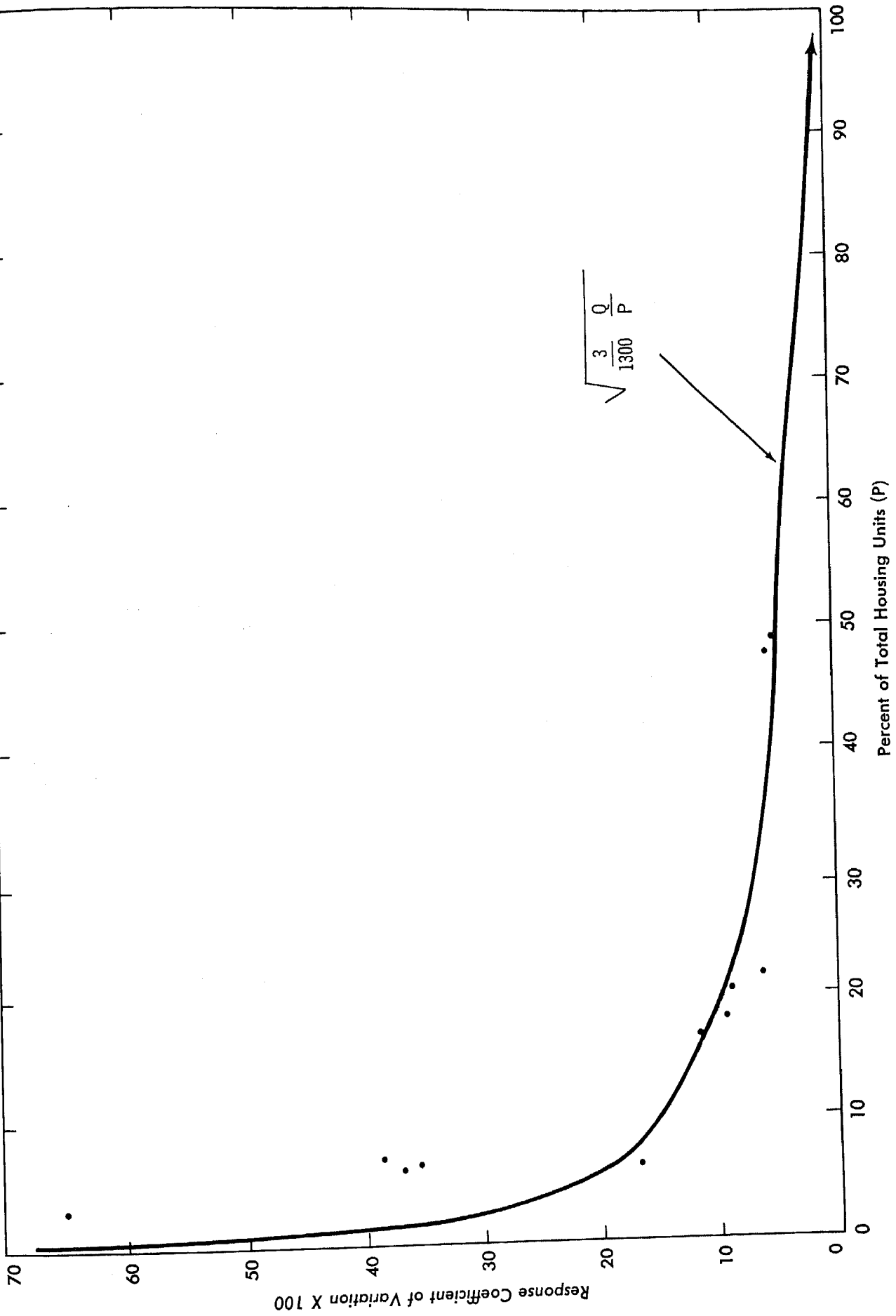


Figure 10. Response Coefficient of Variation for Housing Characteristics in Places of 1,300 Housing Units: 1960 Census



- c. For most of the 0-1 variates studied, the allocation process tended to decrease the response variance. A notable exception to this was the "paying for fuel" item.
- d. There were large differences in the response variances of the housing items depending on the type of area--highly urban, other urban, or rural.
- e. The response variances for housing statistics were large both in 1950 and in 1960. Since the characteristics studied in 1950 and 1960 were not the same, it is not possible to make any comparisons of the levels of response variance in 1950 and 1960.

B. NATIVITY

Figure 11 shows the question used in the 1960 census to determine the nativity status of the population.

The information was used to classify the population into native born and foreign born. Persons who left this item blank were assumed to be native born, unless other entries indicated otherwise. The interviewer was supposed to fill a circle for "this State" or write in the name of the State or foreign country of birth. For persons

P8. What State or foreign country was he born in?
 Mark circle or write name of State, country, U.S. possession, etc. Distinguish Northern Ireland from Ireland (Eire).

This OR

State (Different State, foreign country, U.S. possession, etc.)

Figure 11.--Question P8 on nativity, 1960 Decennial Census schedule.

born in hospitals, interviewers were instructed to enter the State of the mother's residence, not the State the hospital was in. For a discussion of the instructions to interviewers, and the coding, editing and allocation process for this item, see [21], pp. 194-195.

1. Estimates of response variance for 1960 census nativity statistics

Table 13 shows the estimated response relvariances and coefficients of variation for the two nativity items. Sampling relvariances and coefficients of variation were computed for these statistics from the following formula:

$$V_s^2 = \frac{2.43 Q}{N P} \cdot k \quad (7.3)$$

where N is 3,900, where P is the percent shown in column 2 of the table and Q = 1-P. The 2.43 is a factor reflecting the effect of ratio estimation, geographic stratification, and so forth in the census estimation process. This factor was computed during some calculations from a preliminary sample of the 1960 census results. The value of k for nativity items is (1.4)². For most characteristics the use of the household as a sampling unit increased the variance above what would be expected for a simple random sample of the same number of persons. Sample items such as nativity tend to have a similar value for all members in a household and may have a higher variance than if a sample of persons were used. The factor k reflects this increase in variance.

It is immediately apparent, that though the response relvariance is not very large in magnitude, it is very large in comparison with the sampling relvariance, at least for the native born category. It is also apparent that the crew leader effect for that category is quite pronounced.

Table 13.--ESTIMATED RESPONSE RELVARIANCES FOR NATIVITY FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Nativity	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
Total persons.....	3,900	100.0	-	-	-	-	-	-
A. Without Crew Leader Effect								
Native born:								
Before allocation.....	3,592	92.1	.00037	.00010	.019	.010	3.7	.00006
After allocation.....	3,705	95.0	.00024	.00006	.015	.008	4.0	.00006
Foreign born:								
Before allocation.....	230	5.9	.00771	.01947	.088	.140	.40	.00176
After allocation.....	195	5.0	.00760	.02321	.087	.153	.33	.00166
B. With Crew Leader Effect								
Native born:								
Before allocation.....	3,631	93.1	.00114	.00009	.034	.009	12.7	.00004
After allocation.....	3,705	95.0	.00036	.00006	.019	.008	6.0	.00004
Foreign born:								
Before allocation.....	191	4.9	.00000	.02369	.000	.154	.00	.00165
After allocation.....	195	5.0	.00000	.02321	.000	.153	.00	.00166

Estimates of the variability of the response reliabilities were computed and the corresponding 98-percent confidence intervals. For the native born category, the confidence interval does not include zero, for either the estimate with or without the crew leader effect. For the foreign born category, the estimate with the crew leader effect is zero, and without the crew leader effect is greater than zero with the confidence interval not including zero. Figure 12 shows these confidence intervals.

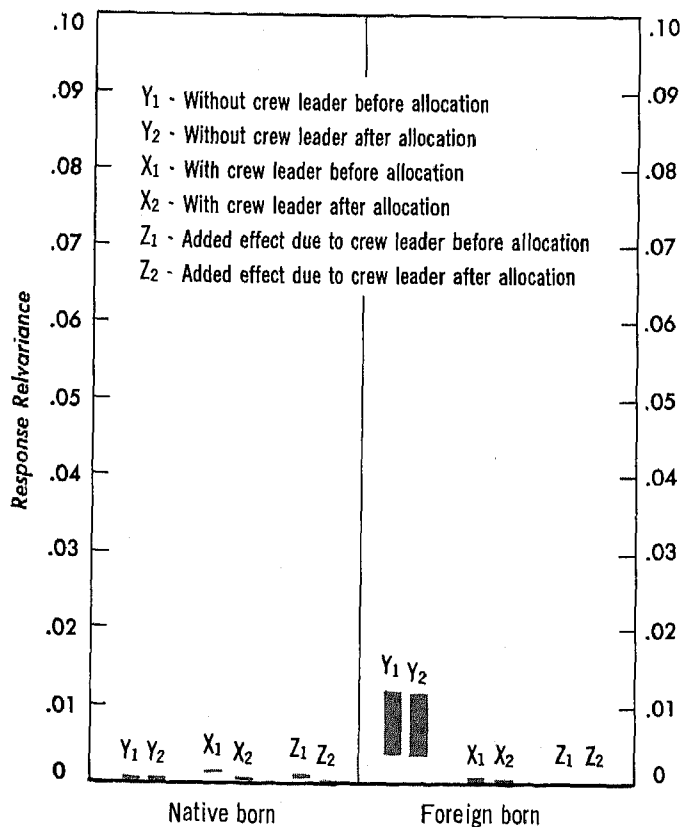
For the native born item, the confidence intervals are short and close to the zero line. Notice, too, that the confidence interval for the added effect due to crew leaders is above the zero line before allocation. This indicates that the crew leader did have an effect on this item.

For the foreign born item, the confidence interval for the response reliability without the crew leader was farther above zero and longer, indicating that there was more variability in the estimate of response variance for this item. The crew leader had no effect on this item.

As with the housing items, it would be helpful to have a factor by which to multiply the sampling variance to reflect the proportional increase in the variance accounted

Figure 12. 98-Percent Confidence Intervals for Response Relvariances

Nativity Items



for by the increased variability due to interviewers and crew leaders. Because there are only two items, and the estimates with and without the crew leader effect are so different, it is difficult to assign a value to the multiplier. A conservative approach is to use 3. This will underestimate the value for native born, and overestimate the value for foreign born. If a person had a specific item in mind for which he wanted to estimate the increase in variance due to interviewers and crew leaders, it would be more appropriate to decide which of the two items listed it resembles. He should then apply the multiplier for that item. For example, suppose a person were interested in the item "native-born white persons, 14 years and over." This clearly resembles the "native born" item. Therefore, he should use the factor 6.0 (from column 7 of table 13) to measure the increased variability due to interviewers and crew leaders.

An examination of the effects of allocation show that the allocation process effectively decreased the response variance for the native born category. The effect for the foreign born category is not so striking, though there was a decrease. The effect of allocation is partially explained when it is noted that blanks were always changed to native born.

2. Estimates of response variance by type of area

We are interested in knowing whether the response variances for the nativity items varied by type of area. Table 14 shows the ratios of the response to sampling variance for highly urban, other urban, and rural areas.

The rural areas produced extremely high response variances for the native born category, and the crew leader effect was especially noticeable. The sampling variances of these estimates were not calculated, so we do not know whether these estimates may be within sampling variability of one another.

3. Comparison of 1950-1960 levels of response variance

An exact comparison of the response variances for nativity items from 1950 and 1960 is not possible. In 1950 the items investigated were "native white" and "foreign white." In 1960 the items were "native born" and "foreign born."

If we compare the ratios of the response to the sampling variances for native born and native white and foreign born with foreign white, the ratio is smaller in 1960 for the foreign born category but larger for the native born category. However, these comparisons are not very meaningful because of the differences in concepts.

4. Summary of data on nativity items

- a. The response variance for the native born item is very large in comparison with the sampling variance for that item. This is probably an indication that some interviewers did not bother to ask the question or if it was left blank on the household questionnaire, they assumed the answer to be native born.

Table 14.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR NATIVITY ITEMS FOR HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Nativity items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
Native born:						
Before allocation.....	3.13	1.06	3.14	3.43	8.00	23.50
After allocation.....	2.75	.39	4.80	1.00	4.00	45.50
Foreign born:						
Before allocation.....	.52	.00	.23	.29	.10	.00
After allocation.....	.53	.00	.24	.31	.11	.00

- b. The crew leader effect was large for the native born item, before allocation. This may be due to the training by the crew leaders of their interviewers, or it may have been due to the editing of the schedules done by the crew leader at regular times during the enumeration. It may reflect the fact that some crew leaders allowed more non-responses than others. During the allocation, nonresponses were changed to native born.
- c. Allocation tended to decrease the response variance.
- d. There were large differences in the response variances of nativity statistics depending on the type of area--highly urban, other urban, or rural.
- e. Comparisons between 1950 and 1960 response variances for nativity statistics are meaningless because of the differences in concepts.

C. RESIDENCE IN 1955

On the census questionnaire, the questions shown in figure 13 were included for the purpose of discovering the mobility of the population in the preceding 5 years.

This was a complex item for interviewers to fill. P12 was to be filled for every person. Then, depending on the answer to P12, the interviewer was to fill P13a or skip to P14, a new characteristic. In P13a, if the person was five years of age or over, or had not lived in the same house on April 1, 1955, the interviewer was to fill P13b or P13c or both. The understanding an interviewer had of the patterns of filling these items was largely dependent on his understanding of the training on these items. The crew leader had the opportunity of affecting the data for this item both by his training on the concepts and by his field editing of this item. As is shown in table 15, the crew leader had a considerable effect on these data.

P12. In what year did he move into this house (or apartment)? Mark date of last move

Jan. 1954 to
 March 1955

1959-60 --- 1950-53 ---

1958 --- 1940-49 ---

1957 --- 1939 or earlier

April 1955 to Dec. 1956 Always lived here --

Ask P13
 ↓

Skip to P14

P13a. In what city (or town) did he live on April 1, 1955?

Born April 1955 or later *Skip to next person*
 This house --- *Skip to P14*
 Not in a city -- *Skip to P13c*
 This city ---
 Different city → *Specify*

P13b. If city or town--Did he live inside (Yes the city limits? (No

P13c. In what county (and State) did he live?

This county County.....
 Different county → *Specify* }
 State.....
 (or foreign country, etc.)

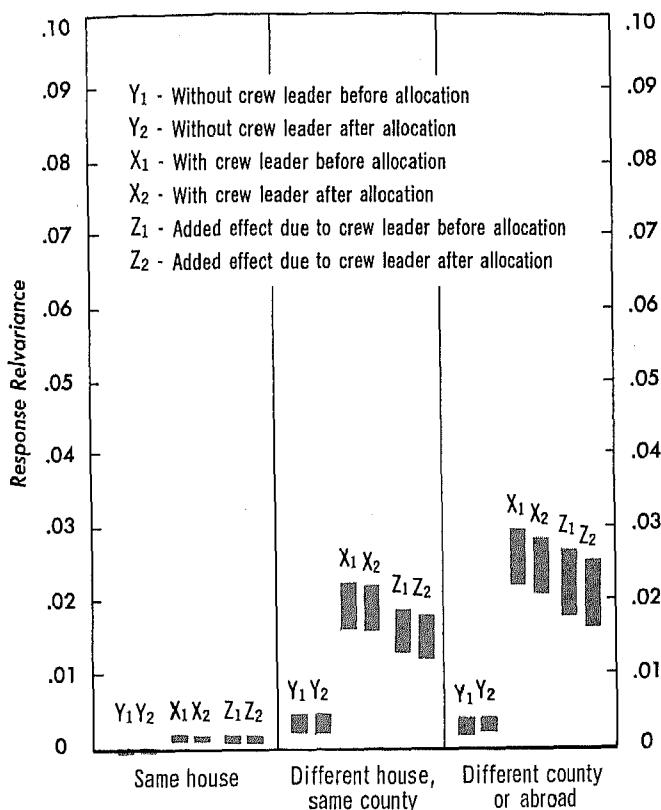
Figure 13.--Questions P12 and P13 on mobility, 1960 Decennial Census schedule.

1. Estimates of response variances for residence in 1955 items

Table 15 shows the estimated response relvariances and coefficients of variation for the residence in 1955 items. Sampling relvariances and coefficients of variation were computed using equation 7.3, where, for these items, k was (1.8)². The estimates refer to places of 3,900 persons.

Ninety-eight percent confidence intervals were constructed for the response relvariances with the crew leader effect, without the crew leader effect, and for the added effect due to crew leaders. These confidence intervals are shown in figure 14.

Figure 14. 98-Percent Confidence Intervals for Response Relvariances 1955 Residence Items



Notice that confidence intervals for only one item include the zero line--the one for "same house," without crew leader effect. Indeed, the crew leader effect shows very dramatically for all three items. Probably the crew leader effect was determined by the understanding the crew leaders had of the questions.

Figure 14 also shows the effect of allocation. Only about .8 percent of the population were allocated a response and 1.6 percent were left as nonresponse. There are no shifts shown for the "same house" category and only minor shifts for the "different house, same county" category.

We would like to develop a multiplier of the sampling variance to reflect the proportional increase in the variance of an estimate due to response variance. If we use the data which includes the crew leader effect, a factor of about 2.8 would be appropriate for all but the "same house" category. However, the multiple should be used only as a rough approximation. A user should decide which of the three items in table 15 is most like the item he is interested in and then apply the appropriate ratio shown in column 7.

2. Estimates of response variance by type of area

Table 16 shows the ratios of response variance to sampling variance for mobility items for highly urban,

other urban, and rural areas. The crew leader effect is especially noticeable in the rural areas, and is also very strong in other urban areas. Only in highly urban areas are some of the estimates without the crew leader effect larger. These estimates may be within sampling variability of each other but we do not know since the estimates of sampling variability were not computed. As with the other characteristics, the response variance varies considerably depending on the type of area.

3. Comparison of 1950-1960 response variances

The question on mobility in the 1950 census referred to residence 1 year earlier rather than 5 years earlier. For that reason, data on the relationship of the response variances are not comparable. However, if we are willing to accept the differences in concept, it may be of interest to make a limited comparison of the 1950 and 1960 data.

Since the estimates of response variances are not directly comparable, we will make the comparisons of the ratios of response to sampling variance. The data from 1960 is without the crew leader effect since that component was not measured in 1950. Let us assume a theoretical sampling variance model as follows:

N = number of persons in population

n = number of persons in sample

P = proportion of population having characteristic

$Q = 1 - P$

ρ = intraclass correlation within households

\bar{n} = average number of persons per household.

The sampling relvariance is:

$$V_s^2 = \frac{N-n}{N-1} \cdot \frac{1}{n} \cdot \frac{Q}{P} [1 + \rho (\bar{n}-1)]$$

$$\doteq \left[1 - \frac{n}{N}\right] \cdot \frac{1}{n} \cdot \frac{Q}{P} [1 + \rho (\bar{n}-1)] \tag{7.4}$$

Assume a 25-percent sample, so $n/N = 1/4$. Also for this characteristic assume $\rho = 0.8$ and $\bar{n} = 3.5$. Then

$$V_s^2 \doteq \frac{3}{4} \cdot \frac{1}{n} \cdot \frac{Q}{P} [1 + 0.8 (2.5)]$$

$$\doteq \frac{1}{4n} \cdot \frac{Q}{P} \cdot 3(3)$$

$$\doteq \frac{9}{4n} \cdot \frac{Q}{P}$$

$$\doteq \frac{9}{N} \cdot \frac{Q}{P} \tag{7.5}$$

For the 1950 experiment, $N = 6,500$; for the 1960 experiment $N = 3,900$.

Table 15.--ESTIMATED RESPONSE RELVARIANCES FOR MIGRATION ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Residence 5 years earlier	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
Same house:								
Before allocation.....	1,767	45.3	.00013	.00244	.011	.049	.05	.00014
After allocation.....	1,786	45.8	.00013	.00239	.011	.049	.05	.00014
Different house, same county:								
Before allocation.....	885	22.7	.00353	.00687	.059	.083	.51	.00059
After allocation.....	885	22.7	.00351	.00687	.059	.083	.51	.00060
Different county or abroad:								
Before allocation.....	714	18.3	.00324	.00902	.057	.095	.36	.00051
After allocation.....	757	19.4	.00385	.00839	.062	.092	.46	.00047
B. With Crew Leader Effect								
Same house:								
Before allocation.....	1,802	46.2	.00158	.00235	.040	.048	.67	.00021
After allocation.....	1,786	45.8	.00156	.00239	.040	.049	.65	.00020
Different house, same county:								
Before allocation.....	885	22.7	.01929	.00687	.139	.083	2.81	.00119
After allocation.....	893	22.9	.01891	.00680	.138	.082	2.78	.00118
Different county or abroad:								
Before allocation.....	714	18.3	.02578	.00902	.161	.095	2.86	.00177
After allocation.....	757	19.4	.02476	.00839	.157	.092	2.95	.00172

Table 16.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR MIGRATION ITEMS FOR HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Residence in 1955 items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
Same house:						
Before allocation.....	.87	.56	.08	.75	.00	.58
After allocation.....	.85	.57	.06	.77	.00	.53
Different house, same county:						
Before allocation.....	.29	1.22	1.03	1.62	.00	6.00
After allocation.....	.34	1.24	1.04	1.62	.00	5.90
Different county or abroad:						
Before allocation.....	.75	.33	.28	2.21	.32	5.28
After allocation.....	.90	.12	.52	2.28	.19	5.08

The sampling relvariances were computed for 1950 and 1960 items after allocation using equation 7.5. The ratios of response to sampling variance was then computed giving the following results:

	1960	1950
Same house. . . . .	.05	.41
Different house, same county. . .	.45	1.03
Different county or abroad. . . .	.40	.45

The ratios are substantially lower in 1960 than in 1950 for the first two items. This result is interesting, since, if the methods of enumeration were the same, we might expect the 1950 ratios to be smaller. The question referred to the year preceding in 1950, so was not as complex. However, for every category, the 1960 ratios were smaller. This is an indication that the response variance was probably smaller in 1960 than in 1950 for mobility items.

4. Summary of data on 1955 residence items

- For the data without the crew leader effect, response variances were less than half the sampling variances for two of the three items. For one item--same house in 1955--the response variance was very small.
- The crew leader effect was very pronounced for this characteristic. In fact, the crew leader component was larger for this characteristic than for any other one. A change in the complex structure of the question, more training, etc., may be of help in reducing the response variance.
- The allocation process tended to decrease the response variances for this characteristic, but only slightly, since very few nonresponses were allocated an entry.
- There were large differences in the response variances of mobility statistics depending on the type of area. The crew leader effect was especially noticeable in the rural areas.
- From the available evidence, there is a strong indication that the response variances for mobility statistics were smaller in 1960 than in 1950.

D. EDUCATIONAL ATTAINMENT

There were four questions asked on the 1960 census schedule about education. Figure 15 shows these questions. Questions P14 and P15 were used to determine educational attainment; questions P14-P17 were used to determine school enrollment and type of school in which enrolled. This section is devoted to educational attainment; the next section deals with school enrollment.

Data on educational attainment were collected for all persons 5 years of age and over. The results in this section deal only with educational attainment of persons 25

P14. What is the highest grade (or year) of regular school he has ever attended? Mark only 1 circle

Never attended school --- Skip to P18

Kindergarten -

Elementary school -- { 1 2 3 4 5 6 7 8

High school - { 1 2 3 4

College --- { 1 2 3 4 5 6 or more

P15. Did he finish this grade (or year)? Yes No

P16. If born after March 1925-- Has he attended regular school (or college) at any time since Feb. 1, 1960?

Yes, regular school No

Ask P17 ↓ Skip to P18

P17. Is it a public school or a private school?

Public school -----

Private or parochial school

Figure 15.--Questions P14-P17 on educational attainment and school enrollment, 1960 Decennial Census schedule.

years of age and over. The information was to relate to persons in "regular" school only. This included schools which might advance a person toward an elementary or high school degree, or a college, university, or professional diploma. It was not to include nursery schools, vocational or trade schools, and so forth.

No manual coding was needed. However, there was extensive computer editing and allocation. For details on the concepts, interviewer instructions, machine editing and the allocation process, see [21], pp. 199-201.

1. Estimates of response variances for educational attainment items

Table 17 shows the estimates of response relvariances for the nine educational attainment items studied. The sampling relvariances were estimated from equation 7.3 with the value of k = 1.0.

Ninety-eight percent confidence intervals were constructed for the response relvariances of these educational attainment statistics, omitting the nonresponse item. These confidence intervals are shown on figure 16. From this figure it can be seen that, except for the confidence intervals for the added effect due to crew leaders, most of the intervals did not include zero. This indicates that the response variance was positive.

For several of the items, the confidence intervals for the added effect of the crew leaders included the zero line. This indicates that the crew leader effect is either zero or close to zero.

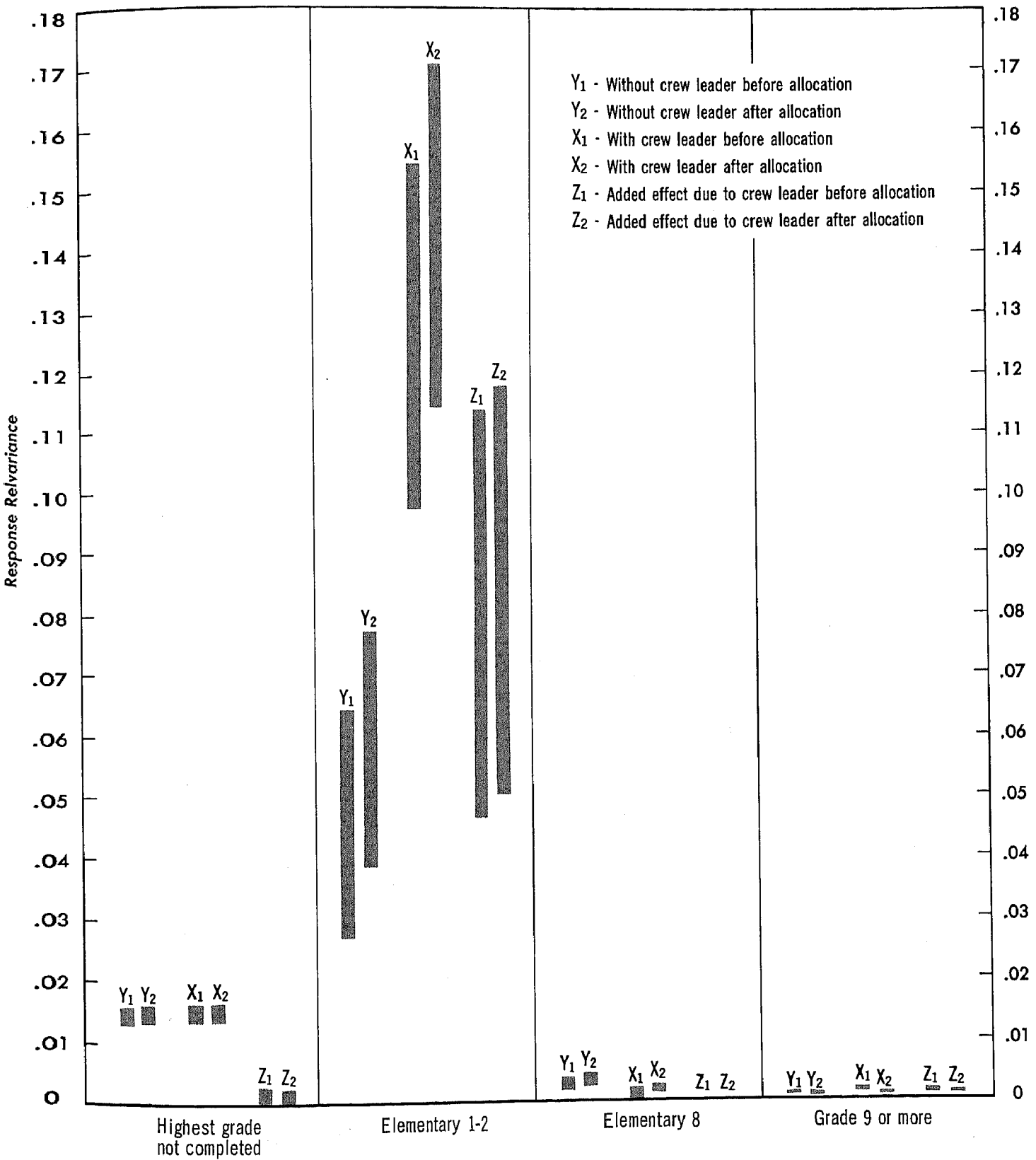
Notice the intervals for "completed elementary 1-2." These are the highest intervals for any category in educational attainment. The crew leaders had a strong effect on this category. They also had a positive effect on "completed college 5 or more."

Evaluation and Research Program, 1960 Censuses

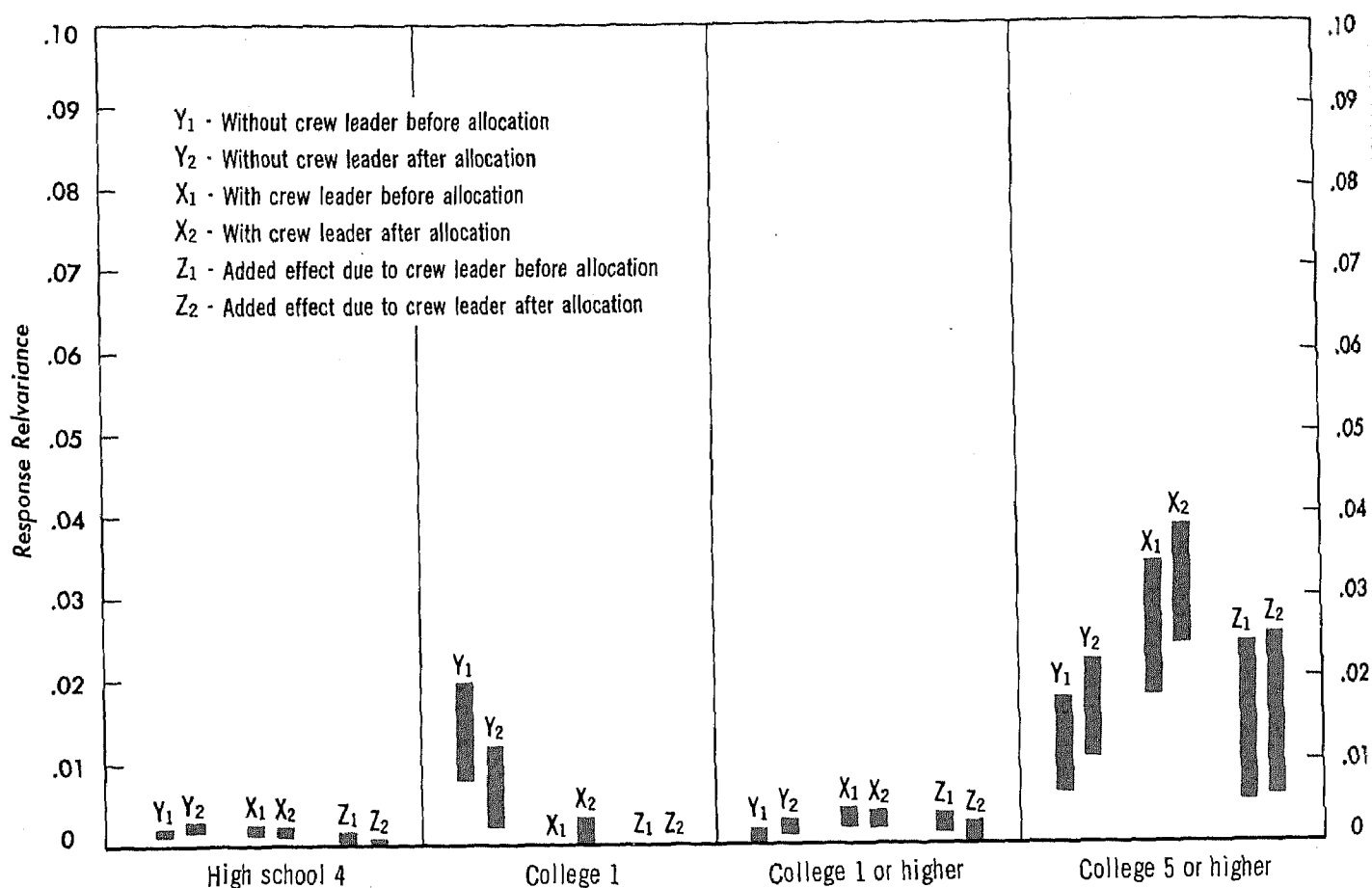
Table 17.--ESTIMATED RESPONSE RELVARIANCES FOR EDUCATIONAL ATTAINMENT ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Educational attainment item	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
Highest grade of school attended not completed:								
Before allocation.....	441	11.3	.01419	.00489	.119	.070	2.90	.00061
After allocation.....	480	12.3	.01438	.00444	.120	.067	3.24	.00056
Highest grade of school completed--								
Elementary 1-2:								
Before allocation.....	20	.5	.04577	.12716	.214	.356	.36	.00807
After allocation.....	23	.6	.05840	.10147	.242	.318	.58	.00829
Elementary 8:								
Before allocation.....	378	9.7	.00224	.00580	.047	.076	.39	.00043
After allocation.....	394	10.1	.00296	.00555	.054	.074	.53	.00043
Grade 9 or over:								
Before allocation.....	1,299	33.3	.00035	.00125	.019	.035	.28	.00008
After allocation.....	1,353	34.7	.00030	.00117	.017	.034	.26	.00008
High school 4:								
Before allocation.....	546	14.0	.00131	.00383	.036	.062	.34	.00024
After allocation.....	569	14.6	.00208	.00364	.046	.060	.57	.00024
College 1:								
Before allocation.....	62	1.6	.01384	.03808	.118	.195	.36	.00257
After allocation.....	66	1.7	.00667	.03587	.082	.189	.19	.00223
College 1 or higher:								
Before allocation.....	386	9.9	.00058	.00567	.024	.075	.10	.00035
After allocation.....	394	10.1	.00192	.00555	.044	.074	.35	.00041
College 5 or higher:								
Before allocation.....	62	1.6	.01147	.03808	.107	.195	.30	.00251
After allocation.....	66	1.7	.01599	.03587	.126	.189	.45	.00262
Not reported.....	86	2.2	.23341	.02777	.483	.167	8.4	.00917
B. With Crew Leader Effect								
Highest grade of school attended not completed:								
Before allocation.....	460	11.8	.01482	.00466	.122	.068	3.18	.00061
After allocation.....	480	12.3	.01478	.00444	.122	.067	3.33	.00060
Highest grade of school completed--								
Elementary 1-2:								
Before allocation.....	20	.5	.12601	.12716	.355	.356	.99	.01217
After allocation.....	23	.6	.14277	.10147	.378	.318	1.41	.01200
Elementary 8:								
Before allocation.....	386	9.9	.00065	.00567	.026	.075	.11	.00028
After allocation.....	394	10.1	.00168	.00555	.041	.074	.30	.00030
Grade 9 or over:								
Before allocation.....	1,326	34.0	.00104	.00121	.032	.035	.86	.00009
After allocation.....	1,353	34.7	.00070	.00117	.026	.034	.60	.00005
High school 4:								
Before allocation.....	558	14.3	.00173	.00374	.042	.061	.46	.00029
After allocation.....	569	14.6	.00160	.00364	.040	.060	.44	.00024
College 1:								
Before allocation.....	62	1.6	.00000	.03808	.000	.195	.00	.00176
After allocation.....	66	1.7	.00000	.03587	.000	.189	.00	.00189
College 1 or higher:								
Before allocation.....	386	9.9	.00316	.00567	.056	.075	.56	.00048
After allocation.....	371	9.5	.00303	.00594	.055	.077	.51	.00050
College 5 or higher:								
Before allocation.....	62	1.6	.02587	.03808	.161	.195	.68	.00349
After allocation.....	66	1.7	.03118	.03587	.177	.189	.87	.00324
Not reported.....	86	2.2	.23987	.02776	.490	.167	8.6	.01118

Figure 16. 98-Percent Confidence Intervals for Response Relvariances
Educational Attainment Items



**Figure 16. 98-Percent Confidence Intervals for Response Relvariances
Educational Attainment Items (continued)**



In contrast to the characteristics presented in previous sections, allocation tended to increase the response variances, especially for the estimates without the crew leader effect.

A multiplier of the sampling variance was computed to reflect the increase in the variance due to the interviewers and crew leaders. As with the other items, we used the median of the ratios after allocation in column 7 of part B of table 17. This multiplier is .60. A person who has a specific item in mind should find that item or the item most similar to it in table 17 and apply the ratio shown in column 7.

2. Estimates of response variance by type of area

Table 18 shows the ratios of response variances to sampling variances for educational attainment items for highly urban, other urban, and rural areas. For the most part, the estimates with the crewleader effect are larger as we would expect. Some of the ratios are quite large, especially in the rural areas. The sampling variances of the estimates of response variances were not computed by type of area. Therefore, we cannot tell which of the estimates may be within sampling variability.

3. Comparison of 1950-1960 response variances

For the data on educational attainment, the concepts were identical from 1950 to 1960. For these items, then, we are able to assess whether the response variability was less in 1960 than in 1950.

Because of the differences in size of assignment area and number of interviewers in an area, the estimates of response variance are not directly comparable. Again we make the comparisons of ratios of response to sampling variance. The data from 1960 are those estimates without the crew leader effect since this component was not measured in 1950. The sampling relvariances were computed by using formula 7.4, with $n/N = 1/4$, $\rho = 0.1$ and $\bar{n} = 3.5$; 1950 $N = 6,500$ and 1960 $N = 3,900$.

Though some of the items were identical from 1950 to 1960, there were some differences. The items and ratios are shown in table 19.

For three of the four items which were tabulated both in 1960 and 1950, the 1960 ratios were much smaller. Only for the nonresponse item was the 1960 ratio larger. It is clear that the response variances in 1960 for educational attainment items were much less than those in 1950.

Table 18.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR EDUCATIONAL ATTAINMENT ITEMS FOR HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Educational attainment items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
Highest grade of school attended not completed:						
Before allocation.....	.62	4.21	3.70	2.69	3.46	3.28
After allocation.....	1.01	4.96	4.16	2.63	3.21	3.16
Highest grade of school completed:						
Elementary 1-2:						
Before allocation.....	.32	.90	.68	.21	.47	3.20
After allocation.....	.63	1.28	.83	.56	.67	3.45
Elementary 8:						
Before allocation.....	.78	.24	.17	.48	.36	.00
After allocation.....	1.16	.83	.05	.54	.64	.00
Grade 9 or over:						
Before allocation.....	.75	.68	.00	.58	.61	1.39
After allocation.....	.69	.48	.02	.24	.31	1.30
High school 4:						
Before allocation.....	.69	.00	.60	.28	.00	1.15
After allocation.....	.84	.00	.97	.13	.00	1.35
College 1:						
Before allocation.....	.71	.00	.72	.00	.00	.32
After allocation.....	.45	.53	.55	.00	.00	.41
College 1 or higher:						
Before allocation.....	.44	1.48	.17	.54	.00	.00
After allocation.....	.44	1.39	.54	.65	.00	.00
College 5 or higher:						
Before allocation.....	.88	.68	.05	.82	.14	.00
After allocation.....	.80	.85	.21	.94	.36	.13
Not reported.....	7.23	7.68	6.32	8.50	11.85	4.99

Table 19.--RATIOS OF ESTIMATED RESPONSE VARIANCE TO A 25-PERCENT SAMPLING VARIANCE FOR EDUCATIONAL ATTAINMENT ITEMS: 1950 AND 1960 CENSUSES

1950 Census		1960 Census	
Category	Ratio of response to sampling variance	Category (after allocation)	Ratio of response to sampling variance
Highest grade attended not completed.	7.7	Highest grade attended not completed	2.1
Grade 5 or higher.....	0.03	Grade 1-2.....	0.4
Grade 8 or higher.....	0.3	Grade 8.....	0.3
Grade 9 or higher.....	0.6	Grade 9 or higher.....	0.2
Grade 12 or higher.....	2.1	Grade 12.....	0.4
Grade 13 or higher.....	3.1	Grade 13.....	0.1
		Grade 13 or higher.....	0.2
Highest grade completed not reported.	4.8	Grade 17 or higher.....	0.3
Highest grade attended not reported..	2.0	Highest grade completed not reported	5.5

A second way of making a comparison of the 1950 and 1960 data is as follows. To determine response relvariances in areas having more than 3,900 inhabitants for the 1960 statistics, the response relvariances shown in table 17 should be divided by $N/3,900$, where N is the size of the area of interest. (See [15], p. 15.) To get the estimates of response relvariances for an area of 6,500 inhabitants, the estimates in table 17 were multiplied by 65/39. For comparable items, the results are shown below.

	Estimates for area of 6,500 persons--	
	1950	1960
Highest grade attended not completed..	.42406	.03116
Grade 9 or higher.....	.00070	.00065
Grade 13 or higher .....	.02465	.00416
Highest grade completed not reported.	.13666	.50572

We see the same result illustrated in table 19. Except for the nonresponse item, the response relvariances were smaller in 1960.

4. Summary of data on educational attainment items

- a. Response variances for educational attainment items were generally positive, indicating a definite interviewer component to the total mean-square error of these statistics. For a few items, the contribution from the response variance to the mean-square error was greater than from the sampling variance.
- b. The crew leader effect for many of the items was within sampling variability of zero. For these items, we may assume the crew leader adds little or nothing to the variability. Some exceptions are "completed elementary 1-2" and "completed college 5 or higher."
- c. The allocation process tended to increase the response variances for this characteristic.
- d. Large differences in response variances for educational attainment items were found between different types of areas--highly urban, other urban, and rural. Generally the rural areas had very high response variances.
- e. The response variances for educational attainment items were much smaller in 1960 than in 1950, except for the nonresponse category.

E. SCHOOL ENROLLMENT

Figure 15 on page 43 shows questions P14-P17 on the 1960 census questionnaire which were used to determine year of school and type of school in which enrolled.

Data were collected for all persons between the ages of 5 and 34. As with the data on other educational characteristics, data were to relate to persons in "regular" school only. No manual coding of these items was necessary. See [21], pp. 199-201, for the details on the instructions to interviewers, and the machine editing and allocation process.

1. Estimates of response variance for school enrollment items

Table 20 shows the estimates of response relvariance for the 11 school enrollment categories studied. The sampling relvariances were estimated from equation 7.3 with the value of $k = .64$.

Notice that for the type of school in which enrolled, public or private elementary, high school--many of the response relvariances were larger than the sampling relvariances. Perhaps more intensive training is needed on these concepts.

Notice, also, the very large response relvariance for the "not reported" item. This was the largest response relvariance produced in the entire set of characteristics. Also the estimate with the crew leader effect is much larger than that without the crew leader effect.

Ninety-eight percent confidence intervals for the response relvariances with and without the crew leader effect were constructed. In addition, confidence intervals for the added effect due to crew leaders were constructed. These intervals are shown in figure 17, except for the nonresponse item.

Notice, from figure 17, the variability in some of these estimates of response relvariance. This is shown by the length of the confidence interval. The confidence intervals for "enrolled in college 1" are especially long.

The confidence intervals for "enrolled in kindergarten or elementary 1" are close to zero, and include zero after allocation. All of the intervals for "enrolled in elementary 8" include zero. Similar results show for "enrolled in high school 4" before allocation. For these items, the estimates of response relvariance are within sampling variability of zero.

The following items show very large response relvariances:

1. Enrolled in college 5 or higher
2. Enrolled in private elementary school
3. Enrolled in private high school

For most of the items on school enrollment, the estimates with and without the crew leader effect are within sampling variability. The item "enrolled in public elementary school" is an exception. This item showed a positive crew leader effect. One item not shown on the chart--the nonresponse item--had a very strong crew leader contribution to the total mean-square error.

The effect of allocation was not clear-cut for this characteristic. For most items, allocation tended to decrease the estimates of response variance. However, for a few items--enrolled in high school 4, enrolled in college 1, and enrolled in private high school--allocation tended to increase the estimate of response variance by a substantial amount.

Table 20.--ESTIMATED RESPONSE RELVARIANCES FOR SCHOOL ENROLLMENT ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

School enrollment items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
Enrolled in--								
Kindergarten or first grade:								
Before allocation.....	133	3.4	.00873	.01124	.093	.106	.78	.00104
After allocation.....	144	3.7	.00122	.01082	.035	.104	.11	.00096
Elementary 8:								
Before allocation.....	66	1.7	.00000	.02132	.000	.146	.00	.00181
After allocation.....	74	1.9	.00000	.01931	.000	.139	.00	.00193
High school 1:								
Before allocation.....	51	1.3	.02577	.02969	.161	.172	.87	.00341
After allocation.....	55	1.4	.01875	.02969	.137	.172	.63	.00315
High school 4:								
Before allocation.....	51	1.3	.00782	.02969	.088	.172	.26	.00326
After allocation.....	55	1.4	.01865	.02969	.137	.172	.63	.00333
College 1:								
Before allocation.....	16	.4	.04833	.08294	.220	.288	.58	.01752
After allocation.....	20	.5	.14344	.08294	.379	.288	1.73	.03025
College 5 or higher:								
Before allocation.....	4	.1	.64644	.40960	.804	.640	1.58	.04517
After allocation.....	4	.1	.44102	.40960	.664	.640	1.08	.04087
Public elementary school:								
Before allocation.....	569	14.6	.00034	.00230	.018	.048	.15	.00044
After allocation.....	597	15.3	.00000	.00221	.000	.047	.00	.00041
Private elementary school:								
Before allocation.....	101	2.6	.04239	.01367	.206	.117	3.10	.00631
After allocation.....	109	2.8	.04042	.01306	.201	.114	3.07	.00638
Public high school:								
Before allocation.....	183	4.7	.00884	.00783	.094	.089	1.13	.00122
After allocation.....	179	4.6	.00675	.00783	.082	.089	.86	.00120
Private high school:								
Before allocation.....	16	.4	.03780	.08294	.194	.288	.46	.01063
After allocation.....	20	.5	.06761	.08294	.260	.288	.82	.01149
Not reported.....	117	3.0	.58555	.01254	.766	.112	46.7	.02112
B. With Crew Leader Effect								
Enrolled in:								
Kindergarten or first grade:								
Before allocation.....	133	3.4	.00269	.01124	.052	.106	.24	.00103
After allocation.....	144	3.7	.00000	.01082	.000	.104	.00	.00091
Elementary 8:								
Before allocation.....	66	1.7	.00096	.02132	.031	.146	.05	.00284
After allocation.....	74	1.9	.00000	.01931	.000	.139	.00	.00239
High school 1:								
Before allocation.....	51	1.3	.00000	.02969	.000	.172	.00	.00237
After allocation.....	55	1.4	.00000	.02969	.000	.172	.00	.00227
High school 4:								
Before allocation.....	51	1.3	.00650	.02969	.081	.172	.22	.00315
After allocation.....	55	1.4	.01238	.02969	.111	.172	.42	.00309
College 1:								
Before allocation.....	16	.4	.06110	.08294	.247	.288	.74	.02433
After allocation.....	20	.5	.09175	.08294	.303	.288	1.11	.02184
College 5 or higher:								
Before allocation.....	4	.1	.27218	.40960	.522	.640	.66	.05621
After allocation.....	4	.1	.33679	.40960	.580	.640	.82	.05060

Table 20--ESTIMATED RESPONSE RELVARIANCES FOR SCHOOL ENROLLMENT ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS--Con.

School enrollment items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
B. With Crew Leader Effect--								
Con.								
Enrolled in--								
Public elementary school:								
Before allocation.....	554	14.2	.00486	.00246	.070	.050	1.98	.00057
After allocation.....	581	14.9	.00480	.00228	.069	.048	2.11	.00051
Private elementary school:								
Before allocation.....	101	2.6	.03880	.01367	.197	.117	2.84	.00625
After allocation.....	109	2.8	.03439	.01306	.185	.114	2.63	.00627
Public high school:								
Before allocation.....	168	4.3	.00503	.00900	.071	.095	.56	.00102
After allocation.....	179	4.6	.00490	.00783	.070	.089	.63	.00096
Private high school:								
Before allocation.....	16	.4	.09078	.08294	.301	.288	1.09	.01393
After allocation.....	20	.5	.09855	.08294	.314	.288	1.19	.01166
Not reported.....	117	3.0	.75039	.01254	.866	.112	59.84	.02798

As with the other characteristics studied, a multiplier of the sampling variance to reflect the increase due to the interviewers and crew leaders was desired. This multiplier is the median of the ratios after allocation shown in column 7 of part B of table 20. The multiplier is .82. However, as with the other characteristics, a user should select the item in table 20 which is most like the item in which he is interested and then apply the appropriate ratio shown in column 7.

2. Estimates of response variance by type of area

Table 21 shows the ratios of response variances to sampling variances for school enrollment items for highly urban, other urban, and rural areas. There are large variations in the sizes of the estimates, both by area and by whether with or without crew leader effect. Again, it is evident that the type of area must be taken into account when applying these estimates to school enrollment statistics. The median ratios of the response variance to the sampling variance show some interesting results:

	Median ratios--	
	Without crew leader effect	With crew leader effect
Highly urban.....	.8	1.3
Other urban.....	.7	.7
Rural.....	.6	.1

First, the ratios from the highly urban areas are much larger than the ratios from other types of areas. Second, the median ratio for other urban areas is about the same as the median ratio over all areas. Third, the ratios for the rural areas are very different depending on whether the estimates were with or without the crew leader effect. While the ratio for the estimates with the crew leader effect was higher than the ratio for the estimates without the crew leader effect in the other types of area, it was much smaller in rural areas. As pointed out

earlier, the crew leader either contributes nothing or a positive amount to the variance. It may well be that the estimates of response variance in the rural areas are within sampling variability of each other, considering the large variances of these items for the total United States. The variances are even larger for these subsets.

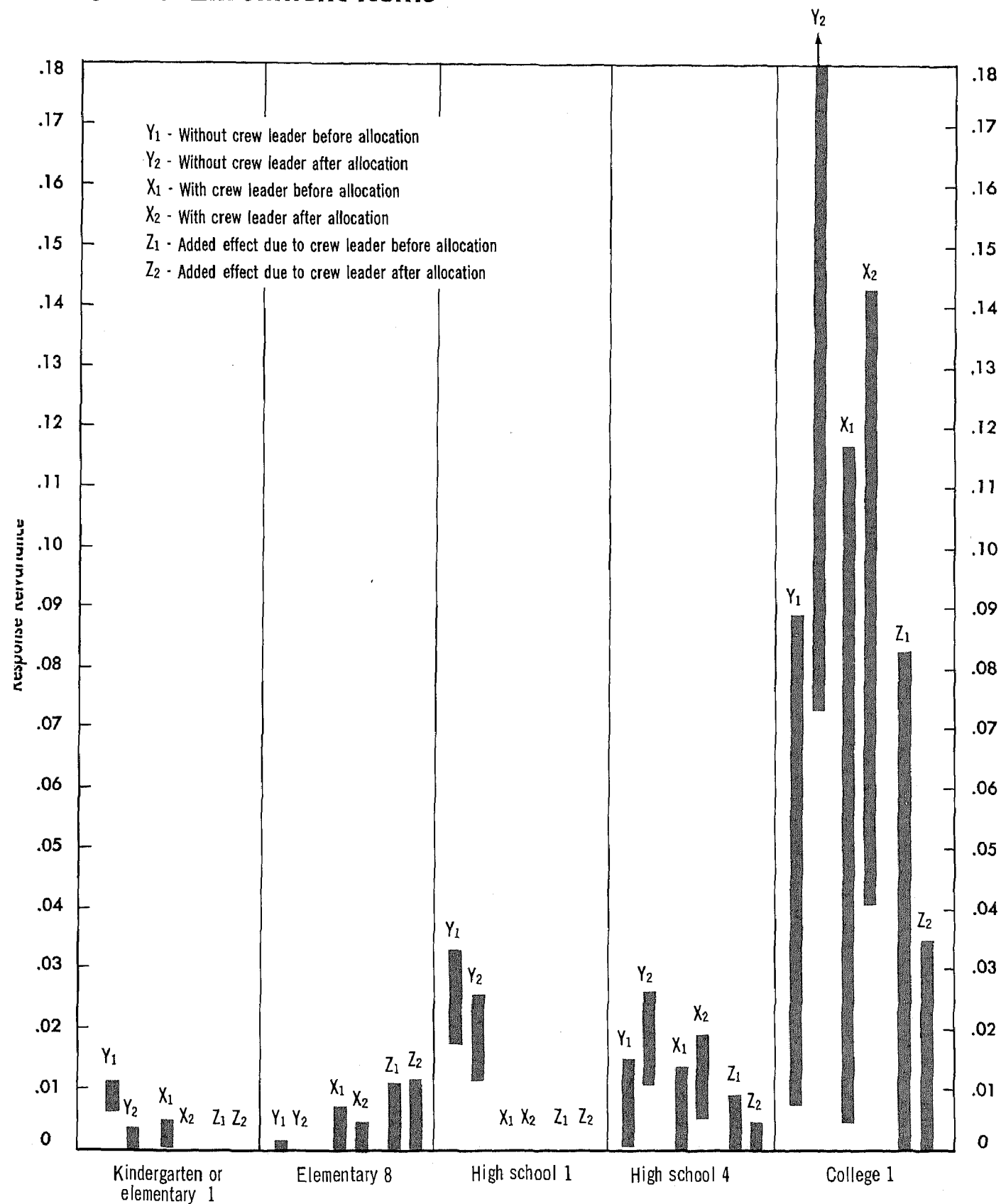
3. Comparison of 1950-1960 response variances

A comparison between 1950 and 1960 is not possible for this characteristic, since the only item for which the response variance was computed in 1950 was "now attending school not reported." For this one category, the ratio of the response variance to a sampling variance of a 25-percent sample was 9.34 in 1950 and 18.85 in 1960. This indicates that the response variance increased from 1950 to 1960 for this item, just as it did for the non-response item for educational attainment.

4. Summary of data on school enrollment items

- a. Some of the response variances for school enrollment items were very large. For those items relating to type of school in which enrolled, the response variances were generally larger than the sampling variances. Further training on these items may be of help in reducing the response variances.
- b. The response variance for the item "now attending school not reported" was the largest produced for any item.
- c. The crew leader effect for many of these items was very small and may have been zero. Exceptions were "enrolled in private high school" and "now attending school not reported."
- d. For most of the items, allocation tended to decrease the estimates of response variance. There were some exceptions to this for which allocation increased the estimates by a substantial amount.

**Figure 17. 98-Percent Confidence Intervals for Response Relvariances
School Enrollment Items**



**Figure 17. 98-Percent Confidence Intervals for Response Relvariances
School Enrollment Items (continued)**

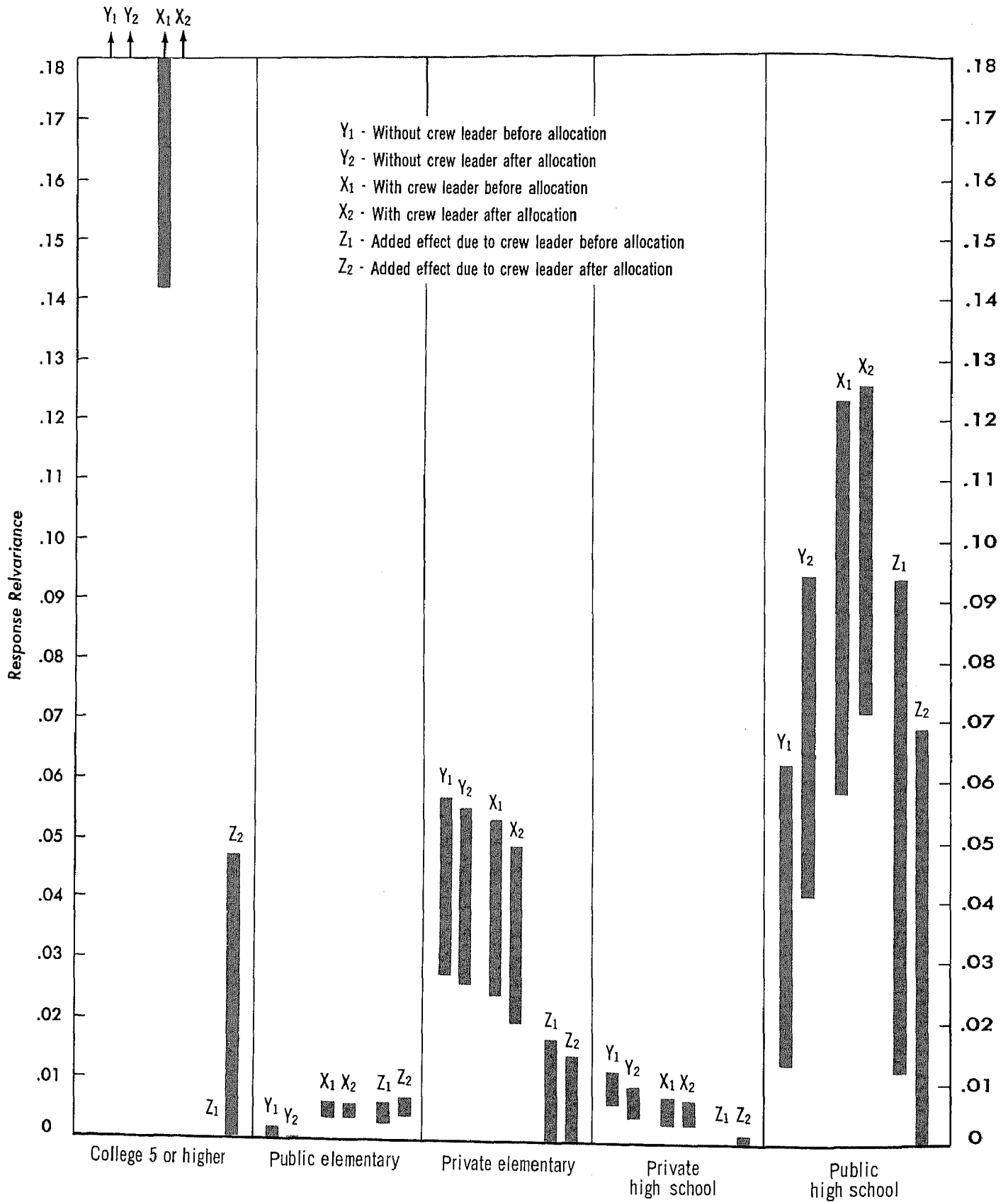


Table 21.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR SCHOOL ENROLLMENT ITEMS FOR HIGHLY URBAN, OTHER URBAN AND RURAL AREAS

School enrollment items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader	With crew leader	Without crew leader	With crew leader	Without crew leader	With crew leader
Enrolled in--						
Kindergarten or first grade:						
Before allocation.....	1.23	.07	.84	.58	.45	.00
After allocation.....	.28	.21	.08	.00	.09	.00
Elementary 8:						
Before allocation.....	.00	.34	.00	.00	.53	.37
After allocation.....	.00	.37	.00	.00	.34	.13
High school 1:						
Before allocation.....	1.44	.00	.65	.00	.72	.00
After allocation.....	1.45	.00	.31	.00	.65	.00
High school 4:						
Before allocation.....	.34	1.33	.54	.52	.00	.00
After allocation.....	.83	1.34	.77	.66	.30	.00
College 1:						
Before allocation.....	.56	2.62	.00	.00	(¹)	(¹)
After allocation.....	1.00	2.77	1.78	.00	(¹)	(¹)
College 5 or higher:						
Before allocation.....	8.30	.00	.00	(¹)	(¹)	(¹)
After allocation.....	5.91	.00	.00	(¹)	(¹)	(¹)
Public elementary school:						
Before allocation.....	.00	2.31	.62	1.46	.00	2.55
After allocation.....	.40	3.10	.07	1.07	.00	3.09
Private elementary school:						
Before allocation.....	8.28	2.42	.53	3.49	1.17	.00
After allocation.....	8.38	1.56	.74	3.53	.81	.07
Public high school:						
Before allocation.....	.00	.00	1.85	.63	.56	.86
After allocation.....	.19	.37	1.37	.52	.49	.76
Private high school:						
Before allocation.....	.77	1.97	.15	2.02	2.58	.00
After allocation.....	.82	3.58	1.30	.92	3.78	.00
Not reported.....	42.70	48.08	61.81	84.47	53.71	72.46

¹The percentage of the population in these categories was less than .1 percent. On the basis of .1 percent, the ratio of the response to sampling variance is greater than 1.0.

e. Large differences in response variances for school enrollment items were found between different types of areas. The highly urban areas had very large response variances.

f. A comparison between 1950 and 1960 response variances was not possible since only the non-response item was studied in 1950.

F. NUMBER OF CHILDREN

Figure 18 shows question P20 on the 1960 census questionnaire. This question was used to determine the number of children ever born to women over 14 who had ever been married. The interviewers were instructed not to count adopted children or stepchildren.

No manual coding was done for the item. Also, there was no editing on the basis of consistency with the

**P20. If this is a woman who has ever been married--
How many babies has she ever had, not
counting stillbirths?**

None 1 2 3 4 5 6 7 8 9 10 11 12+

Figure 18.--Question P20 on number of children, 1960 Decennial Census schedule.

woman's age or duration of marriage or with other characteristics of the woman and her family. This was in contrast to the editing practices of earlier censuses. The allocation process for nonresponses was accomplished by assigning the response for a previously reported woman with similar characteristics. For details on the instructions to interviewers and the allocation process, see reference [21], pp. 202-204.

This is the first characteristic studied for which all the response variances were smaller than the sampling variances. The multiplier of the sampling variance which reflects the increase in the variability due to interviewers and crew leaders is only .05.

Estimates of the variability of these estimates of response relvariances were produced and 98-percent confidence intervals were constructed for the response relvariances with and without crew leader effect. Also, 98-percent confidence intervals for the added effect due to crew leaders were constructed. These intervals are shown on figure 19.

As shown in table 22, we can see on the chart that the response relvariances for these number-of-children items are small. The only intervals substantially above zero are those for five or more children.

The confidence intervals for the added effect due to crew leaders all include zero. This indicates that the crew leader adds little to the variability of these items.

The effect of allocation was rather interesting. For both sets of estimates, allocation decreased the response variance for the first two categories and increased it for the last two categories. In the examination of the individual cluster variances, it was found that

for the first two items every cluster with an extremely high value before allocation had a considerably smaller value after allocation.

2. Estimates of response variance by type of area

Table 23 shows the ratios of response variances to sampling variances for number-of-children items for highly urban, other urban, and rural areas. Some interesting facts emerge from this table:

- a. The response variance is not a negligible fraction of the sampling variance for some categories in some types of areas. For example, the item "3 or more children" has a very high ratio in highly urban areas.
- b. The crew leader effect does not appear to be consistent over all areas. However, the sampling variances of these estimates of response relvariance were not computed, so the difference between the estimates with and without the crew leader effect is not known.
- c. The allocation process decreases the response variance for the "no children" category and increases it for the "5 or more children" category except for the highly urban clusters without the crew leader effect.

**Figure 19. 98-Percent Confidence Intervals for Response Relvariances
Fertility Items**

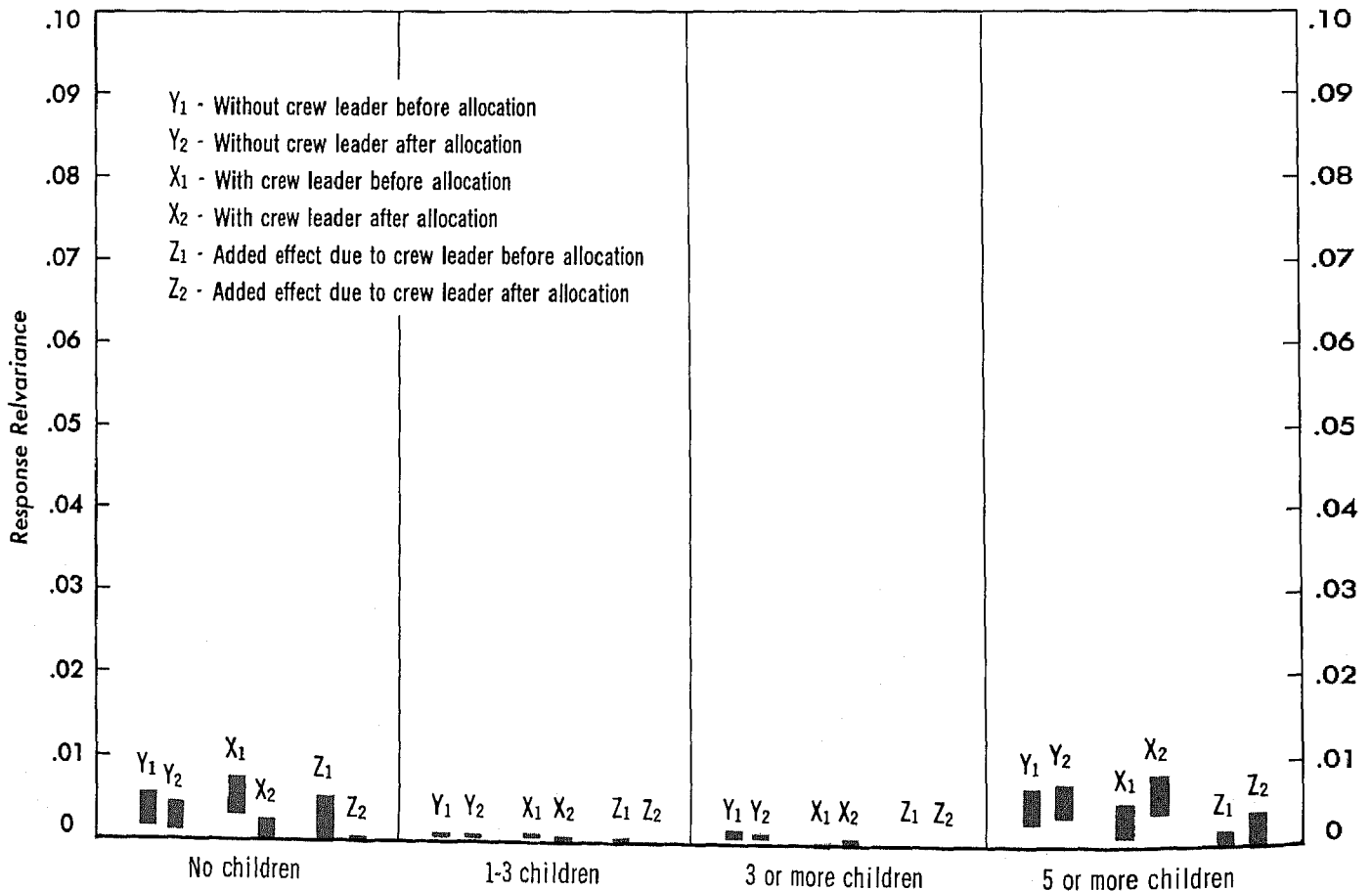


Table 22.--ESTIMATED RESPONSE RELVARIANCES FOR FERTILITY ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Number of children ever born items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect:								
None:								
Before allocation.....	176	4.5	.00314	.01326	.056	.115	.24	.00085
After allocation.....	195	5.0	.00274	.01184	.052	.109	.23	.00071
1-3 children:								
Before allocation.....	671	17.2	.00055	.00300	.023	.055	.18	.00010
After allocation.....	706	18.1	.00040	.00282	.020	.053	.14	.00009
3 or more children:								
Before allocation.....	441	11.3	.00077	.00489	.028	.070	.16	.00022
After allocation.....	464	11.9	.00081	.00461	.028	.068	.18	.00017
5 or more children:								
Before allocation.....	144	3.7	.00477	.01618	.069	.127	.29	.00099
After allocation.....	152	3.9	.00548	.01534	.074	.124	.36	.00090
B. With Crew Leader Effect:								
None:								
Before allocation.....	176	4.5	.00524	.01326	.072	.115	.40	.00105
After allocation.....	195	5.0	.00025	.01184	.016	.109	.02	.00090
1-3 children:								
Before allocation.....	671	17.2	.00056	.00300	.024	.055	.19	.00011
After allocation.....	706	18.1	.00023	.00282	.015	.053	.08	.00009
3 or more children:								
Before allocation.....	441	11.3	.00000	.00489	.000	.070	.00	.00016
After allocation.....	452	11.6	.00015	.00474	.012	.069	.03	.00014
5 or more children:								
Before allocation.....	144	3.7	.00306	.01618	.055	.127	.19	.00093
After allocation.....	152	3.9	.00626	.01534	.079	.124	.41	.00104

Table 23.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR FERTILITY ITEMS FOR HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Number of children items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
No children:						
Before allocation.....	.17	.80	.62	.00	.00	1.20
After allocation.....	.03	.28	.53	.00	.00	.94
1-3 children:						
Before allocation.....	.12	.00	.21	.00	.16	.24
After allocation.....	.13	.26	.31	.00	.00	.16
3 or more children:						
Before allocation.....	1.16	.78	.00	.00	.00	.04
After allocation.....	.96	.80	.00	.00	.00	.29
5 or more children:						
Before allocation.....	.24	.29	.22	.65	.40	.00
After allocation.....	.23	.70	.29	.81	.49	.00

3. Comparison of 1950-1960 response variances

No comparison between 1950 and 1960 data is possible since this characteristic was not studied in 1950.

4. Summary of data on number-of-children items

- a. Response variances for number-of-children items were very small. For all items, the response variance was less than half the sampling variance, and in most cases was a good deal smaller than that.
- b. The crew leader apparently contributed nothing to the variability of these statistics. The estimates of response variance with and without the crew leader effect are within sampling variability.
- c. The allocation process tended to decrease the response variances for the items "no children" and "1-3 children" and increase them for "3 or more" and "5 or more" children.
- d. Large differences in response variances for a given item occurred, depending on the type of area--highly urban, other urban, and rural. Some of these differences might be accounted for by sampling variability. However, the sampling variances were not computed for these items.
- e. No 1950-1960 comparison of response variances for these number-of-children items is possible since these items were not studied in 1950.

G. LABOR FORCE

The questions shown in figure 20 were asked in the 1960 census to determine employment status and number of hours worked.

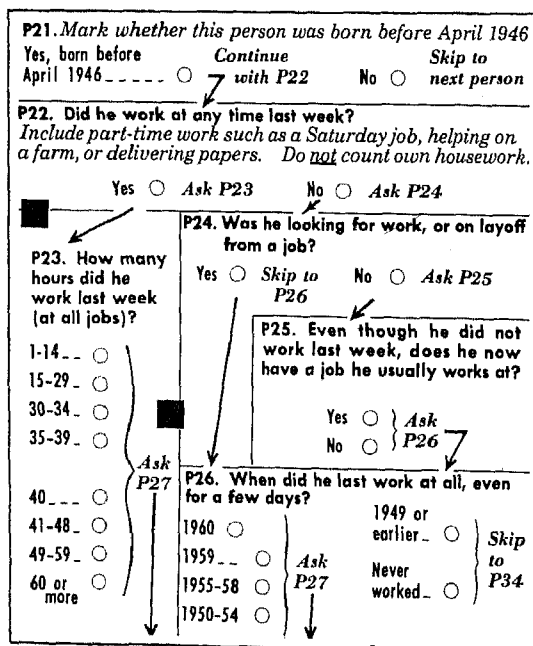


Figure 20.--Questions P21-26 on labor force, 1960 Decennial Census schedule.

P21 was a screening question. The questions following this on the schedule were asked only of persons 14 years old and over. The questions do not look difficult, but the response variances are large for this characteristic.

Persons not in the labor force were those who were not classified as at work or with a job but not at work or unemployed, or in the Armed Forces. Persons employed were those at work and those with a job but not at work; persons unemployed were those not at work but looking for work or on layoff from a job.

The data on hours worked referred to the number of hours actually worked, not the usual number of hours for persons at work. Lunch hours, sick leave and other time off was to be excluded and overtime included.

Though the concepts did not appear difficult, there were opportunities for the interviewers to affect the data, both for labor force status and hours working. There was also a skip pattern to the questions on the schedule which may have confused some interviewers.

Manual coding was not necessary for the labor force characteristic, but there was manual editing. The computer assigned an employment status recode to each person 14 years old and over. One of the recodes was the "not reported category." Persons in this category were assigned a labor force status during the allocation process. Also, an entry for number of hours worked was allocated if the person was recoded as "at work" but had no entry for hours worked.

An interesting discussion of the labor force concepts, the selection of the census questions, and the coding and allocation process is in reference [21], pages 204-209.

1. Estimates of response variance for labor force characteristics

Table 24 shows the estimates of response relvariance for the six categories studied. The sampling relvariances were computed from equation 7.3 with the value of $k=1.0$.

One of the first things noticeable from this table is that the unemployment category has a response variance about twice as large as the sampling variance. This represents a large increase in the variability of the statistic.

Ninety-eight percent confidence intervals were constructed for the response relvariances with and without the crew leader effect and for the added effect due to crew leaders. These confidence intervals are shown in figure 21.

The first three sets of confidence intervals are very short and very close to zero. These are the intervals for major groups in the labor force--males, females, and total population. For these items, the response relvariances are small or zero, and the added effect due to crew leaders is close to zero.

The intervals for the next item--females, 14-19, attending school and in the labor force--are very long. This indicates that the estimates of response relvariance had large standard errors. The intervals for the added effect due to crew leaders include zero.

Table 24.--ESTIMATED RESPONSE RELVARIANCES FOR LABOR FORCE ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Labor force items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
Males in labor force:								
Before allocation.....	1,030	26.4	.00080	.00174	.028	.042	.46	.00008
After allocation.....	1,041	26.7	.00073	.00171	.027	.041	.43	.00008
Females in labor force:								
Before allocation.....	472	12.1	.00000	.00453	.000	.067	.00	.00024
After allocation.....	480	12.3	.00000	.00444	.000	.067	.00	.00021
Total in labor force:								
Before allocation.....	1,474	37.8	.00046	.00102	.021	.032	.45	.00007
After allocation.....	1,529	39.2	.00028	.00097	.017	.031	.29	.00006
Females, 14-19, attending school, in labor force:								
Before allocation.....	20	.5	.01005	.12716	.100	.356	.08	.00859
After allocation.....	20	.5	.03090	.12716	.176	.356	.24	.00799
Unemployed:								
Before allocation.....	74	1.9	.07693	.03213	.277	.179	2.39	.00363
After allocation.....	78	2.0	.07552	.03053	.275	.175	2.47	.00373
Worked less than 35 hours last week:								
Before allocation.....	222	5.7	.00229	.01030	.048	.101	.22	.00087
After allocation.....	242	6.2	.00943	.00943	.097	.097	.30	.00086
B. With Crew Leader Effect								
Males in labor force:								
Before allocation.....	1,030	26.4	.00005	.00174	.007	.042	.03	.00008
After allocation.....	1,041	26.7	.00009	.00171	.009	.041	.05	.00008
Females in labor force:								
Before allocation.....	484	12.4	.00066	.00440	.026	.066	.15	.00023
After allocation.....	495	12.7	.00064	.00428	.025	.065	.15	.00021
Total in labor force:								
Before allocation.....	1,509	38.7	.00060	.00099	.024	.031	.61	.00007
After allocation.....	1,556	39.9	.00022	.00094	.015	.031	.23	.00006
Females, 14-19, attending school, in labor force:								
Before allocation.....	20	.5	.00118	.12716	.034	.356	.01	.00846
After allocation.....	20	.5	.01431	.12716	.120	.356	.11	.00766
Unemployed:								
Before allocation.....	74	1.9	.05970	.03213	.244	.179	1.86	.00338
After allocation.....	78	2.0	.06394	.03053	.253	.175	2.09	.00366
Worked less than 35 hours last week:								
Before allocation.....	242	6.2	.00961	.00943	.098	.097	1.02	.00094
After allocation.....	250	6.4	.01041	.00913	.102	.096	1.14	.00097

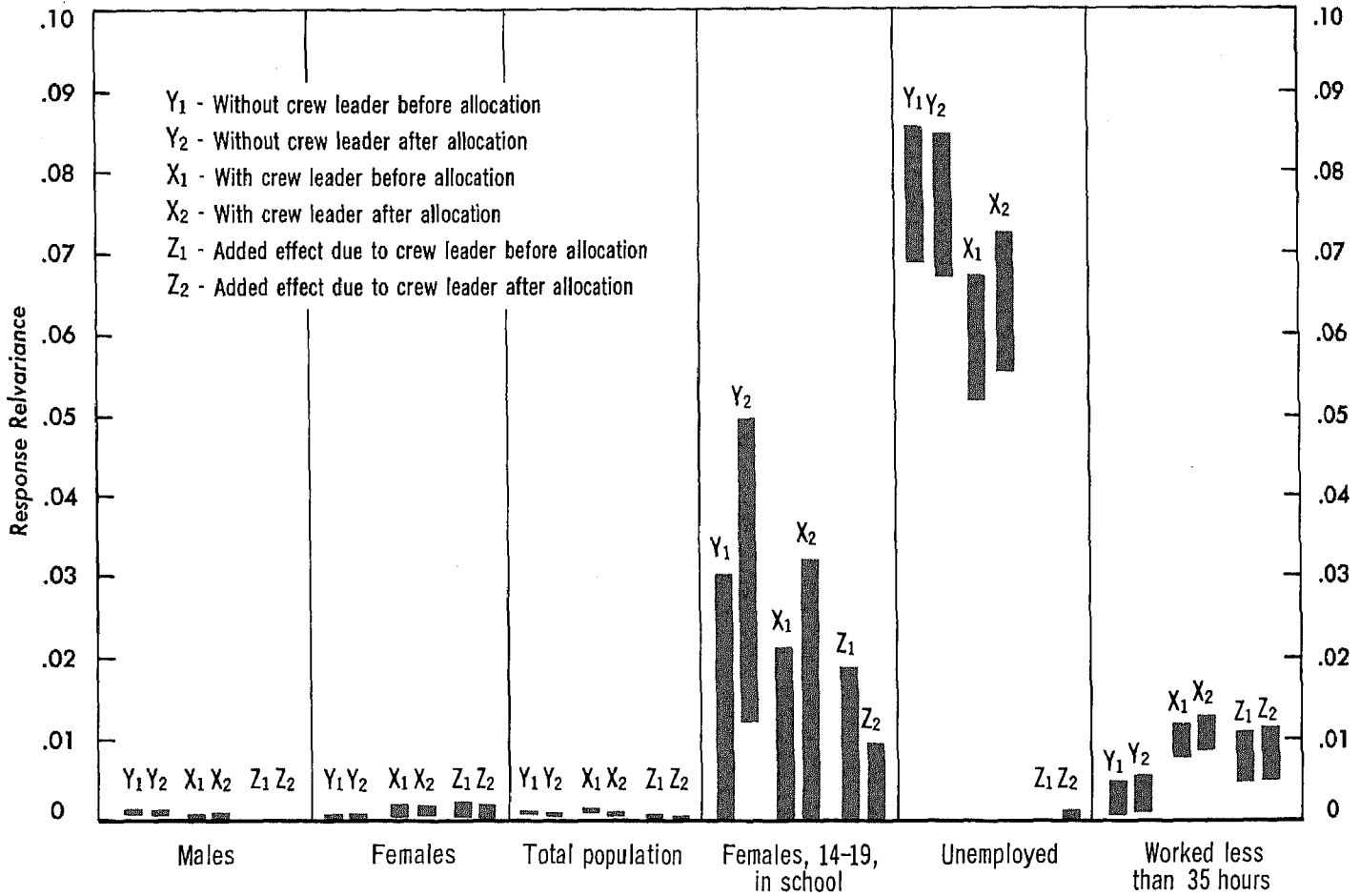
The unemployment item showed the largest response variances, as we might have expected from the results shown in table 24. The variability of the estimates was rather small, yielding relatively short confidence intervals. The crew leader added nothing to the variability of this item.

Indeed, the only item in this group for which the crew leader did have an effect was "worked less than 35 hours last week." One possible explanation is that the crew leaders may have been more conscientious in training their interviewers to ask about time off for sickness, holidays, etc.

Allocation seemed to have no consistent effect on the response variances. It decreased the estimates for males in the labor force and total population, and increased the estimates for "females, 14-19, in school" and for "worked less than 35 hours last week."

As with the other characteristics, we are interested in developing a multiplier of the sampling variance which will reflect the increase in variance due to the interviewers and crew leaders. For a few of the categories, this increase is negligible; for unemployment and hours worked, the increase is substantial. Over all categories, the median ratio, after allocation, shown in

**Figure 21. 98-Percent Confidence Intervals for Response Relvariances
Labor Force Items**



column 7, part B of table 24, is about .20. However, this multiplier will understate the increase substantially for the unemployment category. A user should pick the item in this table which most closely resembles the item of interest to him and apply the ratio shown in column 7 for that item.

2. Estimates of response variance by type of area

Table 25 shows the ratios of response variances to sampling variances for labor force items for highly urban, other urban, and rural areas.

The median ratios of response to sampling variance are as follows:

	Without crew leader effect	With crew leader effect
Highly urban . . .	.5	.9
Other urban . . .	.2	.2
Rural . . . . .	.4	.2

The estimates are subject to sampling variability. Estimates of the sampling variability were not computed by type of area. Therefore, we cannot tell whether the

differences shown in table 25 are within sampling variability.

3. Comparison of 1950-1960 response variances

Of the six labor force categories studied in 1960, four were studied in 1950. In order to make the comparisons, we converted both the 1950 and 1960 data to ratios of response variances to 25-percent sampling variances. The sampling variances were computed from equation 7.4, with N = 3,900 for 1960 and 6,500 for 1950 and $\rho = .1$ for both 1950 and 1960. Table 26 shows the ratios.

For the four categories studied both in 1950 and 1960, the 1960 ratios are smaller, except for the item "males in labor force." This is an indication that the response variances were smaller in 1960 for most of the categories in this characteristic.

We can make the comparison in a somewhat different way. If the 1960 estimates are multiplied by 3900/6500, the estimates will be applicable to an area of population size 6,500 and the 1950 and 1960 estimates can be compared directly. This comparison is as follows:

Estimates of
response relvariance

1950 1960

Males in labor force. . . . .	.00017	.00044
Females in labor force. . . . .	.00020	.00000
Total in labor force. . . . .	.00035	.00017
Females, 14-19, attending school, in labor force . . . . .	.04807	.01854

The same evidence is shown in this comparison. Except for males in the labor force, all 1960 response relvariances are smaller.

4. Summary of data on labor force items

- a. Response variances for most of the labor force items are small. The big exception is the unemployment item. This item shows a very large response variance.

Table 25.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR LABOR FORCE ITEMS FOR HIGHLY URBAN, OTHER URBAN AND RURAL AREAS

Labor force items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
Males in labor force:						
Before allocation.....	.66	.00	.16	.12	.68	.00
After allocation.....	.63	.00	.11	.18	.67	.00
Females in labor force:						
Before allocation.....	.21	.92	.00	.00	.03	.32
After allocation.....	.36	.94	.00	.00	.00	.15
Total in labor force:						
Before allocation.....	.50	1.66	.10	.28	.85	.42
After allocation.....	.33	.86	.00	.00	.77	.27
Females, 14-19, attending school, in labor force:						
Before allocation.....	.00	.00	.56	.13	.18	.00
After allocation.....	.44	.11	1.49	.09	.14	.11
Unemployed:						
Before allocation.....	2.00	1.84	2.79	3.21	1.85	1.31
After allocation.....	1.87	2.71	2.86	3.82	2.00	1.36
Worked less than 35 hours last week:						
Before allocation.....	.39	1.67	.37	.67	.00	2.09
After allocation.....	.66	1.87	.28	.86	.08	2.18

Table 26.--RATIOS OF ESTIMATED RESPONSE VARIANCES TO 25-PERCENT SAMPLING VARIANCES FOR LABOR FORCE ITEMS: 1950 AND 1960 CENSUSES

1950 Census		1960 Census	
Labor force category	Ratio of response to sampling variance	Labor force category (after allocation)	Ratio of response to sampling variance
Males in labor force.....	0.1	Males in labor force.....	0.3
Females in labor force.....	0.4	Females in labor force.....	0.0
Total in labor force.....	0.4	Total in labor force.....	0.2
Females, 14-19, attending school, in labor force.....	0.3	Females, 14-19, attending school, in labor force.....	0.2
		Unemployed.....	1.6
		Worked less than 35 hours last week.	0.2

- b. The crew leader component of the variability of these labor force statistics is very small, except for the item "worked less than 35 hours last week."
- c. Allocation had no consistent effect on the response variances for labor force items. It increased the response variances for some items and decreased them for others.
- d. Differences in response variances by type of area are difficult to interpret in the absence of knowledge of the variability of estimates of the response variances. However, the highly urban areas tended to have larger response variances for most items.
- e. Response variances for labor force items were smaller in 1960 than in 1950.

H. OCCUPATION

Figure 22 below shows the questions asked on the 1960 census schedule to determine occupation, industry, and class of worker for each person in the 25-percent sample who was 14 years of age or over and who had worked in the period from 1950 to April 1, 1960.

<p>P27. If he worked in 1950 or after: Describe in P27a to P27e the job or business held last week. If no job or business last week, give information for last job or business</p>	
<p>P27a. For whom did he work?</p> <p>..... (Name of company, business, organization, or other employer)</p>	<p>Now in Armed Forces <input type="radio"/> Skip to P28 <input type="radio"/></p>
<p>P27b, c. What kind of business or industry was this?</p> <p>..... (Examples: poultry hatchery, county junior high school, auto assembly plant, radio and TV service, retail supermarket, highway construction, farm)</p>	
<p>P27d. What kind of work was he doing?</p> <p>..... (Examples: truck driver, 8th grade English teacher, paint sprayer, repairs TV sets, grocery checker, civil engineer, farmer)</p>	
<p>P27e. Class of worker. Mark from information in P27a to P27d or ask if not clear.</p> <p>Employee of a <u>private</u> company, business, or individual, for wages, salary, or commissions..... <input type="radio"/></p> <p><u>Government</u> employee (Federal, State, county, or local)..... <input type="radio"/></p> <p>Self-employed in <u>own</u> business, professional practice, or farm..... <input type="radio"/></p> <p>Working <u>without pay</u> in a family business or farm..... <input type="radio"/></p>	

Figure 22.--Question P27 on occupation, industry, class of worker, 1960 Decennial Census schedule.

The occupation question was rather complex for both the persons filling the Household Questionnaire and for the interviewer. The correct skip pattern had to be followed to get to the item on the schedule.

Though information was collected for all persons 14 years old and over who had worked since 1959, for the purposes of this study we looked only at the occupational classification of those persons currently in the labor force. Also, we looked at only a few major occupational groups, not the detailed categories. Interviewer differences between detailed classifications such as lawyers, turbine assemblers, etc. were not identified. Only differences between the interviewers in making

assignment to a major occupational group, such as professional and technical workers, were studied.

A separate coding section was set up for occupation and industry coding. Manual editing was done at the time of coding. Because differences between coders in assigning codes might be interpreted as differences between interviewers, one coder was responsible for an entire EA. This meant that one coder worked on the households assigned to each of the pair of interviewers. Any differences between major occupation groups can then be interpreted as caused by the interviewers, not the coders.

Unlike most of the other characteristics studied, allocation of occupation by the computer was done for only a few cases. Of 5.7 percent of persons in the experienced labor force who did not report occupation, allocation of an occupation was made for only .6 percent. See reference [21], pages 211-214, for a description of the concepts, instructions to interviewers, coding, and the allocation process.

1. Estimates of response variance for occupation groups

Table 27 shows the estimates of response relvariances for the seven categories studied. The sampling relvariances were computed from equation 7.3 with the value of $k = 1.0$.

In comparison with most of the other characteristics studied, the ratios of response to sampling variances are small for occupation items. From column 7 of the table, we see that the ratios are all less than 1.0 and all but one are less than .40.

A multiplier of the sampling variance to reflect the increase in variability due to interviewers and crew leaders was constructed using the ratios, after allocation (column 7, part B of table 27). The median ratio is .25. This value is used to approximate the increase in variance due to response variance. However, as with the other items, a user might more appropriately identify the item in table 27 which is most like the item of interest to him and apply the ratio shown in column 7 for that item.

Ninety-eight percent confidence intervals were constructed for the response relvariances with and without the crew leader effect and also for the added effect due to the crew leaders. These confidence intervals are shown in figure 23.

The sets of confidence intervals for farmers and farm managers and the set for farm laborers are very long. This indicates great variability in the estimates of response relvariance. Except for the interval for farm laborers without the crew leader effect, all the intervals included zero for these two items. This indicates that the estimates are within sampling variability of being zero. Also, the added effect of the crew leader is close to zero.

The item "clerical workers" had intervals above zero and also showed a positive crew leader effect. Salesworkers followed the same pattern, also showing a small, positive crew leader effect. For the item "craftsmen, foremen," the response relvariances were small and positive, but the added effect of the crew leader was zero. For the item "operatives," the response relvariance was small and the crew leader effect was zero or very small.

Table 27.--ESTIMATED RESPONSE RELVARIANCES FOR OCCUPATION ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Occupation groups	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
<u>A. Without Crew Leader Effect</u>								
Professional, technical and kindred workers								
Before allocation.....	144	3.7	.00216	.01618	.046	.127	.13	.00132
After allocation.....	160	4.1	.00026	.01458	.046	.121	.02	.00128
Farmers and farm managers, male:								
Before allocation.....	43	1.1	.00868	.05615	.093	.237	.15	.00835
After allocation.....	43	1.1	.00868	.05615	.093	.237	.15	.00835
Clerical and kindred workers:								
Before allocation.....	230	5.9	.00247	.00993	.050	.100	.25	.00055
After allocation.....	218	5.6	.00247	.01048	.050	.102	.24	.00055
Sales workers:								
Before allocation.....	117	3.0	.00000	.02015	.000	.142	.00	.00107
After allocation.....	117	3.0	.00000	.02015	.000	.142	.00	.00107
Craftsmen, foremen, and kindred workers:								
Before allocation.....	214	5.5	.00397	.01068	.063	.103	.37	.00077
After allocation.....	218	5.6	.00408	.01048	.064	.102	.39	.00078
Operatives and kindred workers:								
Before allocation.....	273	7.0	.00285	.00828	.053	.091	.34	.00050
After allocation.....	277	7.1	.00281	.00816	.053	.090	.34	.00051
Farm laborers and paid workers, male:								
Before allocation.....	20	.5	.04845	.12716	.220	.356	.38	.01414
After allocation.....	20	.5	.04845	.12716	.220	.356	.38	.01414
<u>B. With Crew Leader Effect</u>								
Professional, technical and kindred workers:								
Before allocation.....	160	4.1	.00000	.01458	.000	.121	.00	.00071
After allocation.....	164	4.2	.00000	.01423	.000	.119	.00	.00064
Farmers and farm managers, male:								
Before allocation.....	43	1.1	.01764	.05615	.133	.237	.31	.00961
After allocation.....	43	1.1	.01764	.05615	.133	.237	.31	.00961
Clerical and kindred workers:								
Before allocation.....	234	6.0	.00811	.00976	.090	.099	.83	.00071
After allocation.....	238	6.1	.00811	.00960	.090	.098	.84	.00071
Sales workers:								
Before allocation.....	117	3.0	.00424	.02015	.065	.142	.21	.00115
After allocation.....	117	3.0	.00424	.02015	.065	.142	.21	.00115
Craftsmen, foremen, and kindred workers:								
Before allocation.....	218	5.6	.00316	.01048	.056	.102	.30	.00058
After allocation.....	222	5.7	.00316	.01030	.056	.101	.31	.00058
Operatives and kindred workers:								
Before allocation.....	277	7.1	.00000	.00815	.000	.090	.00	.00049
After allocation.....	281	7.2	.00000	.00804	.000	.090	.00	.00049
Farm laborers and paid workers, male:								
Before allocation.....	20	.5	.03218	.12716	.179	.356	.25	.01749
After allocation.....	20	.5	.03218	.12716	.179	.356	.25	.01749

Allocation had little effect on the response variances. This was to be expected since so few cases were allocated an occupation code.

2. Estimates of response variance by type of area

Table 28 shows the ratios of response variances to sampling variances for occupation items for highly urban, other urban, and rural areas.

The median ratios of response to sampling variances are:

	Without crew leader effect	With crew leader effect
Highly urban . . . . .	.2	1.4
Other urban . . . . .	.0	.3
Rural . . . . .	.4	.2

The ratios with crew leader effect are higher except in the rural areas. However, the sampling variances attached to most of these estimates are so large that the estimates should be used very cautiously.

3. Comparison of 1950-1960 response variances

There were a few occupation categories studied in 1950, but they were tabulated by sex. Therefore, there are only two items which are strictly comparable--farm laborers and paid workers, male, and farmers and farm managers, male.

In order to make a comparison between 1950 and 1960 data, the data were converted to ratios of response to 25-percent sampling variances. The sampling variances were computed from equation 7.4, with $N = 3,900$ for 1960 and 6,500 for 1950 and $\rho = .1$ for both 1950 and 1960. Table 29 shows the ratios.

For the two items which were identical, one has the same ratio in 1960 as in 1950 but the other is considerably reduced. The craftsmen, foremen and kindred workers category also has a smaller ratio in 1960, though the concepts are not strictly comparable. From this limited evidence, the data tend to support the hypothesis that the response variances are smaller in 1960 than in 1950.

Figure 23. 98-Percent Confidence Intervals for Response Relvariances
Occupation Items

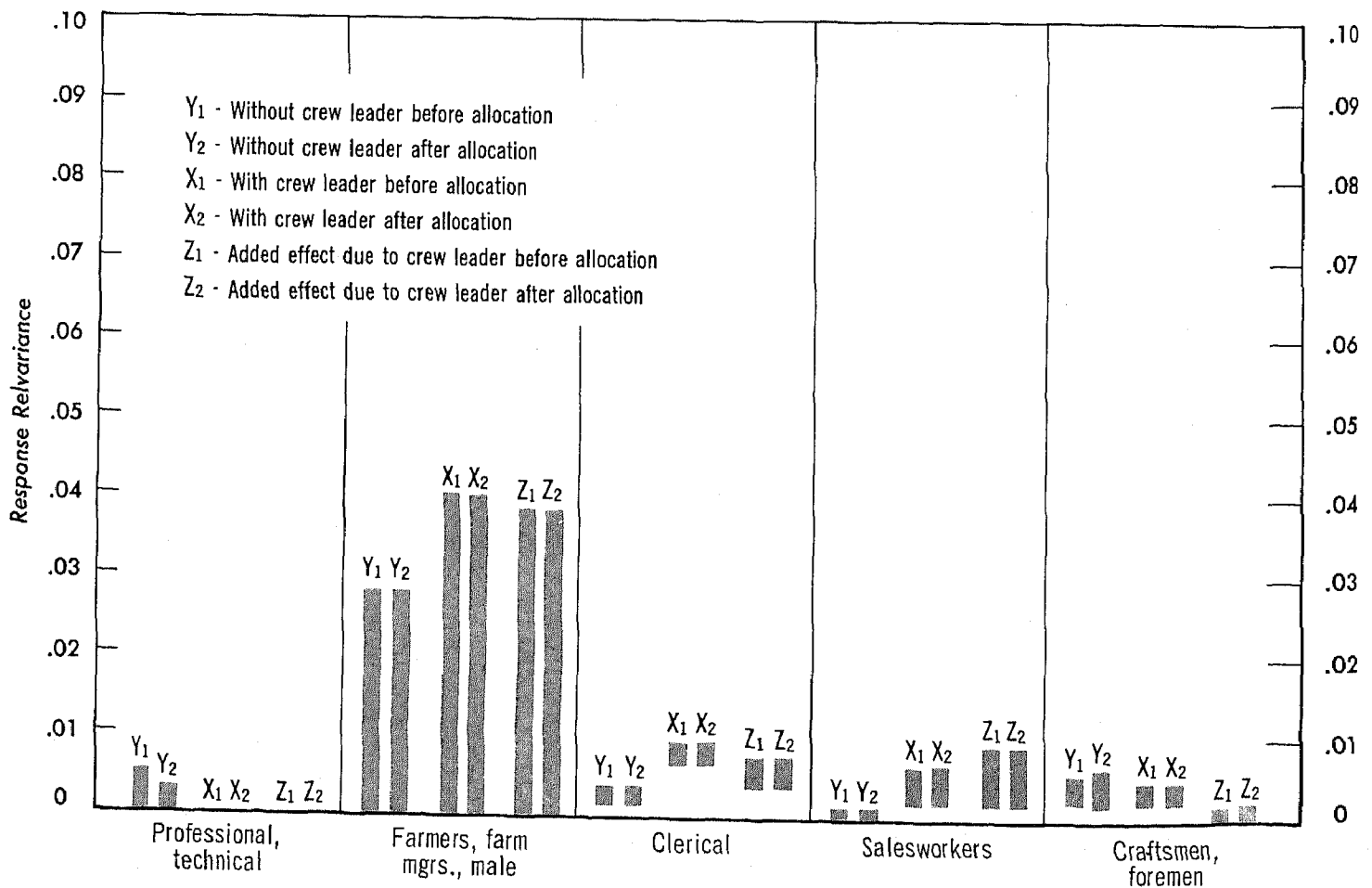
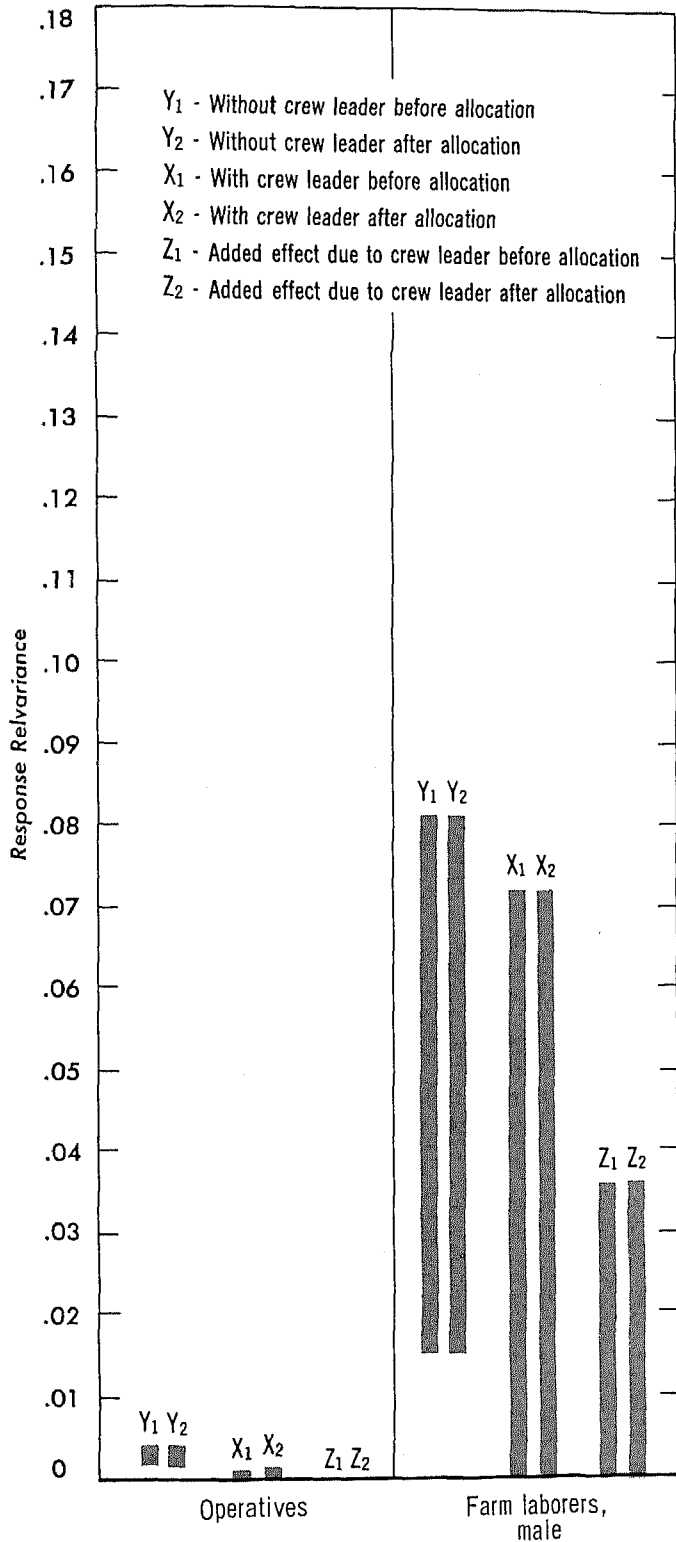


Figure 23. 98-Percent Confidence Intervals for the Response Relvariances Occupation Items (continued)



4. Summary of data on occupation items

- Response variances for most occupation items were small. For almost all of the items, the response variance was less than 40 percent of the sampling variance.
- The crew leader contribution to the variability of occupation statistics was very small or zero for most items; a positive contribution was noticed for clerical workers and salesworkers.
- The allocation process had practically no effect on the response variances of occupation items, since so few nonresponse cases were allocated an entry.
- Differences in response variance by type of area were difficult to interpret. Highly urban areas seemed to be afflicted with the largest response variances.
- Limited evidence tends to support the hypothesis that response variances for occupation items were smaller in 1960 than in 1950.

I. WAGE AND SALARY INCOME

Questions P32-P34 on the 1960 census schedule were for the purpose of obtaining information on individual incomes of persons 14 years old and over. These questions are shown in figure 24. Questions P30 and P31 are also shown because they were screening questions which helped the interviewers to ask the correct questions.

Wage and salary income will be discussed in this section; self-employment income and other income will be discussed in the two succeeding sections.

<p>P30. Last year, 1959, did he work at all, even for a few days?</p> <p>Yes <input type="radio"/> Ask P31</p> <p>No <input type="radio"/> Skip to P34</p>	<p>P31. How many weeks did he work in 1959, either full-time or part-time? Include paid vacation, paid sick leave, and military service</p> <p>13 or less <input type="radio"/></p> <p>14-26 <input type="radio"/></p> <p>27-39 <input type="radio"/></p> <p>40-47 <input type="radio"/></p> <p>48-49 <input type="radio"/></p> <p>50-52 <input type="radio"/></p>	<p>Ask P32</p>
<p>P32. How much did he earn in 1959 in wages or salary from all jobs? Before taxes, bond deductions, etc. \$ Include commissions and tips</p> <p>None <input type="radio"/></p>		
<p>P33. How much did he earn in 1959 working in his own business, professional practice, partnership, or farm? \$ Net income after business expenses</p> <p>None <input type="radio"/></p>		
<p>P34. Last year, 1959, did he receive any income from: Social Security, pensions, or veteran's payments; Rent, interest, or dividends; Unemployment insurance or welfare payments; Any other source not already reported?</p> <p>Yes <input type="radio"/> → Enter amount for entire year \$</p> <p>No <input type="radio"/></p>		

Figure 24.--Questions P30-P34 on income, 1960 Decennial Census schedule.

Evaluation and Research Program, 1960 Censuses

Table 28.--RATIOS OF RESPONSE VARIANCE TO SAMPLING VARIANCE FOR OCCUPATION ITEMS FOR HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Occupation groups	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
Professional, technical and kindred workers:						
Before allocation.....	.30	.00	.07	.05	.11	.00
After allocation.....	.25	.00	.00	.02	.09	.00
Farmers and farm managers, male:						
Before allocation.....	.00	(¹)	.00	.75	.20	.20
After allocation.....	.00	(¹)	.00	.75	.18	.20
Clerical and kindred workers:						
Before allocation.....	.65	1.54	.00	.31	.45	.88
After allocation.....	.66	1.54	.00	.31	.45	.88
Sales workers:						
Before allocation.....	.37	.00	.00	.45	.00	.40
After allocation.....	.42	.00	.00	.45	.00	.40
Craftsmen, foremen, and kindred workers:						
Before allocation.....	.08	1.36	.00	.33	1.09	.00
After allocation.....	.13	1.36	.00	.33	1.09	.00
Operatives and kindred workers:						
Before allocation.....	.22	.85	.00	.00	1.00	.00
After allocation.....	.24	.89	.00	.00	.95	.00
Farm laborers, paid workers, male:						
Before allocation.....	.00	(¹)	.00	.00	.74	.95
After allocation.....	.00	(¹)	.00	.00	.74	.95

¹The number of persons employed in this occupation was less than .1 percent of the total population and therefore the sampling variance was not calculated. On the basis of the sampling variance for .1 percent, the ratio of the response to sampling variance was over 1.0.

Table 29.--RATIOS OF ESTIMATED RESPONSE VARIANCES TO 25-PERCENT SAMPLING VARIANCES FOR OCCUPATION ITEMS: 1950 AND 1960 CENSUSES

1950 Census		1960 Census	
Occupation	Ratio of response to sampling variance	Occupation (after allocation)	Ratio of response to sampling variance
<u>Males</u>			
Farm laborers, unpaid family workers.....	0.9	Professional, technical and kindred workers.....	0.1
Farm laborers, paid workers.....	0.3	Farmers, farm managers, male.....	0.1
Farmers, farm managers.....	1.2	Clerical and kindred workers.....	0.2
Craftsmen, foremen, kindred workers.	0.4	Salesworkers.....	0.0
<u>Males and females</u>			
Occupation not reported.....	0.7	Craftsmen, foremen, kindred workers.	0.2
		Operatives and kindred workers.....	0.2
		Farm laborers, paid workers, male...	0.3

Income from wages or salary was defined as all earnings received for work as an employee. It included wages, salary, pay from the Armed Forces, commissions, tips, etc. For persons who had not worked in 1959, no entry was required.

Interviewers were told that there should be an entry for every person 14 years old or over, except if the work experience section indicated that the income item was to be left blank. He was to fill the circle for "none" or write in the income to the nearest dollar. For amounts greater than \$25,000, he was to write in \$25,000.

The income items were converted into three-digit codes during the general coding process at which time some manual editing was done. However, since the same general coder worked on the books for both interviewers in a cluster, the coding process did not add to the variability between the interviewers.

There was extensive machine editing and allocation processing on the computer for the income items. After allocation, no required entry was missing for the income items for any person 14 years old or over. Allocation of wage and salary income was made for approximately 5.2 percent of all persons who worked in 1959. For a de-

scription of the income concepts, the instructions to interviewers, the coding process, and the editing and allocation process, see reference [21], pages 219-221.

1. Estimates of response variances for wage and salary income

Table 30 shows the estimates of response relvariance for the 13 categories studied. The sampling relvariances were computed from equation 7.3 with $k = 1.0$.

It can be seen that the response variances are generally smaller than the sampling variances, except for the nonresponse item. Also, the standard errors of the response variances for all categories of female wage and salary income \$5,000 and over are very large.

A multiplier of the sampling variance to reflect the increase in variance due to interviewers and crew leaders is .43. This is the median of the ratios, after allocation (column 7, part B of table 30). For rough approximations, this value may be used in calculating the variance, including both sampling and response components, for a wage and salary income statistic. However, it is more appropriate to select the item in the table which is most like the item of interest and then apply the ratio shown in column 7 that applies to that item.

Table 30.--ESTIMATED RESPONSE RELVARIANCES FOR WAGE AND SALARY INCOME ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Wage and salary income items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
None:								
Before allocation.....	1,236	31.7	.00086	.00134	.029	.037	.64	.00008
After allocation.....	1,248	32.0	.00090	.00137	.030	.037	.66	.00008
\$2,500 or more:								
Before allocation.....	893	22.9	.00049	.00210	.022	.046	.23	.00009
After allocation.....	920	23.6	.00026	.00202	.016	.045	.13	.00007
Males, less than \$3,000:								
Before allocation.....	238	6.1	.00839	.00960	.092	.098	.87	.00079
After allocation.....	246	6.3	.00745	.00928	.086	.096	.80	.00068
Females, less than \$3,000:								
Before allocation.....	347	8.9	.00318	.00638	.056	.080	.50	.00042
After allocation.....	367	9.4	.00322	.00601	.057	.078	.54	.00038
Males, \$3,000 to \$4,999:								
Before allocation.....	238	6.1	.00313	.00960	.056	.098	.33	.00040
After allocation.....	261	6.7	.00425	.00867	.065	.093	.49	.00053
Females, \$3,000 to \$4,999:								
Before allocation.....	125	3.2	.00885	.01888	.094	.137	.47	.00146
After allocation.....	140	3.6	.01060	.01664	.103	.129	.64	.00140
Males, \$5,000 to \$6,999:								
Before allocation.....	254	6.5	.00127	.00898	.036	.095	.14	.00050
After allocation.....	261	6.7	.00320	.00867	.057	.093	.37	.00060
Females, \$5,000 to \$6,999:								
Before allocation.....	27	.7	.01477	.08742	.122	.296	.17	.00656
After allocation.....	27	.7	.02848	.08742	.169	.296	.33	.00603
Males, \$7,000 to \$9,999:								
Before allocation.....	113	2.9	.00836	.02084	.091	.144	.40	.00110
After allocation.....	117	3.0	.01118	.02015	.106	.142	.55	.00120

Table 30.--ESTIMATED RESPONSE RELVARIANCES FOR WAGE AND SALARY INCOME ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS--Con.

Wage and salary income items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
<u>A. Without Crew Leader Effect--Con.</u>								
Females, \$7,000 to \$9,999:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.08654
After allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.08654
Males, \$10,000 or more:								
Before allocation.....	51	1.3	.00000	.04758	.000	.218	.00	.00313
After allocation.....	51	1.3	.00256	.04758	.051	.218	.05	.00411
Females, \$10,000 or more:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.14663
After allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.19209
Not reported.....	82	2.1	.19134	.02908	.437	.171	6.58	.00659
<u>B. With Crew Leader Effect</u>								
None:								
Before allocation.....	1,217	31.2	.00099	.00137	.031	.037	.72	.00010
After allocation.....	1,229	31.5	.00092	.00136	.030	.037	.68	.00010
\$2,500 or more:								
Before allocation.....	901	23.1	.00080	.00207	.028	.045	.39	.00014
After allocation.....	956	24.5	.00046	.00192	.021	.044	.24	.00009
Males, less than \$3,000:								
Before allocation.....	238	6.1	.00699	.00960	.084	.098	.73	.00094
After allocation.....	246	6.3	.00714	.00928	.084	.096	.77	.00089
Females, less than \$3,000:								
Before allocation.....	347	8.9	.00139	.00638	.037	.080	.22	.00046
After allocation.....	367	9.4	.00056	.00601	.024	.078	.09	.00041
Males, \$3,000 to \$4,999:								
Before allocation.....	250	6.4	.00130	.00913	.036	.096	.14	.00045
After allocation.....	261	6.7	.00146	.00867	.038	.093	.17	.00036
Females, \$3,000 to \$4,999:								
Before allocation.....	125	3.2	.00429	.01888	.066	.137	.23	.00145
After allocation.....	140	3.6	.00618	.01664	.079	.129	.37	.00124
Males, \$5,000 to \$6,999:								
Before allocation.....	254	6.5	.00002	.00898	.004	.095	.00	.00040
After allocation.....	261	6.7	.00181	.00868	.042	.093	.21	.00043
Females, \$5,000 to \$6,999:								
Before allocation.....	27	.7	.03376	.08742	.184	.296	.39	.00936
After allocation.....	27	.7	.05258	.08742	.229	.296	.60	.01030
Males, \$7,000 to \$9,999:								
Before allocation.....	113	2.9	.00524	.02084	.072	.144	.25	.00092
After allocation.....	117	3.0	.00864	.02015	.093	.142	.43	.00101
Females, \$7,000 to \$9,999:								
Before allocation.....	(¹)	(¹)	.31061	(¹)	.557	(¹)	(²)	.07510
After allocation.....	(¹)	(¹)	.50246	(¹)	.709	(¹)	(²)	.08142
Males, \$10,000 or more:								
Before allocation.....	51	1.3	.00561	.04758	.075	.218	.12	.00314
After allocation.....	51	1.3	.01370	.04758	.117	.218	.29	.00261
Females, \$10,000 or more:								
Before allocation.....	(¹)	(¹)	1.66438	(¹)	1.290	(¹)	(³)	.24042
After allocation.....	(¹)	(¹)	1.62403	(¹)	1.274	(¹)	(³)	.23043
Not reported.....	82	2.1	.19527	.02908	.442	.171	6.71	.00826

¹The number of persons having a wage and salary income of this amount was less than .1 percent of the total population and therefore the sampling variance was not calculated.

²The response variance was less than the sampling variance for a characteristic that belongs to .1 percent of the total population. The ratio would be less than 1.0.

³The response variance was so large that the ratio of the response variance to the sampling variance would be over 1.0.

**Figure 25. 98-Percent Confidence Intervals for Response Relvariances
Wage and Salary Income Items (continued)**

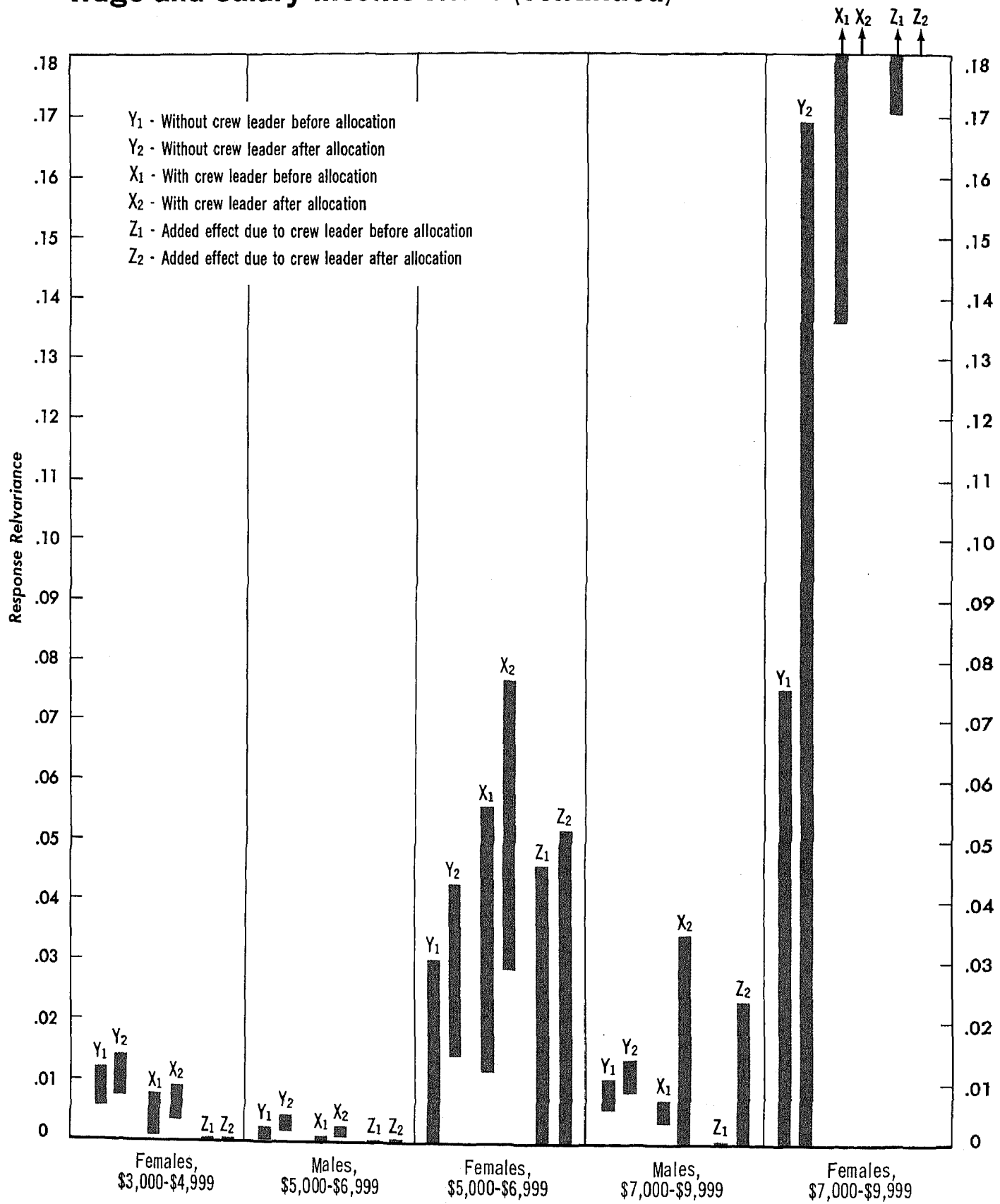
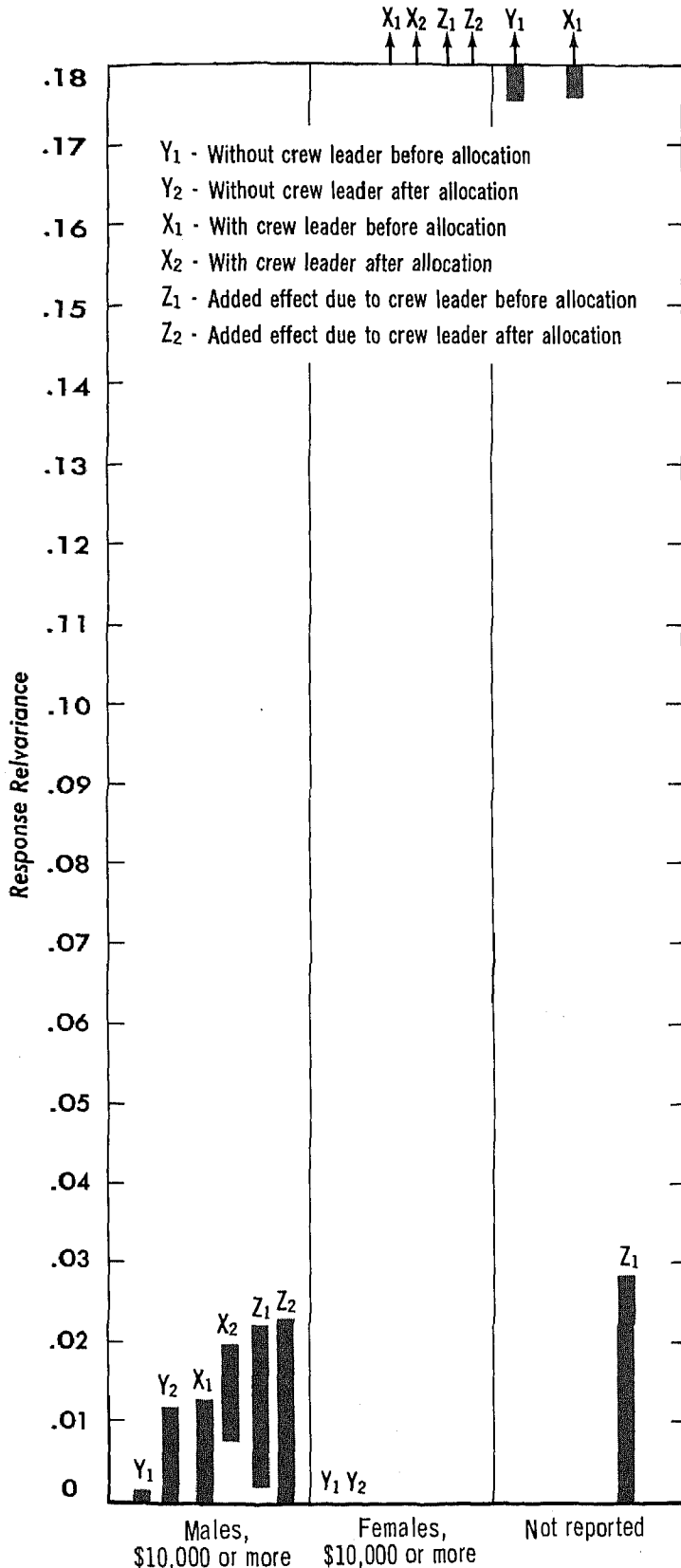


Figure 25. 98-Percent Confidence Intervals for Response Relvariances Wage and Salary Income Items (continued)



2. Estimates of response variance by type of area

Table 31 shows the ratios of response variances to sampling variances for wage and salary income items for highly urban, other urban, and rural areas.

The median ratios of response to sampling variance are:

	Without crew leader effect	With crew leader effect
Highly urban. . . . .	.7	.7
Other urban . . . . .	.1	.2
Rural . . . . .	.5	.5

Notice the large ratios in the highly urban areas and the small ratios in the other urban areas.

3. Comparison of 1950-1960 response variances

There were four wage and salary income categories studied in 1950, three of which were also studied in 1960. To make the comparisons, the data were converted to ratios of response variances to 25-percent sampling variances. The sampling variances were computed from equation 7.4 with $N = 3,900$ for 1960 and $6,500$ for 1950 and $\rho = .1$ for both 1950 and 1960. The data from 1960 are without the crew leader effect and after allocation. Table 32 shows the comparison.

For the three items which were identical, the 1960 ratio is much smaller than the 1950 ratio. In fact, the largest ratio for any 1960 item, excluding the nonresponse item, was 0.5. The 1950 ratios, except for \$2,500 or over, were much larger than that. So there is good reason to believe that the 1960 response variances were considerably smaller for the wage and salary income characteristic.

4. Summary of data on wage and salary income items

- Response variances were generally small for wage and salary income items. Also, the estimates of response relvariance for the income groups \$5,000 and over were subject to much variability themselves. A few items--the nonresponse items, in particular--had very large response variances.
- The crew leader contributed very little to the variability of the wage and salary income items. There were two exceptions for the two categories of females with income over \$7,000.
- The allocation process tends to increase the estimates of response variance.
- Large differences in response variances for a given item occurred, depending on the type of area--highly urban, other urban, and rural.
- The 1960 response variances for wage and salary income items tended to be smaller than those for 1950.

Table 31.--RATIOS OF RESPONSE VARIANCE TO SAMPLING VARIANCE FOR WAGE AND SALARY INCOME ITEMS FOR HIGHLY URBAN, OTHER URBAN, AND RURAL AREAS

Wage and salary income items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
No income:						
Before allocation.....	.61	.21	.68	.52	.57	1.31
After allocation.....	.75	.66	.75	.52	.62	1.23
\$2,500 or more:						
Before allocation.....	.11	.89	.16	.30	.43	.03
After allocation.....	.00	.71	.13	.16	.25	.00
Males, less than \$3,000:						
Before allocation.....	.13	.74	.30	.21	1.78	1.36
After allocation.....	.68	1.07	.14	.16	1.54	1.46
Females, less than \$3,000:						
Before allocation.....	.36	.73	.33	.00	.80	.54
After allocation.....	.67	.65	.45	.00	.53	.36
Males, \$3,000 to \$4,999:						
Before allocation.....	.20	.05	.12	.17	.68	.16
After allocation.....	.18	.21	.21	.15	1.04	.16
Females, \$3,000 to \$4,999:						
Before allocation.....	.73	.90	.00	.00	1.59	.46
After allocation.....	.79	1.06	.00	.00	1.71	.49
Males, \$5,000 to \$6,999:						
Before allocation.....	.50	.49	.13	.00	.00	.18
After allocation.....	.79	1.04	.35	.00	.00	.60
Females, \$5,000 to \$6,999:						
Before allocation.....	.37	.51	.01	.41	.12	.07
After allocation.....	.74	.75	.00	.65	.26	.14
Males, \$7,000 to \$9,999:						
Before allocation.....	.00	1.10	.00	.09	2.03	.04
After allocation.....	.00	1.36	.10	.28	2.36	.17
Females, \$7,000 to \$9,999:						
Before allocation.....	.00	.23	.00	(¹)	.00	.00
After allocation.....	.32	.69	.00	(¹)	.00	.00
Males, \$10,000 or more:						
Before allocation.....	.61	.00	.00	.00	.00	1.48
After allocation.....	1.46	.00	.00	.00	.00	2.31
Females, \$10,000 or more:						
Before allocation.....	.00	(¹)	.00	.00	.00	(¹)
After allocation.....	.00	(¹)	.00	.00	.00	(¹)
Not reported.....	4.93	5.64	9.38	6.43	3.49	3.28

¹The number of persons having a wage and salary income of this amount was less than .1 percent of the total population and therefore the sampling variance was not calculated. On the basis of the sampling variance for .1 percent, the ratio of the response variance to the sampling variance is over 1.0.

Effects of Interviewers and Crew Leaders

Table 32.--RATIOS OF ESTIMATED RESPONSE VARIANCES TO 25-PERCENT SAMPLING VARIANCES FOR WAGE AND SALARY ITEMS: 1950 AND 1960 CENSUS

1950 Census		1960 Census	
Wage and salary income items	Ratio of response to sampling variance	Wage and salary income items (after allocation)	Ratio of response to sampling variance
No income.....	1.2	No income.....	0.4
Under \$2,500.....	1.6	\$2,500 or over.....	0.1
\$2,500 or over.....	0.3	Males, less than \$3,000.....	0.5
Not reported.....	9.7	Females, less than \$3,000.....	0.3
		Males, \$3,000 to \$4,999.....	0.3
		Females, \$3,000 to \$4,999.....	0.4
		Males, \$5,000 to \$6,999.....	0.2
		Females, \$5,000 to \$6,999.....	0.2
		Males, \$7,000 to \$9,999.....	0.4
		Females, \$7,000 to \$9,999.....	0.0
		Males, \$10,000 or more.....	0.04
		Females, \$10,000 or more.....	0.0
		Not reported.....	4.3

Table 33.--ESTIMATED RESPONSE RELVARIANCES FOR SELF-EMPLOYMENT INCOME ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Self-employment income items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
\$2,500 or more:								
Before allocation.....	105	2.7	.00432	.02240	.066	.149	.19	.00104
After allocation.....	136	3.5	.00704	.01712	.084	.131	.41	.00109
Males, less than \$3,000:								
Before allocation.....	101	2.6	.01646	.02325	.128	.153	.71	.00258
After allocation.....	105	2.7	.01235	.02240	.111	.149	.55	.00197
Females, less than \$3,000:								
Before allocation.....	27	.7	.06564	.08742	.256	.296	.75	.00717
After allocation.....	27	.7	.07884	.08742	.281	.296	.90	.00672
Males, \$3,000 to \$4,999:								
Before allocation.....	39	1.0	.00000	.06168	.000	.248	.00	.00431
After allocation.....	39	1.0	.00000	.06168	.000	.248	.00	.00445
Females, \$3,000 to \$4,999:								
Before allocation.....	(1)	(1)	.09129	(1)	.302	(1)	(2)	.02571
After allocation.....	(1)	(1)	.16999	(1)	.412	(1)	(2)	.02494
Males, \$5,000 to \$6,999:								
Before allocation.....	23	.6	.04387	.10147	.209	.318	.43	.00798
After allocation.....	27	.7	.04805	.08742	.219	.296	.55	.00777
Females, \$5,000 to \$6,999:								
Before allocation.....	(1)	(1)	.08516	(1)	.292	(1)	(2)	.08532
After allocation.....	(1)	(1)	.38484	(1)	.620	(1)	(2)	.12207
Males, \$7,000 to \$9,999:								
Before allocation.....	12	.3	.00000	.21237	.000	.460	.00	.00790
After allocation.....	12	.3	.00000	.21237	.000	.460	.00	.00835
Females, \$7,000 to \$9,999:								
Before allocation.....	(1)	(1)	.00000	(1)	.000	(1)	.00	.26325
After allocation.....	(1)	(1)	.00000	(1)	.000	(1)	.00	.27423

Table 33.--ESTIMATED RESPONSE RELVARIANCE FOR SELF-EMPLOYMENT INCOME ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS--Con.

Self-employment income items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
<u>A. Without Crew Leader Effect--Con.</u>								
Males, \$10,000 or more:								
Before allocation.....	23	.6	.00000	.10147	.000	.318	.00	.00802
After allocation.....	27	.7	.02354	.08742	.153	.296	.27	.00887
Females, \$10,000 or more:								
Before allocation.....	(1)	(1)	.00000	(1)	.000	(1)	.00	.23195
After allocation.....	(1)	(1)	.00000	(1)	.000	(1)	.00	.23195
Not reported.....	55	1.4	.19721	.04420	.444	.210	4.5	.00897
<u>B. With Crew Leader Effect</u>								
\$2,500 or more:								
Before allocation.....	105	2.7	.01562	.02239	.125	.149	.70	.00198
After allocation.....	109	2.8	.01417	.02159	.119	.147	.66	.00173
Males, less than \$3,000:								
Before allocation.....	101	2.6	.01014	.02340	.101	.153	.43	.00158
After allocation.....	105	2.7	.00826	.02239	.091	.149	.37	.00157
Females, less than \$3,000:								
Before allocation.....	27	.7	.07665	.08742	.277	.296	.88	.00628
After allocation.....	27	.7	.07044	.08742	.265	.296	.80	.00632
Males, \$3,000 to \$4,999:								
Before allocation.....	39	1.0	.00743	.06168	.086	.248	.12	.00602
After allocation.....	39	1.0	.00699	.06168	.084	.248	.11	.00562
Females, \$3,000 to \$4,999:								
Before allocation.....	(1)	(1)	.53160	(1)	.729	(1)	(2)	.04539
After allocation.....	(1)	(1)	.44642	(1)	.668	(1)	(2)	.04572
Males, \$5,000 to \$6,999:								
Before allocation.....	23	.6	.00780	.10147	.088	.318	.08	.00534
After allocation.....	27	.7	.02356	.08742	.153	.296	.27	.00539
Females, \$5,000 to \$6,999:								
Before allocation.....	(1)	(1)	.41558	(1)	.645	(1)	(2)	.15133
After allocation.....	(1)	(1)	.38683	(1)	.622	(1)	(2)	.14491
Males, \$7,000 to \$9,999:								
Before allocation.....	12	.3	.06806	.21237	.261	.460	.32	.01034
After allocation.....	12	.3	.09794	.21237	.313	.460	.46	.01086
Females, \$7,000 to \$9,999:								
Before allocation.....	(1)	(1)	.00000	(1)	.000	(1)	.00	.28107
After allocation.....	(1)	(1)	.38086	(1)	.617	(1)	(2)	.25573
Males, \$10,000 or more:								
Before allocation.....	23	.6	.02984	.10147	.173	.318	.29	.00866
After allocation.....	27	.7	.02038	.08742	.143	.296	.23	.00744
Females, \$10,000 or more:								
Before allocation.....	(1)	(1)	2.51545	(1)	1.586	(1)	(3)	.39749
After allocation.....	(1)	(1)	2.21538	(1)	1.488	(1)	(3)	.40249
Not reported.....	55	1.4	.24423	.04420	.494	.210	5.5	.00956

¹The percent of persons having a self-employment income of this amount was less than .1 percent of the total population and therefore the sampling variance was not calculated.

²The response variance was less than the sampling variance for a characteristic that belongs to .1 percent of the total population. The ratio would be less than 1.0.

³The response variance is so large that the ratio of the response variance to the sampling variance would be over 1.0.

J. SELF-EMPLOYMENT INCOME

Question P33 on the 1960 census schedule was for the purpose of obtaining information on self-employment income. This question is shown in figure 24 in the previous section. As with the question on wage and salary income, this question was asked of all persons 14 years old and over who had worked in 1959.

Self-employment income was defined as the net money income from a business, farm, or professional enterprise in which a person was engaged on his own account or as an unincorporated employer.

The instructions to interviewers and coders were similar to those for wage and salary income. Pages 219-221 of reference [21] give a description of the concepts, instructions, and editing and allocating process.

1. Estimates of response variance for self-employment income

Table 33 shows the estimates of response relvariance for the 12 categories studied. The sampling relvariances shown in column 4 were computed from equation 7.3 with $k = 1.0$.

Notice that several of the categories involve only a small percentage of the total population. Indeed, all the categories composed of women with self-employment income of over \$3,000 comprised less than 0.1 percent of the total population. As with most of the characteristics, the ratio of response to sampling variance is highest for the nonresponse item. To get a multiplier of the sampling variance which would reflect the increase in variance due to interviewers and crew leaders, we computed the median, for the estimates after allocation, of the ratios shown in column 7, part B of table 33. This median ratio is approximately .5. However, a user should select the item in table 33 which most closely resembles the item of interest to him and apply the corresponding ratio shown in column 7.

Ninety-eight percent confidence intervals were constructed for the response relvariances with and without the crew leader effect and for the added effect due to crew leaders. These confidence intervals are shown in figure 26.

Except for the first three items, there was very great variability in the estimates of response relvariance, as is shown by the length of the confidence intervals. About half of the confidence intervals for the response relvariances without crew leader effect included zero, and slightly less than half for those with the crew leader effect. Very large response relvariances were shown for "females, less than \$3,000," "females, \$3,000 to \$4,999," "males, \$7,000 to \$9,999," "females, \$10,000 and over," and the nonresponse category.

For only a few categories was the added effect due to the crew leaders close to zero. Most of the items showed a positive crew leader effect. The strongest crew leader effect was shown in the items "males, \$7,000 to \$9,999," "females, \$10,000 or more," and the nonresponse item.

The effects of allocation depend on whether we consider the estimates with or without the crew leader effect. Without the crew leader effect, allocation tended to raise the estimates of response variance; with the crew leader effect, allocation tended to lower the estimates.

This shows in the intervals for the added effect due to crew leaders. The intervals after allocation are usually closer to the zero line.

2. Estimates of response variance by type of area

Table 34 shows the ratios of response variances to sampling variances for self-employment income items for highly urban, other urban, and rural areas.

The median ratios of response to sampling variance are:

	Without crew leader effect	With crew leader effect
Highly urban . . . . .	.2	.2
Other urban . . . . .	.3	.4
Rural . . . . .	.0	.5

Undoubtedly, the estimates of response variance by type of area were subject to large variances. Therefore, the estimates in the table must be used with caution.

3. Comparisons of 1950-1960 response variances

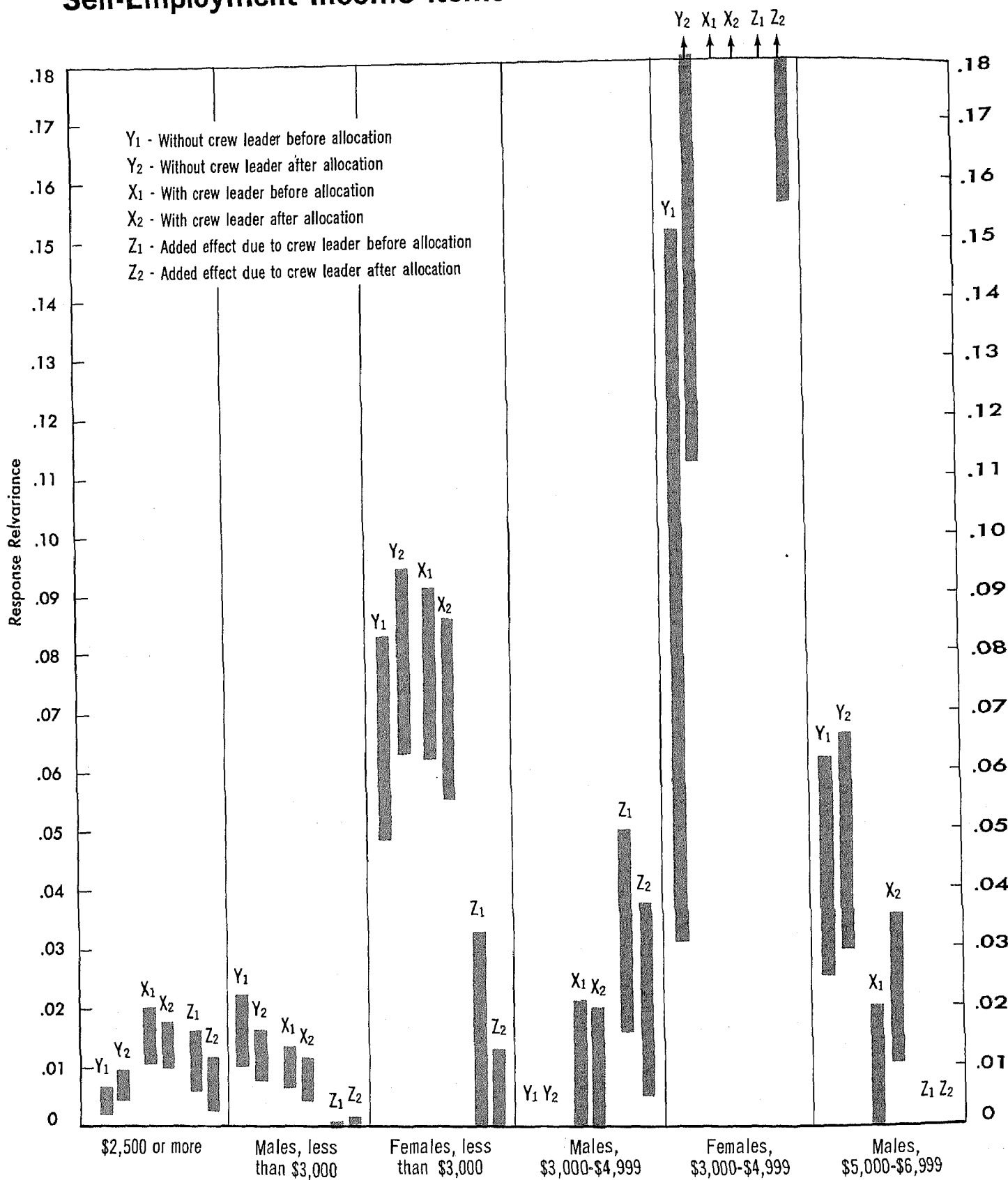
There were four self-employment income items studied in 1950, two of which were also studied in 1960. To make the comparisons, the estimates of response variances were converted to proportions of 25-percent sampling variances. The sampling variances were computed from equation 7.4 with $N = 3,900$ for 1960 and 6,500 for 1950 and $\rho = .1$ for both 1950 and 1960. The data for 1960 are the estimates without the crew leader effect and after allocation. Table 35 shows the comparison.

Notice that for the two categories which were the same, the 1960 ratios are much smaller than the 1950 ratios. None of the ratios for 1960, except for the nonresponse item, are over 1.0. Three of the four 1950 ratios are over 1.0. This indicates that the 1960 response variances were considerably smaller for the self-employment income characteristics.

4. Summary of data on self-employment income items

- Large response variances were found for about half of the self-employment income items. Unfortunately, most of the estimates of response variance were subject to large sampling variances themselves. However, the response variances were usually not within sampling variability of zero.
- A strong crew leader effect showed for several items, including the nonresponse item. In particular, those items concerning income \$7,000 or over for females showed a large crew leader effect.
- The allocation process tended to depress the differences between the estimates with and without crew leader effect. The estimates without the crew leader effect were raised and the estimates with the crew leader effect were lowered by the allocation process.

**Figure 26. 98-Percent Confidence Intervals for Response Relvariances
Self-Employment Income Items**



**Figure 26. 98-Percent Confidence Intervals for Response Relvariances
Self-Employment Income Items (continued)**

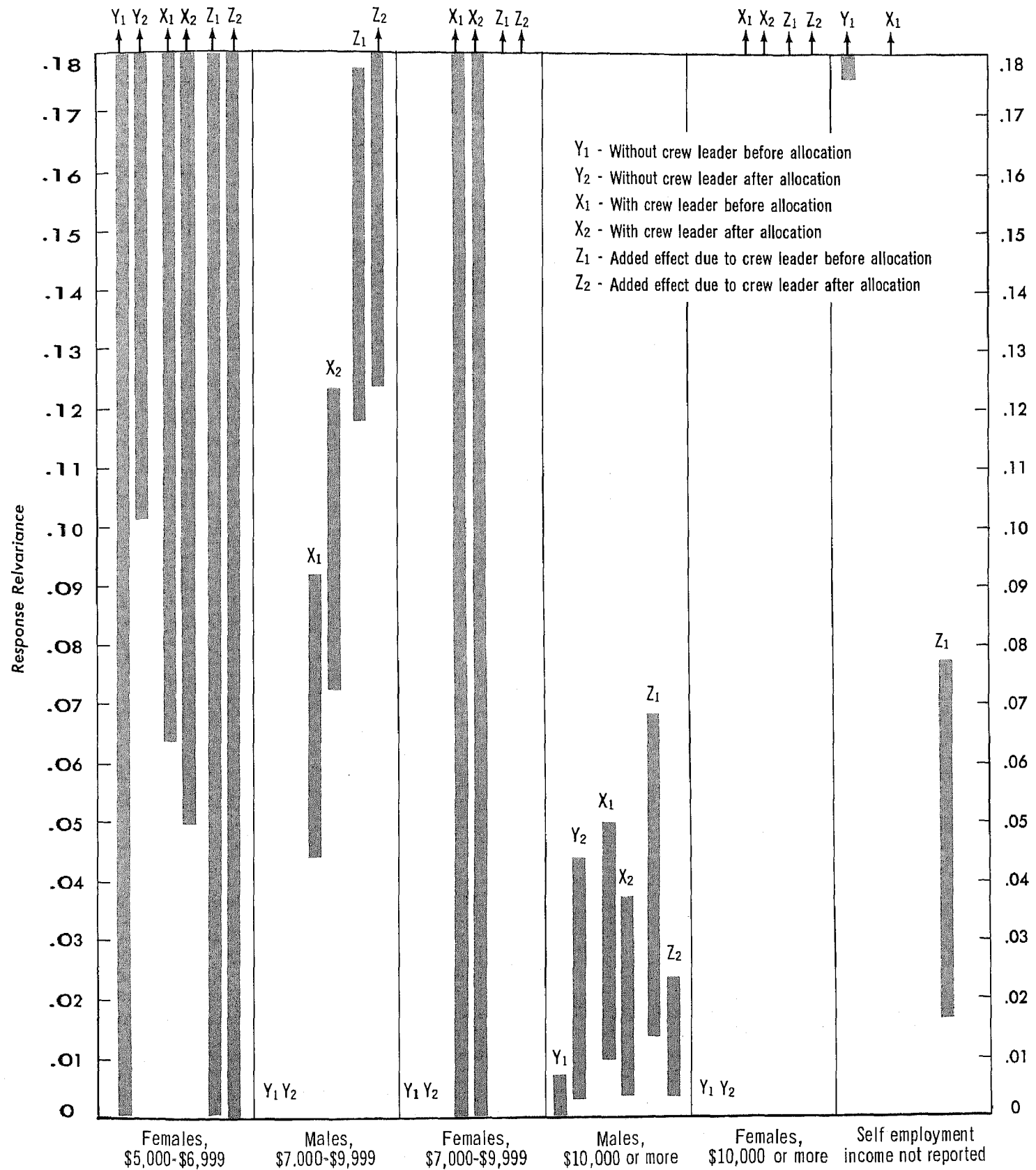


Table 34.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR SELF-EMPLOYMENT INCOME ITEMS FOR HIGHLY URBAN, OTHER URBAN AND RURAL AREAS

Self-employment income items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
\$2,500 or more:						
Before allocation.....	.61	.18	.24	.47	.00	1.47
After allocation.....	1.08	.63	.32	.36	.00	1.18
Males, less than \$3,000:						
Before allocation.....	.00	1.25	.23	.26	1.12	.37
After allocation.....	.31	1.37	.33	.30	.70	.18
Females, less than \$3,000:						
Before allocation.....	.37	.80	1.06	.06	.53	2.28
After allocation.....	1.51	.19	1.27	.15	.52	2.17
Males, \$3,000 to \$4,999:						
Before allocation.....	.00	.00	.00	.00	.00	.65
After allocation.....	.24	.11	.00	.00	.00	.55
Females, \$3,000 to \$4,999:						
Before allocation.....	.00	(¹)	(¹)	(¹)	(¹)	(²)
After allocation.....	.00	1.69	(¹)	(¹)	(¹)	(²)
Males, \$5,000 to \$6,999:						
Before allocation.....	.45	.00	.70	.00	.26	.59
After allocation.....	.52	.25	.74	.00	.29	.67
Females, \$5,000 to \$6,999:						
Before allocation.....	(¹)	.00	(¹)	(²)	.00	(¹)
After allocation.....	(¹)	.00	(¹)	(²)	.00	(¹)
Males, \$7,000 to \$9,999:						
Before allocation.....	.00	.00	.00	.57	.00	.23
After allocation.....	.00	.00	.00	.75	.00	.33
Females, \$7,000 to \$9,999:						
Before allocation.....	.00	.00	.00	(²)	.00	.00
After allocation.....	.00	.00	.00	(²)	.00	.00
Males, \$10,000 or more:						
Before allocation.....	.62	.20	.00	.70	.00	.00
After allocation.....	.88	1.26	.35	.40	.00	.00
Females, \$10,000 or more:						
Before allocation.....	.00	.00	.00	(²)	.00	.00
After allocation.....	.00	.00	.00	(²)	.00	.00
Not reported.....	3.90	5.78	6.13	8.14	4.25	5.43

¹The percent of the total population having this characteristic was less than .1 percent. Therefore, the sampling variance was not computed. On the basis of the sampling variance for .1 percent, the ratio of the response variance to the sampling variance was greater than zero but less than 1.0.

²The percent of the total population having this characteristic was less than .1 percent. Therefore, the sampling variance was not computed. On the basis of the sampling variance for .1 percent, the ratio of the response variance to the sampling variance was greater than 1.0.

d. Differences in response variances by type of area were difficult to interpret, with not too much difference in the overall level of variability.

e. From limited evidence, the 1960 response variances for self-employment items tended to be smaller than the 1950 response variances.

K. OTHER INCOME

Question P34 on the 1960 census schedule was for the purpose of obtaining information on income from

sources other than wages or salary and self-employment. It included net income from rents, royalties, interest, dividends, Social Security benefits, pensions, etc. Question P34 is shown in figure 24 on page 63. This question was to be asked of all persons 14 years of age or over, regardless of whether they had worked in 1959.

There was an opportunity for interviewers to affect the information on other income. As shown in Bureau of the Census, *Evaluation and Research Program of the U.S. Censuses of Population and Housing, 1960: Accuracy of Data on Population Characteristics as Measured by Reinterviews*, Series ER60, No. 4, there are many people

Table 35.--RATIOS OF ESTIMATED RESPONSE VARIANCES TO 25-PERCENT SAMPLING VARIANCES FOR SELF-EMPLOYMENT INCOME ITEMS: 1950 AND 1960 CENSUSES

1950 Census		1960 Census	
Self-employment income items	Ratio of response to sampling variance	Self-employment income items (after allocation)	Ratio of response to sampling variance
No income.....	1.9	\$2,500 and over.....	0.3
Under \$2,500.....	1.3	Males, less than \$3,000.....	0.4
\$2,500 and over.....	0.6	Females, less than \$3,000.....	0.6
Not reported.....	10.5	Males, \$3,000 to \$4,999.....	0.0
		Females, \$3,000 to \$4,999.....	0.2
		Males, \$5,000 to \$6,999.....	0.4
		Females, \$5,000 to \$6,999.....	0.4
		Males, \$7,000 to \$9,999.....	0.0
		Females, \$7,000 to \$9,999.....	0.0
		Males, \$10,000 and over.....	0.2
		Females, \$10,000 and over.....	0.0
		Not reported.....	2.9

who don't report small amounts--less than \$500--of other income to the census interviewers. This may be because they don't think of it when filling the schedule. If one interviewer of the pair asked about unearned income from various sources while the other one assumed that blanks represented no income from other sources, a large interviewer variance would occur.

1. Estimates of response variance for other income items

Table 36 shows the estimates of response relvariance for the 12 categories studied. The sampling relvariances shown in column 4 were computed from equation 7.3 with $k = 1.0$.

Except for the categories concerning income less than \$3,000, most of the categories contain less than 0.1 percent of the total population. All of the categories concerning income over \$5,000 contain less than 0.1 percent of the total population. As might be expected from these kinds of items, the variances of the estimates of response relvariance are very large, as is shown in column 8. The ratios of response to sampling variances are generally less than 1, the notable exception being the nonresponse item.

A multiplier of the sampling variance which will reflect the increase in variability due to interviewers and crew leaders was devised. This multiplier is the median of the ratios shown in part B of table 36 for the estimates after allocation. The multiplier is .5. A user who wants a multiplier for a specific item should select the item in the table which is most nearly like the item of interest and apply the ratio shown for that item.

Ninety-eight percent confidence intervals were constructed for other income items for the response relvariances with and without crew leader effect and for the added effect due to crew leaders. These confidence intervals are shown in figure 27.

The first three items on the chart show rather short confidence intervals, indicating little variability in the estimates of response variance. The first item--\$2,500 or more--shows a large, positive response relvariance and a definite crew leader effect. The two following items dealing with other income less than \$3,000 show small or zero response relvariances and no strong crew leader effect.

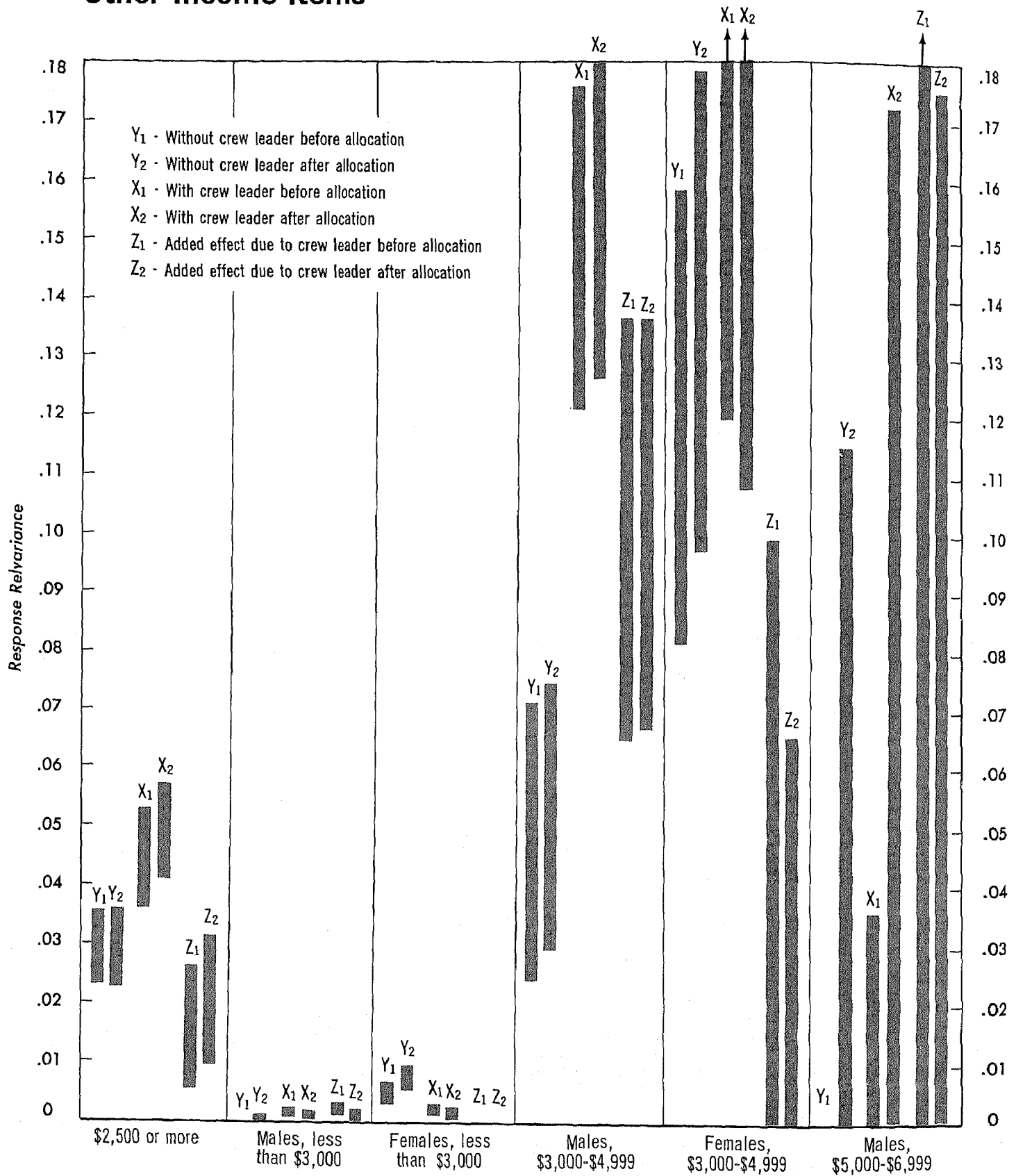
The next two items--males and females, \$3,000 to \$4,999--show large response relvariances. The item on males shows a strong crew leader effect while the item with females shows no added effect due to crew leaders.

From this point on, the confidence intervals are very long and frequently encompass the zero line, indicating that the estimates of response relvariances are subject to large sampling variances and are within sampling variability of zero.

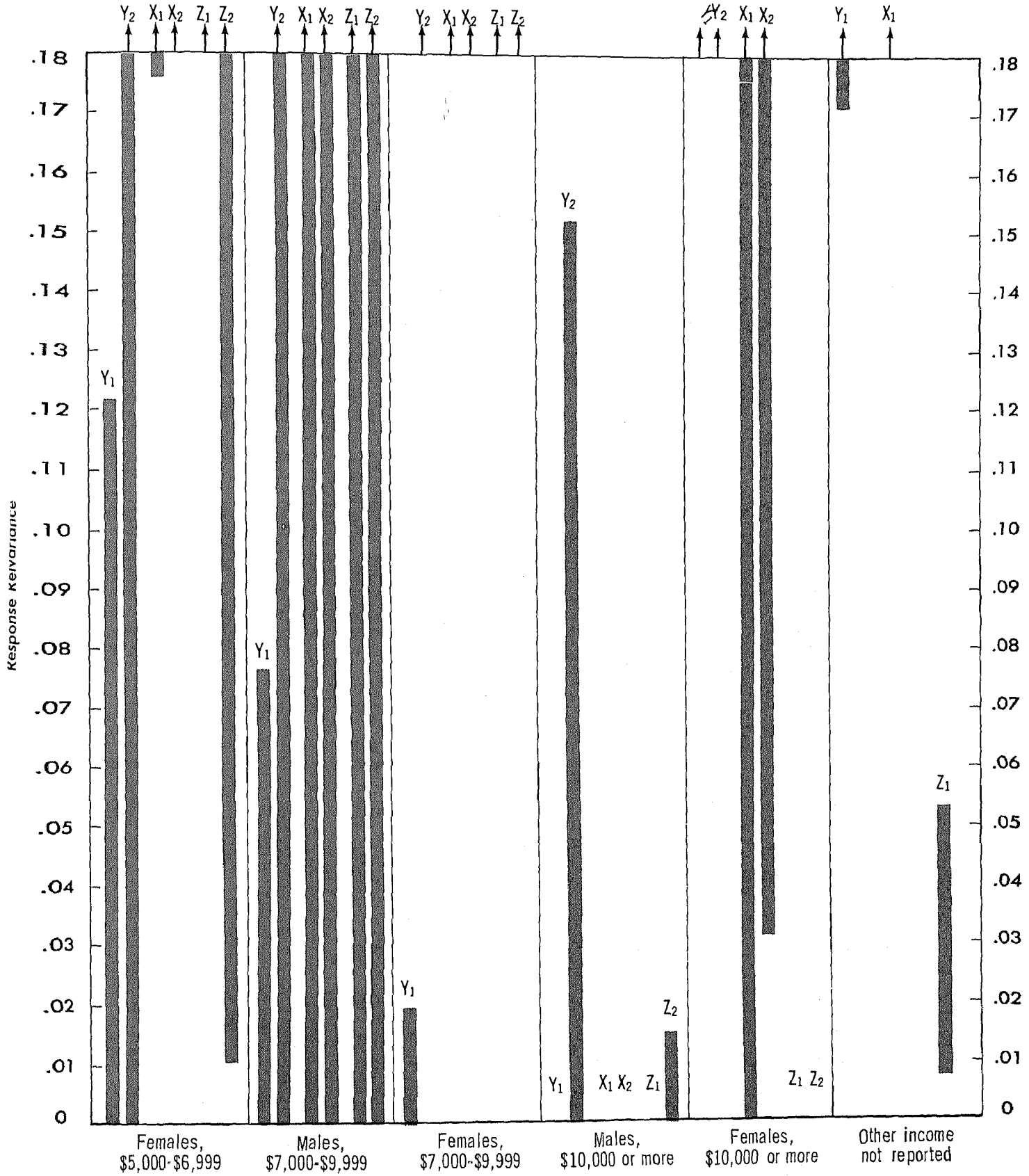
The nonresponse item showed large response relvariances and a strong crew leader effect.

The effect of allocation followed the same general pattern as with the self-employment characteristic. The estimates without the crew leader effect tended to be raised by allocation; the estimates with the crew leader effect tended to be lowered.

**Figure 27. 98-Percent Confidence Intervals for Response Relvariances
Other Income Items**



**Figure 27. 98-Percent Confidence Intervals for Response Relvariances
Other Income Items (continued)**



Evaluation and Research Program, 1960 Censuses

Table 36.--ESTIMATED RESPONSE RELVARIANCES FOR OTHER INCOME ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Other income items	Average census result		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
\$2,500 or more:								
Before allocation.....	51	1.3	.02868	.04758	.169	.218	.60	.00272
After allocation.....	55	1.4	.02865	.04420	.169	.210	.65	.00291
Males, less than \$3,000:								
Before allocation.....	386	9.9	.00000	.00567	.000	.075	.00	.00022
After allocation.....	402	10.3	.00003	.00543	.005	.074	.01	.00022
Females, less than \$3,000:								
Before allocation.....	285	7.3	.00474	.00792	.069	.089	.60	.00087
After allocation.....	296	7.9	.00709	.00757	.084	.087	.94	.00091
Males, \$3,000 to \$4,999:								
Before allocation.....	12	.3	.04763	.21237	.218	.460	.22	.01015
After allocation.....	12	.3	.05200	.21237	.228	.460	.24	.00986
Females, \$3,000 to \$4,999:								
Before allocation.....	12	.3	.11975	.21237	.346	.460	.56	.01652
After allocation.....	16	.4	.13785	.15911	.371	.399	.87	.01735
Males, \$5,000 to \$6,999:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.04135
After allocation.....	(¹)	(¹)	.02590	(¹)	.161	(¹)	(²)	.03847
Females, \$5,000 to \$6,999:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.14491
After allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.17146
Males, \$7,000 to \$9,999:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.07772
After allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.08222
Females, \$7,000 to \$9,999:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.12166
After allocation.....	(¹)	(¹)	1.18107	(¹)	1.087	(¹)	(³)	.11314
Males, \$10,000 or more:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.07120
After allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.07477
Females, \$10,000 or more:								
Before allocation.....	(¹)	(¹)	2.06687	(¹)	1.438	(¹)	(³)	.11619
After allocation.....	(¹)	(¹)	2.44674	(¹)	1.564	(¹)	(³)	.12845
Not reported.....	109	2.8	.18532	.02159	.430	.147	8.58	.00587
B. With Crew Leader Effect								
\$2,500 or more:								
Before allocation.....	51	1.3	.04430	.04758	.210	.218	.93	.00367
After allocation.....	55	1.4	.04885	.04420	.221	.210	1.10	.00371
Males, less than \$3,000:								
Before allocation.....	386	9.9	.00121	.00567	.035	.075	.21	.00036
After allocation.....	402	10.3	.00088	.00543	.030	.074	.16	.00033
Females, less than \$3,000:								
Before allocation.....	285	7.3	.00174	.00792	.042	.089	.22	.00046
After allocation.....	296	7.6	.00112	.00757	.035	.087	.15	.00043
Males, \$3,000 to \$4,999:								
Before allocation.....	12	.3	.14836	.21237	.385	.460	.70	.01170
After allocation.....	12	.3	.15325	.21237	.391	.460	.72	.01140
Females, \$3,000 to \$4,999:								
Before allocation.....	12	.3	.16215	.21237	.403	.460	.76	.01822
After allocation.....	12	.3	.14693	.21237	.383	.460	.69	.01688
Males, \$5,000 to \$6,999:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.05010
After allocation.....	(¹)	(¹)	.05229	(¹)	.229	(¹)	(²)	.05148

Table 36.--ESTIMATED RESPONSE RELVARIANCES FOR OTHER INCOME ITEMS FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS--Con.

Other income items	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
B. With Crew Leader Effect--Con.								
Females, \$5,000 to \$6,999:								
Before allocation.....	(¹)	(¹)	.35324	(¹)	.594	(¹)	(²)	.07596
After allocation.....	(¹)	(¹)	.38957	(¹)	.624	(¹)	(²)	.09011
Males, \$7,000 to \$9,999:								
Before allocation.....	(¹)	(¹)	.13011	(¹)	.361	(¹)	(²)	.09006
After allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.08155
Females, \$7,000 to \$9,999:								
Before allocation.....	(¹)	(¹)	.79872	(¹)	.894	(¹)	(³)	.13892
After allocation.....	(¹)	(¹)	1.82446	(¹)	1.351	(¹)	(³)	.12530
Males, \$10,000 or more:								
Before allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.08367
After allocation.....	(¹)	(¹)	.00000	(¹)	.000	(¹)	.00	.08972
Females, \$10,000 or more:								
Before allocation.....	(¹)	(¹)	.25679	(¹)	.506	(¹)	(²)	.28966
After allocation.....	(¹)	(¹)	.69629	(¹)	.834	(¹)	(³)	.28566
Not reported.....	109	2.8	.21569	.02159	.465	.147	10.0	.00800

¹The percentage of the population having this characteristic was less than .1 percent. For that reason the sampling variance was not computed.
²On the basis of the sampling variance for a category based on .1 percent of the total population, the ratio of the response variance to the sampling variance is less than 1.0.
³On the basis of the sampling variance for a category based on .1 percent of the total population, the ratio of the response variance to the sampling variance is greater than 1.0.

2. Estimates of response variance by type of area

Table 37 shows the ratios of response variances to sampling variances for other income items for highly urban, other urban, and rural areas.

The median ratios of response to sampling variance are:

	Without crew leader effect	With crew leader effect
Highly urban.....	.9	.3
Other urban.....	.3	.4
Rural.....	.0	less than 1.0

The ratio for the rural areas with the crew leader effect, since the proportion of the population in so many of the categories was so small, was greater than 0.0 and less than 1.0.

The variances attached to the estimates by type of area are very large. For that reason, it is difficult to use the ratios shown in table 37. However, the table does indicate that there is a difference in the estimate of response variance depending on the type of area.

3. Comparisons of 1950-1960 response variances

There were four other income categories studied in 1950, two of which were also studied in 1960. To make

the comparisons, the estimates of response variances were converted to proportions of 25-percent sampling variances. The sampling variances were computed from equation 7.4 with N = 3,900 for 1960 and 6,500 for 1950 and $\rho = .1$ for both 1950 and 1960. The data used for 1960 are without the crew leader effect and after allocation. Table 38 shows the comparison.

Notice that the 1960 ratio was much smaller for the nonresponse item, but larger for the category "\$2,500 and over." Two of the 1960 ratios, in addition to that for the nonresponse category, are greater than 1.0. However, the 1950 ratios, except for one category, were all over 3.0. It seems that the 1960 ratio over all items is smaller than that for 1950. However, with such a few items to compare, it is not possible to say that the 1960 response variances are smaller than those in 1950.

4. Summary of data on other income items

- a. Response variances for most other income items were small. The estimates of response relvariances for items on income \$5,000 and over were subject to large sampling variances. A few items--the nonresponse item, income \$2,500 or more, and male and female income, \$3,000 to \$4,999--had substantial response relvariances.
- b. The crew leader effect was very strong for some items--income \$2,500 and over, males, \$3,000 to \$4,999, and the nonresponse item. However, for

Table 37.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR OTHER INCOME ITEMS FOR HIGHLY URBAN, OTHER URBAN AND RURAL AREAS

Other income items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
\$2,500 or more:						
Before allocation.....	.09	.50	1.00	.50	.47	3.06
After allocation.....	.12	.33	1.19	.87	.25	2.94
Males, less than \$3,000:						
Before allocation.....	.00	.75	.00	.00	.00	.57
After allocation.....	.26	.57	.00	.00	.00	.55
Females, less than \$3,000:						
Before allocation.....	1.72	.25	.36	.09	.00	.45
After allocation.....	2.35	.11	.73	.00	.00	.47
Males, \$3,000 to \$4,999:						
Before allocation.....	.68	.42	.08	.57	.48	1.68
After allocation.....	.90	.51	.02	.58	.51	1.72
Females, \$3,000 to \$4,999:						
Before allocation.....	.62	.83	.40	.26	1.25	2.40
After allocation.....	1.06	.41	.44	.41	(¹)	2.36
Males, \$5,000 to \$6,999:						
Before allocation.....	.00	.00	.00	.00	.00	(¹)
After allocation.....	.00	.00	(¹)	.00	(¹)	(¹)
Females, \$5,000 to \$6,999:						
Before allocation.....	.00	(²)	.00	(¹)	.00	(²)
After allocation.....	.00	(¹)	(¹)	(¹)	.00	(²)
Males, \$7,000 to \$9,999:						
Before allocation.....	(¹)	.00	.00	(¹)	.00	.00
After allocation.....	(²)	.00	(¹)	(¹)	.00	.00
Females, \$7,000 to \$9,999:						
Before allocation.....	(²)	.00	.00	(²)	.00	.00
After allocation.....	(²)	.00	.00	(²)	.00	.00
Males, \$10,000 or more:						
Before allocation.....	.00	.00	.00	.00	.00	(¹)
After allocation.....	(²)	.00	.00	.00	.00	(¹)
Females, \$10,000 or more:						
Before allocation.....	(²)	(²)	(²)	(¹)	(²)	.00
After allocation.....	(²)	(²)	(²)	.00	(²)	(²)
Not reported.....	7.02	10.30	10.30	10.92	12.40	7.54

¹On the basis of the sampling variance for a characteristic based on .1 percent of the total population, the ratio of the response variance to the sampling variance is less than 1.0.

²On the basis of the sampling variance for a characteristic based on .1 percent of the total population, the ratio of the response variance to the sampling variance is greater than 1.0.

most items, the sampling variances of the estimates of response relvariance were usually so large that it was impossible to detect differences in the estimates with and without the crew leader effect.

- c. The allocation process tended to increase the estimates of response variance for the data without the crew leader effect and decrease the estimates with the crew leader effect.
- d. Large differences in the estimates of response variance of a given other income item occurred for different types of areas--highly urban, other urban, and rural. However, it is difficult to in-

terpret these differences in the absence of the sampling variance of these estimates.

- e. Because of a limited number of items to compare, the comparison of 1950 and 1960 response variances for other income items is not very meaningful. On the basis of the available evidence, the 1960 response variances are probably smaller than the 1950 response variances.

L. VETERAN STATUS

Question P35 on the 1960 census schedule was for the purpose of determining the veteran status of males 14 years old and over in the United States. Figure 28 shows the question.

Table 38.--RATIOS OF ESTIMATED RESPONSE VARIANCES TO 25-PERCENT SAMPLING VARIANCES FOR OTHER INCOME ITEMS: 1950 AND 1960 CENSUSES

1950 Census		1960 Census	
Other income items	Ratio of response to sampling variance	Other income items (after allocation)	Ratio of response to sampling variance
No income.....	3.2	\$2,500 and over.....	0.4
Under \$2,500.....	4.5	Males, less than \$3,000.....	0.004
\$2,500 and over.....	0.0	Females, less than \$3,000.....	0.6
Not reported.....	10.4	Males, \$3,000 to \$4,999.....	0.2
		Females, \$3,000 to \$4,999.....	0.6
		Males, \$5,000 to \$6,999.....	0.03
		Females, \$5,000 to \$6,999.....	0.0
		Males, \$7,000 to \$9,999.....	0.0
		Females, \$7,000 to \$9,999.....	1.2
		Males, \$10,000 and over.....	0.0
		Females, \$10,000 and over.....	2.5
		Not reported.....	5.6

Table 39.--ESTIMATED RESPONSE RELVARIANCES FOR A VETERAN STATUS ITEM FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Veteran status	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
World War II veterans:								
Before allocation.....	308	7.9	.00282	.00726	.053	.085	.39	.00045
After allocation.....	324	8.3	.00304	.00689	.055	.083	.44	.00042
B. With Crew Leader Effect								
World War II veterans:								
Before allocation.....	312	8.0	.00164	.00717	.040	.085	.23	.00028
After allocation.....	324	8.3	.00172	.00689	.041	.083	.25	.00028

P35. If a man—Has he ever served in the Army, Navy, or other Armed Forces of the U.S.?

Yes No Yes No

Mark "Yes" or "No" for each period →

- Korean War (June 1950 to Jan. 1955) _ _ _
- World War II (Sept. 1940 to July 1947) _
- World War I (April 1917 to Nov. 1918) _ _
- Any other time, incl. present service

Figure 28.--Question P35 on veteran status, 1960 Decennial Census schedule.

P35 was the last question on the schedule, following a series of labor force and income questions. The placement on the schedule may have been responsible for a high rate of nonresponse. (9.7 percent of the entries for this question for civilian males 14 years old and over were allocated by the computer.) This was the first time that detailed data on veteran status was published in the

census. The high rate of underreporting was one of the reasons for not publishing the data in earlier censuses.

Four categories were used to classify the veteran population. In this study we investigated only one of the four categories--World War II veterans.

There was no manual editing or coding required for this characteristic. The computer performed an edit on the data and allocated entries for blanks. See reference [21], pages 221-223, for an explanation of the concepts, pretesting, and allocation process for the item.

1. Estimates of response variance for veteran status

Table 39 shows the estimates of response relvariance for the category studied. The sampling relvariances were computed from equation 7.3 with k = 1.0.

Table 37.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR OTHER INCOME ITEMS FOR HIGHLY URBAN, OTHER URBAN AND RURAL AREAS

Other income items	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
\$2,500 or more:						
Before allocation.....	.09	.50	1.00	.50	.47	3.06
After allocation.....	.12	.33	1.19	.87	.25	2.94
Males, less than \$3,000:						
Before allocation.....	.00	.75	.00	.00	.00	.57
After allocation.....	.26	.57	.00	.00	.00	.55
Females, less than \$3,000:						
Before allocation.....	1.72	.25	.36	.09	.00	.45
After allocation.....	2.35	.11	.73	.00	.00	.47
Males, \$3,000 to \$4,999:						
Before allocation.....	.68	.42	.08	.57	.48	1.68
After allocation.....	.90	.51	.02	.58	.51	1.72
Females, \$3,000 to \$4,999:						
Before allocation.....	.62	.83	.40	.26	1.25	2.40
After allocation.....	1.06	.41	.44	.41	(¹)	2.36
Males, \$5,000 to \$6,999:						
Before allocation.....	.00	.00	.00	.00	.00	(¹)
After allocation.....	.00	.00	(¹)	.00	(¹)	(¹)
Females, \$5,000 to \$6,999:						
Before allocation.....	.00	(²)	.00	(¹)	.00	(²)
After allocation.....	.00	(¹)	(¹)	(¹)	.00	(²)
Males, \$7,000 to \$9,999:						
Before allocation.....	(¹)	.00	.00	(¹)	.00	.00
After allocation.....	(²)	.00	(¹)	(¹)	.00	.00
Females, \$7,000 to \$9,999:						
Before allocation.....	(²)	.00	.00	(²)	.00	.00
After allocation.....	(²)	.00	.00	(²)	.00	.00
Males, \$10,000 or more:						
Before allocation.....	.00	.00	.00	.00	.00	(¹)
After allocation.....	(²)	.00	.00	.00	.00	(¹)
Females, \$10,000 or more:						
Before allocation.....	(²)	(²)	(²)	(¹)	(²)	.00
After allocation.....	(²)	(²)	(²)	.00	(²)	(²)
Not reported.....	7.02	10.30	10.30	10.92	12.40	7.54

¹On the basis of the sampling variance for a characteristic based on .1 percent of the total population, the ratio of the response variance to the sampling variance is less than 1.0.

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most items, the sampling variances of the estimates of response relvariance were usually so large that it was impossible to detect differences in the estimates with and without the crew leader effect.

- c. The allocation process tended to increase the estimates of response variance for the data without the crew leader effect and decrease the estimates with the crew leader effect.
- d. Large differences in the estimates of response variance of a given other income item occurred for different types of areas--highly urban, other urban, and rural. However, it is difficult to in-

terpret these differences in the absence of the sampling variance of these estimates.

- e. Because of a limited number of items to compare, the comparison of 1950 and 1960 response variances for other income items is not very meaningful. On the basis of the available evidence, the 1960 response variances are probably smaller than the 1950 response variances.

L. VETERAN STATUS

Question P35 on the 1960 census schedule was for the purpose of determining the veteran status of males 14 years old and over in the United States. Figure 28 shows the question.

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1950 Census		1960 Census	
Other income items	Ratio of response to sampling variance	Other income items (after allocation)	Ratio of response to sampling variance
No income.....	3.2	\$2,500 and over.....	0.4
Under \$2,500.....	4.5	Males, less than \$3,000.....	0.004
\$2,500 and over.....	0.0	Females, less than \$3,000.....	0.6
Not reported.....	10.4	Males, \$3,000 to \$4,999.....	0.2
		Females, \$3,000 to \$4,999.....	0.6
		Males, \$5,000 to \$6,999.....	0.03
		Females, \$5,000 to \$6,999.....	0.0
		Males, \$7,000 to \$9,999.....	0.0
		Females, \$7,000 to \$9,999.....	1.2
		Males, \$10,000 and over.....	0.0
		Females, \$10,000 and over.....	2.5
		Not reported.....	5.6

Table 39.--ESTIMATED RESPONSE RELVARIANCES FOR A VETERAN STATUS ITEM FOR AN ENUMERATION BY ONE INTERVIEWER IN A PLACE OF 3,900 PERSONS

Veteran status	Average census results		Relvariance		Coefficient of variation		Ratio of response to sampling variance	Standard error of response rel-variance
	Number of persons	Percent of total	Response	Sampling	Response	Sampling		
A. Without Crew Leader Effect								
World War II veterans:								
Before allocation.....	308	7.9	.00282	.00726	.053	.085	.39	.00045
After allocation.....	324	8.3	.00304	.00689	.055	.083	.44	.00042
B. With Crew Leader Effect								
World War II veterans:								
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After allocation.....	324	8.3	.00172	.00689	.041	.083	.25	.00028

P35. If a man—Has he ever served in the Army, Navy, or other Armed Forces of the U.S.

Yes No Yes No

Mark "Yes" or "No" for each period →

- Korean War (June 1950 to Jan. 1955) _ _
- World War II (Sept. 1940 to July 1947) _ _
- World War I (April 1917 to Nov. 1918) _ _
- Any other time, incl. present service

Figure 28.--Question P35 on veteran status, 1960 Decennial Census schedule.

P35 was the last question on the schedule, following a series of labor force and income questions. The placement on the schedule may have been responsible for a high rate of nonresponse. (9.7 percent of the entries for this question for civilian males 14 years old and over were allocated by the computer.) This was the first time that detailed data on veteran status was published in the

census. The high rate of underreporting was one of the reasons for not publishing the data in earlier censuses.

Four categories were used to classify the veteran population. In this study we investigated only one of the four categories--World War II veterans.

There was no manual editing or coding required for this characteristic. The computer performed an edit on the data and allocated entries for blanks. See reference [21], pages 221-223, for an explanation of the concepts, pretesting, and allocation process for the item.

1. Estimates of response variance for veteran status

Table 39 shows the estimates of response relvariance for the category studied. The sampling relvariances were computed from equation 7.3 with $k = 1.0$.

Since only one category was studied, a multiplier of the sampling variance for other veteran status categories is unknown. A value of .3 seems appropriate for the "World War II veterans" category.

Ninety-eight percent confidence intervals for the response relvariances with and without the crew leader effect were constructed as well as confidence intervals for the added effect due to crew leaders. These intervals are shown in figure 29.

Figure 29 shows that the response variances for this item are positive, though small. However, the crew leader has contributed little or nothing to the response variance.

Allocation raised the estimates of response variance, both with and without the crew leader effect, but only slightly.

2. Estimates of response variance by type of area

Table 40 shows the ratios of response variances to sampling variances for World War II veterans for highly urban, other urban, and rural areas. Again, it is difficult to interpret these numbers, in the absence of the sampling variances of the estimates of response variance.

3. Comparison of 1950-1960 response variances

For the category "World War II veterans" the ratio of the response variance to the variance of a 25-percent sampling variance was 0.5 in 1950 and 0.3 in 1960. This is some indication that the response variance was smaller for this characteristic in 1960.

4. Summary of data on veteran status items

Since only one item was studied, there is no need for a summary. The available data are discussed in parts 1-3 of this section.

Figure 29. 98-Percent Confidence Intervals for Response Relvariances Veteran Status Items

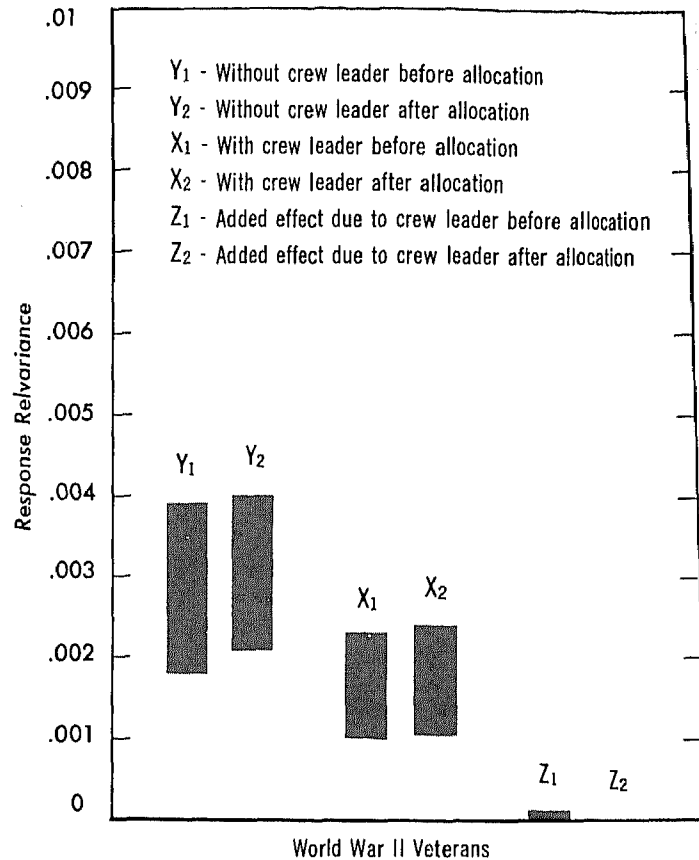


Table 40.--RATIOS OF RESPONSE VARIANCES TO SAMPLING VARIANCES FOR VETERAN STATUS FOR HIGHLY URBAN, OTHER URBAN AND RURAL AREAS

Veteran status	Ratio of response to sampling variance					
	Highly urban		Other urban		Rural	
	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect	Without crew leader effect	With crew leader effect
World War II veterans:						
Before allocation.....	.32	.68	.56	.00	.06	.32
After allocation.....	.35	.67	.61	.00	.09	.31

Chapter 8--CHARACTERISTICS OF RVS CREW LEADERS AND INTERVIEWERS

The results of the interviewer and crew leader effect on census statistics may prompt the following question, "How typical of all census crew leaders and interviewers were those who participated in the RVS?" Supposedly we had selected a sample of all available crew leaders and interviewers in the sample areas. Were there differences with regard to age, education, sex, and so forth between those selected to participate in the study from those not selected? Some data are available for a few comparisons to be made.

All applicants for crew leader and interviewer positions were given a test in an attempt to eliminate those persons who would have difficulty in reading, understanding, and following directions. There were two parts to the test: one on vocabulary and reading comprehension and one on map reading. About 50 percent of the applicants passed the test on a nationwide basis. The scores for most of the RVS crew leaders and interviewers are available. Some comparisons of the RVS crew leaders and interviewer's test scores with the test scores of all Stage I interviewers and Stage II crew leaders are possible. We also have available data on age, sex, education, and former work experience for most of the RVS crew leaders and interviewers and can make some comparisons using these data.

Further research projects using the data on the RVS personnel are possible. For example, we might get some insight into the relationship between factors such as age, education, and so forth, and the tendency to get large response variances.

About one-third of all crew leaders who worked in Stage I were retained for a Stage II assignment. Fifty-four percent of the crew leaders who were offered a Stage II assignment accepted it. Supposedly, these crew leaders were the ones who had performed best in Stage I.

It is of interest to compare the characteristics of the RVS crew leaders with the characteristics of the census crew leaders. Limited data are available to make these comparisons.

Table 41 shows a comparison of the RVS crew leaders with all Stage II crew leaders for characteristics such as age, sex, and education.

The similarity between the RVS crew leaders and all Stage II crew leaders is striking. Though there were some differences such as more college graduates in the RVS group than the Stage II group, we might expect such results from a sample of 100 crew leaders. The RVS crew leaders performed almost the same as all Stage II crew leaders on Part II of the test.

There is additional information available about RVS crew leaders which may be of interest. For example, over 50 percent of them had previous employment as teachers, as clerical workers, or as secretaries. Eight percent had never worked previous to the 1960 census.

We can make similar comparisons for the interviewers, except that for these comparisons data are available only for Stage I interviewers. Since the Stage II interviewers were, supposedly, the best of the Stage I interviewers, we might expect somewhat different results for the Stage II interviewers. Table 42 compares the RVS interviewers with all Stage I interviewers.

About the same percentage of RVS interviewers were women as all Stage I interviewers. However, there were fewer RVS interviewers in the under 30 age group and somewhat more in the age group between 30 and 49. It may be that all Stage II interviewers, not just RVS interviewers, were older than the Stage I interviewers. Among the RVS interviewers were fewer people who had some college training, though the test scores were about the same as all Stage I interviewers.

There are additional data available about the RVS interviewers. For example, the average age was 40 years old. Only 15 percent had fewer than 4 years of high school. Also, about 19 percent had no previous work experience.

Table 41.--COMPARISON OF RVS CREW LEADERS WITH ALL STAGE II CREW LEADERS

Characteristic	Stage II crew leaders ¹ (percent)	RVS crew leaders (percent)
Sex:		
Male.....	36	26
Female.....	64	74
Age:		
20 to 29.....	8	5
30 to 39.....	30	36
40 to 49.....	32	38
50 to 59.....	17	12
60 to 69.....	11	7
70 and over.....	2	2
Education:		
Not high school graduate..	7	8
High school graduate.....	37	36
Some college.....	31	20
College graduate.....	25	36
Enumerator test score: ²		
Part I less than 25.....	33	18
Part I 25 or more.....	67	82
Part II less than 13.....	12	12
Part II 13 or more.....	88	88

¹Data on Stage II interviewers are taken from Bureau of the Census, 1960 Crew Leader Opinion Survey, by Dean Weber, March 1964.

²The highest score possible on part I was 30 and on part II was 16.

Table 42.--COMPARISON OF RVS INTERVIEWERS WITH ALL STAGE I INTERVIEWERS

Characteristic	Stage I interviewers ¹ (percent)	RVS interviewers (percent)
Sex:		
Male.....	18	17
Female.....	82	83
Age:		
Under 30.....	26	15
30 to 39.....	31	35
40 to 49.....	28	33
50 to 59.....	8	12
60 and over.....	7	5
Education:		
Grammar school only.....	3	3
Some high school, no college.....	52	63
Some college.....	45	34
Enumerator test score: ²		
20-10 or above.....	76	77
Less than 20-10.....	24	23

¹Data are taken from Bureau of the Census, U.S. Censuses of Population and Housing, 1960: Enumeration Time and Cost Study. Washington, D.C., 1963.

²The highest possible score was 30-16.

Chapter 9--LIMITATIONS OF THE DATA

A. APPLICABILITY OF DATA

Though we have used the data collected in this study to compute multipliers of the sampling variances for U.S. census statistics, the results are not really applicable to the total United States. The data were collected from the approximately 82 percent of the population of the United States in which a two-stage census was conducted. Technically speaking, the response variances estimated in this study are applicable to statistics from two-stage census areas only. However, many of the statistics in the U.S. census volumes are based on data collected from the two-stage areas. For example, statistics for city blocks and standard metropolitan statistical areas (SMSA's) are based only on data from two-stage areas. The estimates of response variance are directly applicable to these statistics.

There is another question of the applicability of these estimates which is equally important. As pointed out in chapter 4, these estimates apply to the particular set of conditions that underlay the census, in particular, the circumstance that the unit of observation was the household, not the person. The response variances for items relating to persons therefore include components arising from variability in the reporting of the number of persons in a household.¹

A third problem in the application of the estimates of response variance is that we do not yet understand all of the implications of the census-taking process. For example, for most of the items, the allocation process tended to decrease the estimates of response variance. However, for a few items, the estimates of response variance were greatly increased by the allocation process. We do not know why. A study is planned to look into this phenomenon.

B. PROBLEMS IN CONDUCTING THE STUDY

Another problem in using the data is one which arises in almost every experiment or study--the actual field experiment deviated from the experimental design setup.

The experimental program specialist in each sample area was instructed how to select the exact study area on a probability basis. Evidence became available that showed that at least one study area was picked for certain agreeable characteristics. Forms were required to be filled out when interviewers or crew leaders were replaced. Most of the time this was done conscientiously. However, for a few sample areas, no records were available. There was supposed to be no cooperation

between interviewers, and yet, in a few sample areas, the interviewers were trained in such a way that if they had any difficulty they turned to the other interviewer of the pair for help. In one area, there was no interpenetration experiment to measure the crew leader effect. In some areas, interviewers worked for both crew leaders. Yet, with all these occurrences, only a few sample areas (less than 10) were affected.

The replacement of field personnel also constitutes a violation of the experimental design. However, of 100 RVS crew leaders, only four were replaced during enumeration, and in no area were both of the two crew leaders replaced. The four were replaced by their field reviewers.

The replacement of interviewers was more serious. In only eight of the 50 sample areas were there no interviewer replacements. Four or more replacements occurred in 30 sample areas. In New York and Los Angeles all the interviewers originally assigned were replaced and several of the replacements were themselves replaced. Of course, this reflected the pattern that affected the census as a whole.

The model specifies that the estimates from the data with the crew leader effect are independent of the estimates from the data without the crew leader effect. This is not true to the extent that the same interviewers could and did work in both kinds of clusters. At least 100 of the interviewers worked in both kinds of clusters.

Another limitation of the data was that incomplete groups-of-four housing units were omitted from the analysis. As explained in chapter 2, of every four housing units, two were assigned to interviewer 1 of the pair of interviewers assigned to a cluster of EA's, and the remaining two were assigned to interviewer 2. If one unit of the four was cancelled during the bias review, or because of some enumeration problem, all four units were omitted from the analysis of the RVS. As shown in chapter 3, sometimes a substantial part of an ED was lost to the analysis because of editing, matching, or processing. However, the loss in 1960 was only 13 percent of the total number of units randomized.

A further deviation occurred in the processing of the data. At that time, four clusters in which the crew leaders were interpenetrated were added to the group in which the crew leaders were not interpenetrated. Also, eight clusters in which there was no crew leader effect were added to the clusters with the crew leader effect before it was found that the crew leaders had not been assigned correctly. If the processing had been done correctly, there would have been 386, rather than 384, clusters without the crew leader effect and 388, rather than 390, clusters with the crew leader effect. Presumably, some

¹See the appendix for an illustration of the effect of variability in the number of persons reported in a household on the response variances for complementary variables.

of these errors may be partially responsible for the estimate of the added effect of the crew leaders sometimes being negative. Of four items studied, when these clusters were classified correctly, the added effect of the crew leader was changed from negative to positive for one item.

In these ways, the experiment fell short of the specifications. To the extent that the specifications were not met, the data from the study are limited.

C. SAMPLING VARIABILITY OF ESTIMATES OF RESPONSE VARIANCE

Because the data in this study are based on a sample, they are subject to sampling variability. Also, as mentioned in chapter 4, we have used a restricted estimator of the response variance. Since we arrived at our estimate by subtracting an estimate of sampling variance from an estimate of total variance, it was possible to get a negative estimate of response variance. Equation 4.41 shows that the estimate of response variance per cluster was a weighted average of the individual cluster variances. Whenever this averaged estimate was negative, it was replaced by zero in the tables shown in chapter 7. It can be shown that this reduces the mean-square error of the estimate.

Estimates of the variances of the response relvariances were computed. These variances were estimated by the random group method. Each cluster estimate was assigned at random to one of 20 groups. (Twenty groups were set up for the estimates with the crew leader effect and a second 20 for the estimates without the crew leader effect.) We then had 20 estimates of the response relvariance, one for each random group. We then computed the variance by using the following formula:

$$\frac{\text{Var } (C-D)}{\bar{P}^2} = \frac{L^2}{N^4} \sum_j \frac{N_j^4}{L_j^2} \frac{(C_j - D_j)}{\bar{P}_j^2} \quad (9.1)$$

where

$C_j - D_j$ is the estimate of response variance from the j -th random group

\bar{P}_j is the average proportion of persons having the given characteristic in the j -th random group

L_j is the number of clusters in the j -th random group

N_j is the number of housing units in the j -th random group

$$L = \sum L_j$$

$$N = \sum N_j$$

This variance was computed for all items in the study. These estimates of variance were the basis of 98-percent confidence intervals for the response relvariances. The estimates of the standard error are shown in the tables in chapter 7.

Considering the large number of clusters, the estimate of response relvariance averaged over all clusters can be regarded as an observation from an approximately normal distribution. However, we have truncated the distribution by replacing negative estimates by zero.²

Suppose that u'_{99} is an upper 99-percent confidence limit. Then $\text{Prob } (u'_{99} > U) = .99$ where U is the "true" value of the response relvariance. Then we let v'_{99}

$$= \begin{cases} u'_{99} & \text{if positive} \\ 0 & \text{otherwise} \end{cases}$$

Then, since U is non-negative by definition,

$$\text{Prob } (v'_{99} > U) = .99$$

The same procedure was used to construct the lower 99-percent confidence limits. These two limits were used together, and the confidence intervals shown in chapter 7 are 98-percent confidence intervals. The confidence intervals were constructed in the usual way except that whenever the upper limit or the lower limit of the interval was negative, it was replaced by zero.

We also wanted to construct the confidence intervals for the added effect due to crew leaders. We made the assumption that each of the estimates could be viewed as an observation from a normal distribution and that the two observations were independent. Let \underline{x} be the estimate from the data with the crew leader effect and \underline{y} be the estimate from the data without the crew leader effect. We then used the same procedure as shown above for establishing confidence intervals for $\underline{x} - \underline{y}$, the "true" difference in response relvariances. Whenever the limits of the intervals were negative, they were replaced by zero. This is a consequence of the assumption that the crew leader either adds nothing or a positive amount to the total variability of a statistic.

²The restricted estimator, mean-square error of the restricted estimator, and confidence intervals based on the restricted estimator are discussed by Benjamin J. Tepping in a series of unpublished Census Bureau memorandums. See [24].

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