

CHAPTER 14. The 1970 Census Evaluation and Research Program

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Chapter 14. THE 1970 CENSUS EVALUATION AND RESEARCH PROGRAM

HISTORICAL DEVELOPMENTS

Starting with the 1950 Census of Population and Housing, the Census Bureau has followed a policy in each census of carrying out a careful evaluation of the accuracy of census results. Areas of consideration in these programs include coverage error, which results from the omission or duplication of persons and housing units; and content or reporting error, which results from incorrect responses to census questions and from errors in recording and processing the responses. In addition, the programs have also contained experimental and research projects designed to measure specific kinds of error and to test alternative census-taking methods.

The results of the evaluation and research programs have had a profound influence on current census techniques. For example, the 1950 experiments in self-enumeration, the 1960 experiment measuring the effects of interviewers on survey results, and the 1960 study of the use of Post Office resources to improve coverage provided information which was instrumental in the development of a mail census. Many of the specific procedures used in the 1970 census were direct outgrowths of the lessons learned from these programs. Moreover, the facts that emerged regarding the quality of statistics have become important background information for the users of census data and the census staff, both in developing future census plans and in analyzing the results. Consequently, the Bureau regards research and development as a continuing and permanent part of census taking.

This report covers the range of projects making up the 1970 research and evaluation effort as well as a review of the objectives and concepts involved. The results of the 1970 Evaluation and Research Program and more detailed information about the scope of individual projects will be published in Census Bureau reports entitled Evaluation and Research Program, Series PHC(E).

OBJECTIVES AND CONCEPTS

Objectives

The evaluation and research program was considered to have three major objectives:

1. To provide information on the kinds of errors arising in the census. This requires knowledge of the components, correlates, and causes of error with the end in view of methodological improvements and improved design of the total census process.
2. To provide the users of census data with estimates of total mean square error for key census statistics and related information on the components of the error. This is primarily for their general knowledge in understanding the strengths and limitations of the data.

The purposes are to reflect all measurable sources of error, not merely sampling error.

3. To conduct experiments and analyses to evaluate specific procedures, e.g., to test the feasibility of an extension of the mail census beyond the limits adopted for 1970.

The major factors which influenced the composition of the 1970 Evaluation and Research Program were:

1. The need for the data
 - to measure the effectiveness of the new procedures used in the 1970 census;
 - to make an attempt at solving problems of evaluation methodology which were inadequately dealt with in 1960;
 - to pursue more intensively the causes and correlates of errors in census statistics;
 - to obtain further readings on the size of the error in the most important statistics and of the components of the error.
2. The costs of the various projects, relative to the expected knowledge that would be obtained.
3. The likelihood for successful completion of the projects.
4. The extent to which the projects would interfere with normal census operations.
5. The possibility of carrying out the projects as independent studies rather than as part of the census.

Concepts

The total mean square error for a census statistic has two major components--sampling error and nonsampling error. Sampling errors occur because observations are made only on a sample, not the entire population. Because probability samples are used, sampling errors are estimated from the data collected in the sample through the application of formulas based on probability theory. As a part of the publication plans, sampling errors are computed and published with the basic tabulations.

The term "nonsampling error" is used to describe errors introduced during the collection, coding, and processing of the data. Some errors may be compensating while others may be consistent in direction. Errors that would tend to average out (i.e., are compensating) over a large number of repetitions produce nonsampling variance, while errors that are consistent in direction produce nonsampling bias.

Errors by the respondent in providing the data, and errors by the enumerator in recording the data, are referred to as response error. Usually, these errors are analyzed separately from other sources of non-sampling error, such as those arising in processing. The terms response variance and response bias are used in the same way as nonsampling variance and bias. For purposes of study and analysis, response variance is further decomposed into simple response variance and correlated response variance. Simple response variance is the component of response variance which is independent from one person or housing unit to the next. On the other hand, the correlated response variance is the component resulting from consistent or correlated errors introduced by the enumerator and/or crew leader in the data for the persons or housing units in an assignment. Such errors may tend to balance out over the combined work of a large number of enumerators and crew leaders, but may have a substantial effect on statistics for small areas. (A fuller discussion of these concepts is presented in a number of the references in the bibliography at the end of this chapter.)

Nonsampling error is not directly measurable during the basic census data-collection process. Measurement of nonsampling error and its effect on census statistics requires careful checks to identify and isolate errors in the data-collection and processing procedures, or special experiments superimposed on the normal census procedures. Measurement of nonsampling error is the primary focus of the Evaluation and Research Program.

THE PROGRAM

The 1970 Evaluation and Research Program consisted of the following types of projects:

- I. Projects designed to measure the completeness of coverage of the population and housing units.
- II. Projects designed to measure content errors in the census.
- III. A randomization study to measure the interviewer's contribution to certain types of errors.
- IV. An experiment to test the effectiveness of alternative procedures that have been proposed for future censuses.

The overall evaluation program consisted of 25 separate projects. Each project was assigned a project number in order to identify the sample or census data upon which the evaluation was based, and in order to maintain control over the individual projects. Numbers were assigned to the individual projects in a fairly arbitrary manner so that the numbers, by themselves, have no significance, but are useful to identify unpublished documentation.

In the discussions that follow, the title and number are given for each project.

Coverage Evaluation

Demographic Analysis--Project E17--Analysis of the methods used to evaluate the 1950 and 1960 censuses revealed that the technique of demographic analysis

provided more accurate estimates of census population coverage than estimates obtained from reenumerative or record check studies. Therefore, a decision was reached to use this technique in the evaluation of overall population coverage in 1970. This method mainly involves a consistency check between the 1970 population count and data from previous censuses, adjusted in accordance with statistics on birth and death registration, data on immigration and emigration, and data from Medicare registration.

When the census count checked by demographic techniques is the total population count, then the comparison provides a highly reliable estimate of net coverage error. If, on the other hand, the census count checked is for a specific age-sex-color group in the population, then the comparison provides an estimate of net error that combines both coverage problems and misreporting of the correct age, sex, or color. Despite such limitations, the techniques of demographic analysis have demonstrated their value and there is a consensus that past estimates of net error made by such analytic techniques are closer to the truth than comparable estimates derived from other evaluation procedures. (Other types of coverage checks were in the program, but these were essentially either to support the demographic estimates or to provide additional information on certain components of undercoverage or on particular operational problems in the census, rather than to estimate total coverage.)

It is expected that the 1970 demographic estimates will be strengthened by the following two projects:

Medicare Record Check--Project E2--Demographic estimates of undercoverage of the elderly are somewhat weaker than for other ages: This results partially because the iterative system used for the Negro and other-races population builds up the estimate from those for younger age groups, and cumulative biases may result; and partially from the interplay of age-reporting and coverage errors, which may be particularly large for the elderly.

Accurate figures on the coverage of this age group are of particular interest since they figure prominently in mortality estimates and affect the net census error. A study therefore was made to measure a component of this error, namely, undercoverage of the population age 65 and over, and the effect of misreporting ages within this group.

A sample of approximately 8,000 persons age 65 and over was selected by the Social Security Administration from all persons registered for the Medicare health program. The names and addresses of the sample persons were searched for in the 1970 census records in order to obtain estimates of missed persons for the 65-and-over age category. The sample consisted of four independent samples for white males, white females, and males and females of Negro and other races. Separate estimates of coverage error were made by race, sex, and for various geographic regions of the country.

The list of Medicare registrants was chosen over other records, such as Social Security beneficiaries, because it presumably includes virtually all persons age 65 and over.

For persons found to be enumerated in the census, age comparisons were made between the two sources in order to obtain measures of age reporting errors in the census. It was assumed that the Medicare records provided a good standard for accuracy since proof of age is generally required for registration.

The sample was a probability sample selected in two stages: (1) selection of a subset of the counties included in the Census Bureau's Current Population Survey sample design, and (2) a systematic selection of the registrants in those areas.

The matching was performed clerically, with mail or personal followup visits made to persons with unmatched records to determine if there were other residences at which they could have been reported in the census.

Birth Registration Study--Project E14.--As stated earlier (see above, Demographic Analysis--Project E17), evaluation of overall population coverage in the 1970 census was derived primarily from demographic estimates. For the younger age groups demographic estimates are based primarily on registered births, with the estimates corrected for underregistration. These are then projected through use of death registrations to estimate total population in each age group. Since an important part of the technique involves adjustment for underregistration of births, periodic review of the degree of underregistration is desirable. Previous checks to estimate underregistration of births had been carried out in 1940 and 1950. In order to obtain current estimates for underregistration of births, the names of a sample of about 15,000 children born in the years 1964-1968 were searched for among the records of State and independent city vital statistics offices.

The sample was selected from households enumerated in the Current Population Survey, which involves interviews with about 45,000 households each month, and from the Health Interview Survey, a weekly health survey conducted by the Census Bureau for the Department of Health, Education, and Welfare (HEW). The sample consisted of approximately equal numbers of white children and children of Negro and other races. The study was carried out with the cooperation and participation of the National Center for Health Statistics of HEW. Cards containing the names and other characteristics of children in the sample were delivered by Census Bureau employees to the vital statistics offices where the search was performed. Followup visits were made to the households having children for whom no birth records were found to verify the original census information and to determine whether the births could have been registered in other locations or under other names. A second search of the registration files was carried out using any additional information obtained.

Separate estimates of the completeness of birth registration were made by sex and race, and for births occurring in and out of hospitals. Basically, the data are used to improve the estimates of census population coverage obtained by demographic analysis.

Housing Unit Coverage and Sample Control Evaluation in Mail Areas--Project E6.--Of major importance for the 1970 census was the development of an accurate and complete housing-unit mailing list for addressing the

census questionnaires. Since approximately 60 percent of the population was enumerated by mail, an evaluation of the coverage of the mailing list was deemed to be an important part of the program. The evaluation was based upon the following two samples:

1. A probability sample of about 20,000 addresses was selected from the mailing list in order to estimate the number of missed and overenumerated units¹ within addresses included in the census. Visits were made to the sample addresses by the Bureau's permanent staff of highly trained current survey enumerators who conducted interviews along with personal inspection to determine the number of living quarters existing at each address at the time of the census.

The evaluation listings were compared to the census records and reconciliation visits were made to addresses for which the two records differed.

Estimates of "within-structure" housing-unit coverage errors were made by geographic area and size of structure. The sample data also provided estimates of the number of occupied units that were misclassified as vacant in the census, and vice-versa, and estimates of housing undercoverage as a result of erroneous deletions from the mailing list, as well as information on biases occurring in the census sample because of interchanges between the long (sample) and short (100-percent) census questionnaires. (Misclassification, erroneous deletions, and sample bias are discussed in more detail below and on p. 13.

2. A probability sample of about 8,000 city blocks (or, in noncity areas, sample areas about equivalent in size to city blocks) was relisted in order to estimate the number of units within missed addresses. The sample areas were relisted by current survey enumerators, and approximately 500,000 listings were compared with the census records. Residential addresses not found in the census were revisited by the enumerators who (1) established the validity of the addresses searched for, (2) verified that the addresses were residential, and (3) verified the existence of the addresses at the time of the census. The evaluation enumerators also determined the number of units at each address and whether they were occupied or vacant at the time of the census.

The estimated number of missed units within missed addresses was combined with the data obtained from the address sample, described above, to provide estimates of gross and net housing unit coverage errors.

Evaluation of Census Housing Unit Occupancy Status and of Census Deletes--Project E11.--The purposes of this project were to estimate:

1. The net error in occupied housing unit coverage in mail census areas which results from the mis-

¹Missed and overenumerated units are classified as due to either: (1) space error in which the unit and its occupants are missed or counted more than once, and (2) definitional error in which the census population count is correct but the housing count is incorrect. Project E6 measured the space error, whereas project E7, described on p. 4 below, measured definitional error.

classification of occupied units as vacant, or vice versa, and

2. The component of gross housing undercoverage in mail census areas which results from the erroneous deletion of addresses from the mailing lists by census clerks or enumerators. (A legitimate deletion from the mailing list would occur when the address no longer represented living quarters; e.g., when the building had been demolished.)

Theoretically, the census data are considered as representing the population level and housing inventory for a fixed point in time, April 1, 1970; however, it is recognized that it is not feasible to enumerate the entire Nation in a single day. On the basis of theoretical expectations it can be shown that certain kinds of biases can be associated with the length of time required to complete the census.

From the standpoint of both population and housing coverage, error can result from the enumerators having to judge whether to enumerate a vacant house or to classify it as abandoned or unfit for habitation and delete the listing from the census records. Also, for purposes of population coverage, two additional types of errors can occur:

1. Some households are seldom home or are in the process of moving around the time of the census and are missed because their living quarters are enumerated as vacant when the enumerators call for the census data.
2. Other households maintain two places of residence or move from one address to another during the census period and are enumerated at both addresses or at neither, resulting in a population miscount as well as the misclassification of the occupancy status of one or both residences.

While it was expected that such errors were not large, there was interest in determining what effect the self-enumeration mail census had on the level of error.

The results of this project were based on the data obtained from the project E6 address sample, described above.

CPS-Census Match--Project E3.--The Current Population Survey (CPS) is an ongoing survey which the Bureau conducts monthly to collect labor force data on a sample of about 50,000 households. Those households which were enumerated in the March 1970 CPS (during the week of March 19) were searched for in the census records in order to obtain an estimate of the gross number of missed units. The objectives were similar to those described above for project E6 except that estimates were made on a national level, whereas E6 was limited in scope to mail census areas.

For CPS units found to be included in the census, two additional types of estimates were made:

1. A comparison was made of the household members listed in the CPS with those enumerated in the census in order to estimate the census population undercoverage. It was not expected that such comparisons would provide an accurate estimate of underenu-

meration, since persons who were not reported in the CPS were probably correlated with those not reported in the census, but some useful (though probably biased) data were expected on the characteristics of persons who were missed.

2. For content evaluation, data from the two sources were examined for consistency of reporting. This is discussed in more detail below under Content Evaluation.

Data were also tabulated on the number and characteristics of CPS household members whose housing units were not found to be listed in the census.

Definitional Errors in the Housing Unit Count--Project E7.--The total count of housing units in the census is subject to two types of errors--space errors, in which both the housing unit and its occupants were missed or counted more than once, and definitional errors, in which the occupants of two or more housing units were counted as one household or the occupants of one unit were counted as two households. The objective of this project was to measure the gross and net definitional error.

In the census of 1960 both the definitional missed and definitional overenumerated rates were estimated to be 0.2 percent, for a gross error of about 0.4 percent and a net error approximating zero.

During the pretests for the 1970 census, however, the definitional missed rate appeared to be somewhat higher for a mail census than for a conventional census, and the 1970 census incorporated new procedures designed to reduce the error.

For this project the census questionnaires were reviewed for a sample of about 70,000 households in conventional census areas and about 140,000 households in mail areas. The review consisted of examining the questionnaires for households exhibiting a high potential for definitional error, i.e., those including as household members persons not related to the head and related persons other than the wife and children of head, as well as households which reported that their living quarters lacked the facilities to warrant classification as a housing unit--direct access or a kitchen for exclusive use. A field reinterview was conducted for a subsample of the potential error cases in order to determine the actual error rates for mail and conventional areas and, thus, the effectiveness of the census procedures.

Effect of Special Census Procedures to Improve Coverage in Difficult-to-Enumerate Areas--Project E5.--A number of special procedures were employed in the 1970 census to improve the population coverage in areas where enumeration had been the most difficult in earlier censuses. It would have been desirable to measure the effectiveness of each of these procedures but some did not lend themselves to an evaluative process, e.g., the use of permanent Census Bureau staff as district managers and in other key positions in offices where enumeration problems were expected.

The following five coverage improvement procedures, however, were susceptible to some degree of evaluation and were examined mainly to tabulate the number of persons added and their age-sex-color distribution. Of

particular interest was the extent to which additions were concentrated in those segments of the population for which coverage had been the lowest in past censuses.

1. Movers operation. A special effort was made to account for persons who changed residence around the time of the census and who, thus, could be missed. In the inner-city areas of the 20 largest metropolitan areas, the post offices notified the Bureau of changes of address reported for households who moved at any time between a month before and a month after the April 1 Census Day. The names of these movers were searched for in the census records to determine if they had been enumerated either prior to or subsequent to their change of residence. Persons not found to be enumerated were visited by census enumerators for inclusion in the census.

2. Precanvass. Before April, the inner-city areas of large metropolitan cities were canvassed in order to perform a final review of the census mailing lists. Pretest experience had shown that these were the areas in which there was more than normal difficulty in compiling accurate mailing lists. The precensus canvass was performed by specially trained enumerators who added to the census records the addresses of living quarters not previously included in the mailing lists.

3. Community action groups. The Bureau cooperated with local community action groups working for improved neighborhood census counts. Special "missed persons" forms were given to the local groups who campaigned in their respective neighborhoods for completion of the forms by persons who believed they had been missed in the census.

4. Post-enumeration post office check. Experience in testing the plans for the 19th decennial census had shown that appreciable gains could be made by submitting the census lists of living quarters to a postal review, and this was done prior to the census in those areas where mailing lists were used. However, the fact that no such precensus list existed for those areas of the Nation which were enumerated by conventional means, rather than by mail, made it impossible to perform this check before the census. It was decided to perform a postal review of the census list for conventional areas immediately following the field enumeration.

An analysis of households missed in the 1960 census had shown that they were most heavily concentrated in the South. This fact, together with budget limitations, led to restricting the postal review to the South. Subsequent to the census, addresses of housing units in the conventional census enumeration districts of 16 States were submitted to post offices for review. Mail carriers reviewed the census addresses and prepared a "Report of Residence Missed by Census" for each household they believed had been missed. Upon receipt of the postal reports, the households were searched for in the census records in order to determine the extent to which the postal reports duplicated households that had already been enumerated. Households found not to have been enumerated in the census were contacted for enumeration.

5. Vacancy recheck. In the analysis of the undercount following the 1960 census and in subsequent tests of

alternative census procedures, the Bureau discovered that a significant factor in the undercount was caused by the census enumerators' failure to determine which housing units should be classified as vacant on the census reference day. Several methods for dealing with this problem were tested without success.

In 1970, therefore, the Bureau used interviewers with long experience in interviewing methods and with special training in this problem to undertake a systematic review of a national sample of 15,000 housing units that had been classified as vacant by the original enumerators.

Individual area counts were adjusted by applying the findings from this procedure to the census reports of vacant units for individual enumeration districts. While this enumeration defect was not a large figure in and of itself (0.5 to 0.75 percent of the enumerated population), it approximated 25 percent of the 1960 undercount.

Analysis of Census Coverage of Selected Areas by Local Residents--Project E13.--This project was directed toward obtaining information on the nature of population undercoverage in difficult-to-enumerate (essentially inner-city) areas. It was not expected to provide a statistical estimate of the magnitude of undercoverage, but to reveal some insight into the characteristics of missed persons and why they were missed in the census.

The project was actually carried out in advance of the census for one such area. The Bureau obtained the cooperation of two social scientists who had established residence in a community in order to conduct socio-economic research. A sample of living quarters in that community was included in ongoing demographic surveys conducted by the Bureau, and the social scientists provided information about the number and age, sex, and race of the occupants of the sample units as well as information about their household relationships. The information they provided was compared to the survey data and discussions were held with them in order to ascertain the causes of any omissions. While the study did not produce a direct reading of numbers of persons not enumerated in the census, it was felt that the results of the study could be generalized to either a survey or a census because of the similarity of underenumeration problems in those activities.

D.C. Drivers Study--Project E22.--This project is similar to project E13 in that the purpose was to obtain information about the causes of undercoverage for certain population segments rather than to obtain statistics.

This was a record check study for a sample of about 1,000 males, ages 20-29, who newly obtained or renewed drivers' licenses in the District of Columbia between July 1969 and June 1970. Sampling was restricted to certain geographic areas so that the majority of the sample persons were Negroes.

The name and address of each sample person was searched for in the census records to establish whether or not he was enumerated somewhere in the metropolitan D.C. area. Visits were made to the addresses of persons not found in the census to determine whether they (1) were missed, and, if so, why, or (2) had other

addresses where they may have been enumerated. For persons who were left out of the census, analysis was made of what may have been important causes of the undercoverage.

Content Evaluation

There were two general types of projects in the 1970 evaluation program classed under the general heading of content evaluation.

First, there were projects designed to check, on a case-by-case basis, the accuracy of responses to individual census questions or the consistency of responses for those questions. To estimate accuracy, attempts were made to determine a better or more accurate response for the questions, either through reinterview (probing to attempt to develop an accurate classification) or through a record check (comparing census data with independent sources of similar data). The evaluation response and decennial census response were compared, with both gross differences and net differences usually available for analysis. Tables 1 and 2 below show, for population and housing questions respectively, the evaluation projects in which accuracy or consistency of response for each question was estimated. In addition, the randomization study (see p.16) was designed to produce estimates of the enumerator's contribution to the total response variance for many of these questions.

Second, there were projects designed to check on applications of operational techniques as they affected the overall quality of published data.

Three of these projects were designed to evaluate the applications of field operations. These were the National Edit Sample--Project E8, Evaluation of Sample Control in Mail Areas--Project E6, and Evaluation of Quality Control of Field Operations--Project E20.

Two projects were designed to evaluate the overall effects of preparatory work, field operations, and processing on the quality of published data for two key features of census plans. These were the Geographic Coding Evaluation--Project E4 and Evaluation of the Quality of Census Sampling--Project E19.

One project, Evaluation of Coding Quality in the Census--Project E16, was designed to produce data on the applications of processing procedures in preparing the materials from the field for computer tabulations.

One project, Evaluation of Place-of-Work Data--Project E25, was designed to estimate the major components of error (respondent, clerical coding, FOSDIC, and address coding guide) contributing to the total error rate in the place-of-work data.

Table 1. Summary of 1970 Census Evaluation Plans, Population Questions

(The list below shows the census questions for which accuracy or consistency of responses was estimated on a case-by-case basis, along with the individual evaluation projects which provided those estimates)

Subject of inquiry	Decennial question-naire item number	Collected in decennial census in--				Evaluation project in which response errors are estimated for all or part of the applicable universe
		Complete count	20 percent sample only	15 percent sample only	5 percent sample only	
Name.....	1	X				
Relationship to head.....	2	X				E3, E9
Sex.....	3	X				E3, E9
Race.....	4	X				E3
Age.....	5,6,7	X				E2, E3, E9
Marital status.....	8	X				E3
State of birth.....	13a		X			E9
Spanish origin or descent.....	13b				X	E9
Father's country of birth.....	14			X		E9
Mother's country of birth.....	15			X		E9
Citizenship.....	16a				X	E9
Year came to United States.....	16b				X	E9
Language spoken in home.....	17			X		E9
Year moved in.....	18			X		E9
Residence 5 years ago.....	19			X		
School attendance 1970.....	20			X		
Highest grade attended.....	21		X			E3, E9
Finished highest grade.....	22		X			E3, E9
Married more than once.....	24a				X	
Date of (first) marriage.....	24b				X	
Reason first marriage ended.....	24c				X	
Number of children ever born.....	25		X			E9
Age at (first) marriage ¹	6,7,24b				X	E3
Veteran status.....	26a-b			X		E3
Vocational training.....	27a				X	E9
Field of vocational training.....	27b				X	E9
Work limitation.....	28a				X	E10
Severe disability.....	28b				X	E10
Duration of disability.....	28c				X	E10
Work last week.....	29a		X			E3
Hours worked.....	29b		X			E3
Place of work.....	29c			X		E12, E25
Transportation to work.....	29d			X		
Temporarily absent from work.....	30		X			E3
Looking for work.....	31a		X			E3
Reason could not take job.....	31b		X			E3
Year last worked.....	32		X			
Name of employer (company name).....	33a		X			E3, E12
Kind of business or industry.....	33b		X			E3, E12
Type of business.....	33c		X			E3, E12
Kind of work.....	34a		X			E3, E12
Most important activity.....	34b		X			E3, E12
Job title.....	34c		X			E3, E12
Class of worker.....	35		X			E3
State of residence 5 years ago.....	36				X	
Working 5 years ago.....	37a		X			E15
Armed Forces 5 years ago.....	37b		X			E15
Attending school 5 years ago.....	37c		X			E15
Industry 5 years ago.....	38a				X	E15
Occupation 5 years ago.....	38b				X	E15
Class of worker 5 years ago.....	38c				X	
Worked in 1969.....	39a		X			E3
Weeks worked in 1969.....	39b		X			E3
Wage or salary income, 1969.....	40a		X			E3
Nonfarm self-employment income, 1969...	40b		X			E3
Farm self-employment income, 1969.....	40c		X			E3
Social security income, 1969.....	41a		X			E3
Public assistance income, 1969.....	41b		X			E3
Other income, 1969.....	41c		X			E3

¹Derived from census responses to date of birth and date of (first) marriage.

Table 2. Summary of 1970 Census Evaluation Plans, Housing Questions

(The list below shows the census questions for which accuracy or consistency of responses was estimated on a case-by-case basis, along with the individual evaluation projects which provided those estimates)

Subject of inquiry	Decennial question-naire item number	Collected in decennial census in--				Evaluation project in which response errors are estimated for all or part of the applicable universe
		Complete count	20 percent sample only	15 percent sample only	5 percent sample only	
Living quarters at address.....	A	X				E9
Telephone.....	H1	X				E9
Access to living quarters.....	H2	X				E9
Kitchen.....	H3	X				E9
Number of rooms.....	H4	X				E9
Piped water.....	H5	X				E9
Flush toilet.....	H6	X				E9
Bath tub or shower.....	H7	X				E9
Basement.....	H8	X				
Tenure.....	H9	X				E9
One-family house.....	H10a	X				E9
Commercial or medical.....	H10b	X				E9
Value of home.....	H11	X				E9, E21
Contract rent.....	H12	X				E9
Type of unit or quarters.....	B	X				
Vacancy status.....	C	X				E9
Months vacant.....	D	X				
Payments for electricity.....	H13a		X			E9, E23
Payments for gas.....	H13b		X			E9, E23
Payments for water.....	H13c		X			E9
Payments for other fuels.....	H13d		X			E9
Heating equipment.....	H14	X	X			E9
Year built.....	H15		X			E3, E9
Size of building.....	H16		X			E9
Size or type of lot.....	H17		X			E3
Sales of crops, etc.....	H18		X			
Source of water.....	H19				X	
Type of sewer.....	H20				X	
Number of bathrooms.....	H21				X	E9
Air conditioning.....	H22				X	
Number of automobiles.....	H23				X	
Number of stories.....	H24a					X
Passenger elevator.....	H24b					X
Cooking fuel.....	H25a					X
House heating fuel.....	H25b					X
Water heating fuel.....	H25c					X
Number of bedrooms.....	H26					X
Clothes washing machine.....	H27a					X
Clothes dryer.....	H27b					X
Dishwasher.....	H27c					X
Home food freezer.....	H27d					X
Television sets.....	H28a					X
Receive UHF broadcasts.....	H28b					X
Battery-operated radio.....	H29					X
Second home.....	H30					X

CPS-Census Match--Project E3--Among the major sources used to assess the quality of the 1970 census, on a case-by-case basis, were the records in the Current Population Survey (CPS). Information gathered and recorded in the CPS is generally regarded as having higher quality than information recorded in the census. There are a number of reasons for this. CPS has a permanent staff of well trained and closely supervised interviewers. Through highly developed survey control methods, the survey design and field procedures and their applications are constantly reviewed and improved to ensure that accurate information is obtained and recorded.

The records of households and persons in the March 1970 CPS were matched with the corresponding census records for the same households and persons. All March 1970 CPS records were used as the record source for estimating national coverage completeness of housing units in the census and for a study of persons missed from partially enumerated households (see Coverage Evaluation, CPS-Census Match--Project E3, p. 4). In content evaluation, CPS records that were matched to census households enumerated on sample questionnaires were used to obtain estimates of response differences for many of the demographic and labor force items in the census.

The sample also formed the basis for a match of Census Bureau and IRS data on 1969 income and for a linkage through which reports from individual employers on industry and occupation could be compared with census responses on these items. (This latter record linkage is discussed more fully below under Employer Record Check--Project E12.)

In addition to the fact that the CPS was a source of records of high quality for checking the accuracy of the census, there were a number of other reasons for relying so heavily on the CPS as an evaluation source. First, the CPS data-census match produces useful information on causes of differences between the two. Second, similar matching studies had been carried out as a part of the 1960 evaluation program and had produced valuable data on accuracy of responses in the census. The previous experience had indicated that the matching projects were feasible and likely to produce accurate and timely data on completion; that the costs should be quite reasonable for the amount of data to be obtained; and that the projects should not seriously interfere with regular census operations.

The records used for content evaluation were the subset of the 50,000 occupied housing units included in the March 1970 CPS sample that were enumerated as occupied on long census questionnaires (approximately 20 percent of the CPS sample). CPS households enumerated on short questionnaires, enumerated as vacant, or which were missed from the census, were excluded from further processing for content evaluation. As a result, about 10,000 households were included for comparison responses.

For each matched household and matched person, geographic and identification information which would uniquely link the census and CPS records was transcribed for input to the computer. The actual match and comparison of data was a computer operation in which the two data files were matched on the basis of identi-

fication information. Data were tabulated both before and after allocations for nonresponses to individual questions.

For the linkage with IRS records, identification information such as name, address, and social security number was transcribed from census and CPS records to provide a basis for locating 1969 income tax returns in the IRS files. The search of IRS records was done by Bureau employees in order to protect the confidentiality of the census data. When it had been determined that an individual had filed a 1969 tax return, selected information was transcribed for processing to computer tape. This information was linked with census data for the same person so that comparisons could be made as a computer operation.

Content Reinterview Study--Project E9--This was one of the large scale projects in the 1970 evaluation program, planned for estimating the accuracy of responses to individual census questions. The project involved an independent reinterview of a sample of households with an intensive probing type questionnaire. The data collected in the reinterview were compared with the decennial reports for the same households and return visits were made to probe further in cases where the decennial and reinterview data differed in order to determine which data appeared to be correct.

Similar projects were conducted as parts of the 1950 and 1960 evaluation programs. Data from those projects had proved useful both in providing information to the public on the accuracy of the published statistics and in indicating where changes and improvements in data collection techniques were needed. However, there were major differences between the design and scope of the 1970 project and the earlier projects.

One major change was a substantial increase in the number of sample observations. This was made possible in part by collecting both population and housing reinterview data in the same sample of households, rather than in different samples as was done in 1960. The 1970 sample included about 11,000 housing units (about 10,000 occupied and 1,000 vacant) containing about 30,000 persons for which reinterview data were collected. (The 1960 samples included reinterviews with about 5,000 households for housing data and about 10,000 persons for population data.) The 1970 content reinterview sample cases were selected from those households for which already were in the 1970 census sample universe. The increase in sample size produced reliable data for analysis for major geographic subdivisions of the United States as well as for subgroups of the population.

A second major change in the 1970 project was in the scope, or subjects of inquiry, to be included for reinterview. Although every subject could not reasonably be included for reinterview, every subject was reviewed and considered for evaluation of response accuracy, either in this project or in one of the other evaluation projects.

Certain subjects were excluded from this project: One group was excluded because adequate estimates of response error would be obtained from other studies (see especially project E3 which produced data on response

variances for many of the demographic and labor force items and project E10 on the disability question). For some other items, it appeared that reinterview techniques could not produce reliable data on response accuracy, and special projects were set up for that evaluation (see projects E15, E21, and E23). Some of the subjects had been adequately evaluated in the 1950 or 1960 program, so there was no need to repeat them. A few were excluded from reinterview because previous experience had indicated that reinterview was not an effective device for measuring response errors.

A third feature of the 1970 study was the emphasis on subjects introduced in the decennial census for the first time in 1970, in particular, on the methods planned for analyzing reinterview data for some of those subjects for which the notion of "correct" or "incorrect" is rather elusive (e.g., mother tongue, vocational training, Spanish origin or descent). For these, the reinterview and subsequent analyses focused on providing insights on how the respondent interpreted the questions and on the meaning of the resulting census statistics.

The reinterviews were conducted by personal visit using experienced field interviewing staff, usually Bureau employees working on the Current Population Survey. Every adult was expected to respond for himself in the reinterview, and a specific respondent was designated to provide the housing data.

Reinterview responses were compared manually (by an office staff separate from the field staff) with responses on the census questionnaire for identical persons and households. Response differences between the two records were scheduled for reconciliation through a re-visit; the sample was randomly distributed into two parts for reconciliation. In the first sample, which included about seven-eighths of the total sample, the objective was to learn which of the two responses was more accurate so that response biases could be estimated. In the second sample, which comprised the remaining one-eighth of the total sample, the objective was to try to learn why the respondent made an error in his census report (in cases where the census report was confirmed as an error), or, if an item was left blank on the census questionnaire, why the question had not been answered.

A number of additional analyses were conducted with the content reinterview sample: (1) characteristics of the census enumerator were associated with the matched data records to permit studies of the relationship of enumerator characteristics to response error rates; (2) a three-way match of census and reinterview reports on number of children ever born with the birth certificate for the last child born was performed to assess and reconcile differences in fertility rates between the decennial census and the Department of Health, Education and Welfare's vital statistics series; (3) a match of 1960 and 1970 reports for identical persons was made to study consistency of responses between censuses for items in which the responses should be the same or equivalent (age, sex, color, place of birth, etc.); (4) a match was made between census responses before processing and the final computer record after editing, coding, processing, and imputation to measure the net effects of these processing operations on the accuracy of published data; (5) a three-way match was made of census and reinterview reports on the year the structure was built with similar data in local assessment or building permit records.

Disability Study--Project E10.--At the request of the Social Security Administration a reinterview sample was set up, independent of and separate from the evaluation program, to collect more detailed data on disability than was feasible in the census. It was decided to use the results of this study to estimate accuracy of responses for the disability questions.

There were a number of advantages in using those results rather than mounting an independent project or including the subject in the content reinterview. First, the sample size, about 15,000 households in which at least one person was reported as disabled, and about 25,000 households containing only nondisabled persons, would produce more sample observations than was practical in the content reinterview. Second, this survey to collect more data on disability was designed in much greater detail, than would be practical for the disability question in the general evaluation reinterview. Third, the decennial and reinterview responses for identical persons could be matched in the computer. Thus, costs to the evaluation program for obtaining response error data for the disability questions would be fairly minimal.

Employer Record Check--Project E12.--The 1960 evaluation program included a comparison of the census responses on occupation with independent reports on occupation for the same persons by their employers. The study also included a comparison of the census coding on industry with the industry codes assigned the employers by the Social Security Administration.

The 1970 evaluation program repeated the 1960 employer record check, but with an increased sample size. While the 1960 results had provided useful overall measures of response error, the sample size in that earlier project--about 2,000 persons--proved to be too small to allow detailed analysis of reporting differences beyond summary classification levels. The 1970 sample included about 6,000 persons to permit analysis of response errors at detailed classification levels, at least for some of the more important occupation and industry categories.

The sample for this project included those persons 14 years old and over in the March 1970 CPS found to be enumerated as employed on 15-percent census sample questionnaires. Persons with no response on company name in the census, persons with no occupation or industry response, and persons in certain selected occupations such as farm workers, self-employed persons, and private household workers were excluded from this record check project.

(See CPS-Census Match--Project E3, p. 4, for additional details on sampling and matching CPS and census records.)

The employer of each sample person provided information on that employee's occupation, industry, and place of work. Data were collected from employers through mail questionnaires. These data were coded clerically and were placed on computer tape for comparison with the census reports for the same persons.

Employment 5 years Ago--Project E15.--The 1970 census was the first one to include questions on employment, occupation, and industry 5 years ago.

Results of previous testing suggested that respondents' inability to recall information precisely over a 5-year period might introduce serious biases in these data. Errors due to recall bias would probably be the major source of the total response error for those questions. For this reason it was felt that an evaluation of the data did not have to be tied directly to the decennial census and that results from an independent survey, conducted under general census procedures, would provide approximate measures of the quality of corresponding 1970 census data.

The field data-collection operations for this project were carried out in 1968. A subsample of households and persons listed in the July 1963 Current Population Survey was selected for this study. The study included approximately 2,800 households containing about 6,400 persons 14 years old and over as of July 1964. This sample included persons who reportedly were not working in 1963 as well as those who were. Data were collected in 1968 about each person's employment and occupational status in 1963, and the results were compared to corresponding reports in the 1963 Current Population Survey. Reporting differences between the actual 1963 CPS response and the retrospective 1968 response were assumed to represent reporting errors for this item in the census.

The total sample was randomly divided into two subsamples, each of which received a different version of the questionnaire, to see whether the accuracy of the responses was affected by the format of the inquiries.

The initial data-collection operation was conducted by mail. Questionnaires, similar in format and length to the short decennial questionnaire, were mailed to individual household members. Nonrespondents to the mailing were subsampled for field followup to complete the interviews. Three sets of reports on employment, occupation, and industry were prepared for comparison in the computer: (1) current reports for 1968; (2) current reports for 1963 (as collected in July 1963 CPS); and (3) retrospective reports collected in 1968 about 1963 classification.

Record Check Study on Value of Home--Project E21. -- Evaluation of response errors for the value-of-home question was included in the 1950 reinterview program. The question was also evaluated in the 1970 content reinterview; however, there was some concern whether reinterview techniques could produce adequate measures of bias for this question. For example, a respondent who has owned his home for a number of years, but has not considered selling, could be seriously biased in his estimate of "present market value" of his property. In the reinterview, even with probing, he still might be unable to provide an accurate estimate.

In order to obtain reasonably good estimates of bias, a record check project was designed to estimate the accuracy of responses to the value-of-home question. This record check compared actual sales prices with value-of-home reports in the decennial census for a sample of properties. The actual sales prices served as a standard of comparison for the value-of-home reports.

The sample for this project consisted of approximately 3,000 single-family homes (selected within 26 large

SMSA's) sold over the 6-month period July-December 1971. The primary reason for choosing this time period was to take advantage of data collected in the 1972 Census of Governments Property Value Survey for a much larger sample of properties sold during this time period. The selling prices obtained in the value survey were considered to be relatively accurate, and attempts had been made to validate each sale by determining whether the sale price reflected cash market value as opposed to other types of transactions such as foreclosures, tax sales, trades, etc.

The time period specified for project E21 was sufficiently close to the census reference time so that the sales prices essentially reflected market situations in April 1970 (a compensation for changes in the market situation over the 1- to 1-1/2-year period was included in the analysis). The project time period was far enough removed and after the census period so that, for most of the sample cases, the census response should not have been conditioned by the respondent's knowledge of a recent or an imminent sale.

It was expected that a sample of properties sold over a short period of time, as was planned for this record check, would comprise a biased sample of all properties. However, the results were expected to provide insight into whether there are serious reporting problems with the question on value. For example, if large biases were observed, they would indicate basic problems with the value question--at least for this subset of the population. On the other hand, if very little bias was detected, this would be considered encouraging, although not definitive, evidence that value of property is fairly accurately reported in the decennial census.

Gross Rent Record Check Study--Project E23. -- Rental householders completing the long questionnaire were asked to report costs for utilities, water, and fuels other than electricity or gas if those were paid for by the renter in addition to his contract rent. Amounts reported for utilities, etc. were combined, during the census processing, with amounts reported for contract rent to derive a gross rent figure.

Gross rent items were intensively probed in the 1950 Content Reinterview Study, the results of which indicated that gross rent data were not subject to large biases. For example, the difference in median gross rent between decennial and reinterview data was estimated to be less than 3 percent. There was skepticism, however, about whether probing in a reinterview context was an adequate device for detecting errors for these items. For example, many householders do not have utility bills readily available to facilitate accurate reporting; the reinterview, in many cases, would have to accept the respondent's best estimate of utility cost (which was probably the basis of his response in the census). Thus, the probing reinterview might be subject to some of the same biases as the decennial reports. A record check therefore was designed to obtain more accurate data on amounts reported for utilities than seemed possible through a probing reinterview. This project compared amounts reported by households in the decennial census with amounts those same households were billed by the local electric or gas utility companies.

The record check was planned for five medium-sized standard metropolitan statistical areas (SMSA's)--

Richmond, Va.; Reading, Pa.; Lansing, Mich.; Omaha, Nebr.; and Spokane, Wash. Although these SMSA's are not representative of the United States, they were selected so that a wide variety of reporting situations could be observed in the evaluation. For example, the SMSA's were selected from five different parts of the Nation, with a wide variation between the SMSA's in amounts of "add on" utility components in the gross rent figure and with a wide variation in the proportion of households using utility gas for heating. In addition, there was variety in the utility billing situations in the areas selected. In some areas there were separate electric and gas billings, in others the two bills were combined before they were sent to the householders, and in some areas the billing was bimonthly rather than monthly.

In planning the study it was not considered feasible to check records for a national sample of addresses. Coordination was required with each utility company involved in the study both to maintain confidentiality of census records and to obtain the desired data for specified households; the study would have been impractical if a large number of utility companies had been involved.

Within each SMSA, probability samples of about 1,200 rental-occupied households were selected from the census, for a total sample size of about 6,000 cases. The sample in an SMSA included about equal numbers of households in single and multiunit structures. In addition, these samples included a small number of cases where the respondent reported not paying extra for the utility so that a check could be made on the consistency of "yes-no" responses to the utility items.

The sample addresses were given to the local gas and electric utility companies. The utility companies were asked to provide data for each separate billing at the address for each of the 12 months prior to April 1, Census Day. (For sample cases in multiunit structures with 10 or more units, the specific apartment number at the address was identified.)

Reports from utility companies were used to compute average monthly costs of electricity and utility gas for comparison with the decennial census responses on costs for identical units. Analysis included a review of utility company data for cases with serious response differences to develop hypotheses on the probable cause of the response difference.

In this project contract rent and costs for water and fuels other than electricity or gas were not checked, but were held constant in the analyses. From all available evidence it appears that contract rent is fairly accurately reported. Costs for water and for fuels other than electricity or utility gas contribute a very small proportion (3 to 5 percent) to the gross rent figure, and reporting errors in these would have to be very substantial to have any appreciable effect on the gross rent figure. Considering this possible minimal effect and the fact that a significant number of local companies would need to be involved to check records for other fuel costs (especially those for fuel oil, coal, kerosene, etc.) it was decided not to extend the record check project to cover these items.

National Edit Sample--Project E8.--The National Edit Sample project was conducted during the census enumeration. It was planned, as a part of the 1970 evaluation program, to provide a basis for evaluation of field editing and for measuring components of "not answered" (NA) rates.² In addition, these samples provided a basis for an "early warning system" of estimating mail-return and failed-edit rates for various parts of the country and thereby anticipating the workload in the census field offices. (The Early Warning System is described in more detail in another chapter). The National Edit Sample was used to analyze the contributions of mail response cases and personal interviews to the total NA rate, to obtain information on response rates to individual census questions, and for other types of analysis.

Detailed plans for analyses included:

1. Estimation of NA rates at various stages of census operations, such as before clerical edit and after enumerator followup and cleanup. (Those data show the overall effect of various operations on the final reporting rate for each item and provide a basis for estimating the net effect of office coding and processing operations on the final NA rates.)
2. Evaluation of the accuracy of field editing operations (i.e., how frequently did editors or enumerators erroneously apply editing instructions and which instructions or census items were most troublesome in editing).
3. Estimation of components of NA rates, especially the effect that completely blank sample population pages in the questionnaires had on total NA rates. (In pretests of mail census techniques this had been a fairly serious problem, with the result that corrective action was taken for the decennial census.)
4. Evaluation of the effectiveness and application of special field editing rules (e.g., how often did a special edit rule identify a definitionally missed housing unit so that the housing unit count could be corrected before enumeration ended).
5. Identification of types or characteristics of households which were prone to be nonrespondents to the mail census questionnaire or which had high NA rates. (Such data might prove useful in developing future followup procedures.)

There were two phases of sample selection for this project. Sample cases for mail census areas were selected before questionnaires were delivered to householders, while sample cases for conventional areas were selected after census field work was completed.

For mail census areas a sample of mailing pieces was selected during the addressing operation, and a special return envelope addressed to the Bureau's Jeffersonville Census Operations Office was inserted. When the mail area householder in this sample completed and mailed in his questionnaire, it first went to Jeffersonville where a photocopy was made, and then the actual questionnaire was redirected to the appropriate local

²The NA rate for a question expresses the number of times the question was erroneously left blank as a percent of the number of times it should have been answered.

census district office for regular census processing by editors and enumerators. After all field work was finished, the final census questionnaire for the identical case was obtained. By comparing the questionnaire photocopy (as it came from the householder) to the final questionnaire after all field operations, estimates could be made of how the questionnaire had been treated in the field operations and the effect of those operations on its completeness.

The nonresponse sample consisted of those cases where the selected households did not return the mail questionnaires, and had to be followed up by enumerators. The final census questionnaires for the entire mail area sample were obtained for analysis after computer processing. At the same time, a sample of questionnaires for conventional census areas was selected and pulled for analysis.

The approximate sizes for the various samples in the National Edit Sample are shown in the table below.

Evaluation of Sample Control in Mail Areas--Part of Project E6.--Most of the data in the 1970 decennial census were obtained from the one household in every five which received the long census questionnaire. The 1960 and 1950 censuses were similarly dependent on sample data, and it is expected that future censuses will also be based to a large extent on samples. The designation of the census sample households is always a matter of great concern, and various controls are used in each census to assure that the selection is random. The controls are not always perfectly applied, however, and the deviations result in a modification of the overall sample size or in biases in the sample data.

The 1970 program included two evaluations of the effectiveness of the controls in the sampling operations with some examination of whether or not there were serious biases in the sample.

One such project (Evaluation of the Quality of Census Sampling--Project E19), discussed on p. 14, provided national estimates of biases in the sample selection. Project E6 was limited to those areas in which the census was conducted by mail, focusing particularly on the role of the Post Office in delivering the sample questionnaires

to living quarters that were not clearly identified in the census mailing lists. For the units where long and short questionnaire interchanges did occur, data were also obtained on whether or not the mail receptacles were accurately marked so that the census questionnaires could be delivered to their intended units and on whether or not the census enumerators used the intended type of form when visiting households that had not mailed back their census questionnaires.

This latter project was based on approximately 20,000 addresses (structures) that were included in the Evaluation of Housing Unit Coverage in Mail Areas (Project E6). When the addresses of housing units listed by evaluation interviewers for the sample were matched to the census records (on a case-by-case basis), a check was made to ascertain whether the households designated to receive long or short questionnaires actually received and filled out the proper types. Where differences were found, field visits were made to determine whether the checks made in the office correctly described what had happened.

In addition to providing information on the total gross interchanges between long and short questionnaires, the results indicated the extent of mixups between mail-return or nonmail-return units. The evaluation also showed the effect of the biases on: (1) the average number of persons in occupied units enumerated on long questionnaires compared with the average for units enumerated on short questionnaires; (2) the number of vacant units enumerated on short questionnaires compared with the number on long questionnaires; and (3) the net difference between the number of long questionnaires intended and the number actually received.

The analysis was limited to an examination of multi-unit addresses only, since previous evaluations had revealed that the interchanges that do occur generally occur between units within structures rather than between structures.

Evaluation of Quality Control of Field Operations--Project E20.--Past experience with quality control (QC) measures in the field indicated that a small proportion of enumerators make a large proportion of the errors. Field quality control, therefore, was designed to identify the error-prone enumerators so that they might be retrained or replaced. Crew leaders had been reluctant

Table 3. Approximate Sample Sizes for National Edit Sample

Sample cases	Decentralized mail census areas		Centralized mail census areas		Conventional census areas	
	Long questionnaires	Short questionnaires	Long questionnaires	Short questionnaires	Long questionnaires	Short questionnaires
Total.....	2,600	2,300	2,700	2,550	2,200	2,200
Mail return cases.....	2,200	2,000	1,800	1,800	-	-
Nonmail return cases.....	400	300	900	750	2,200	2,200
Occupied units.....	200	200	720	625	(NA)	(NA)
Vacant units.....	200	100	180	125	(NA)	(NA)

to release enumerators for poor work; in 1960 the number released amounted to about one-fifth of what was expected.

For 1970 there was a shift of emphasis from checks by the crew leader to checks in the district office. This study examined the result of these office checks and, where possible, compared the quality of the work detected by the crew leader with that detected in the district office.

This study also examined the results of the QC measures used by the crew leader, to see (1) if they assisted the crew leader in determining whether the enumerators had followed proper census procedures, and (2) the extent to which the crew leader carried out his instructions about releasing enumerators for poor work.

The study was based on a post-census analysis of samples of about a dozen different records maintained in connection with the QC measures, such as the crew leader's first, intermediate, and final review of the enumerator's work; office records of editing errors, etc. The records were sent from each district office to Jeffersonville where they were stored prior to sampling. For each type of record a sampling fraction was used, based on the number of records expected to be returned, which would yield a sample of at least 1,000 of each.

Geographic Coding Evaluation--Project E4.--An important development in the 1970 census was the use of a computerized address coding guide (ACG) for the geographic identification and tabulation of mail-area data. In order to evaluate this new procedure, enumerators visited a sample of addresses to determine the correct geographic codes, which were then compared with the computer-assigned codes. For this part of the evaluation the sample consisted of about 5,000 census listings in 75 SMSA's selected from those areas in which the census data were coded from the ACG. Error rates were established for three levels of coding: block, tract, and minor civil division (MCD) or place.

A second part of the study covered those areas of the country where the data were coded by census enumerators as they listed their areas rather than from the ACG. For these areas a sample of about 5,000 census listings was visited and coded by evaluation interviewers in order to estimate the block, tract, MCD, or place coding errors in these areas and to compare the two coding methods.

For both mail and conventional areas, a number of steps were taken to ensure accuracy in the evaluation data. As part of the coding, when evaluation enumerators visited the sample addresses, they recorded location descriptions by relating each address to the right or left side of the street relative to at least two intersecting streets. They then used these location descriptions, with maps, to determine tract and block codes.

The codes were compared to the original census codes for the same addresses and all differences carefully examined to ascertain which was correct. Where map examinations did not clearly show which code was right, second (and in a few cases, third) field visits were made.

The analysis provided separate estimates of the amount of geographic coding error for mail and conven-

tional census areas, with further breakdowns by central city, balance of SMSA, and contract block areas. For mail areas, separate estimates were made of ACG coding error and census enumerator coding error. Data were also tabulated to show whether error cases were mis-coded to adjacent tracts and blocks or to distant areas.

Evaluation of the Quality of Census Sampling--Project E19.--This study examined the net effect of biases and sample selection errors in the total number of sample households for the census. It was designed to identify distortions from the expected sample size and isolate reasons for biases. The Evaluation of Sample Control in Mail Areas (part of Project E6, see p. 3) had a related objective but was directed toward gross errors in the selection of sample households in multiunit structures.

Project E19 reviewed the counts of sample and non-sample households by households size and by tenure and race at the time the completed questionnaires underwent processing of complete-count data. The counts of persons in sample households by color, sex, age, and household type were compared with 100-percent counts. These data were tabulated by type of census procedure (conventional, centralized mail, or decentralized mail) to determine if there were differences in the quality of the census sample between mail procedure areas and conventional areas. These unweighted data were examined at the State and regional level in addition to the U.S. totals.

As part of the census tabulations produced from the weighted sample, tables were generated at the U.S. level (similar to those in 1960) showing the proportion of persons in the sample by household characteristics. There was also analysis of the distribution of weights and the effect this had on sample reliability.

Another part of the analysis was a case study of problems specifically related to processing errors and the effect some of the errors of these types had on the quality of the sample data.

During the census some 800 ED's were identified where the apparent bias in the sample was considered beyond acceptable tolerance. These ED's were re-sampled and additional field enumeration was done. Project E19 attempted to measure the improvement in the sample data due to this procedure.

Evaluation of Coding Quality in the Census--Project E16.--In the census respondents answered the questions either by darkening a small circle (FOSDIC code) adjacent to an applicable preprinted response or, if no such response was appropriate or none was provided, by writing in the response. A major operation in the processing of questionnaires prior to computer tabulation consisted of assigning numeric or alphabetic codes in FOSDIC form to the written responses, reviewing for inconsistencies the FOSDIC codes entered by the respondent and, when no response was provided, entering a response by following prescribed rules. Coding was divided among three groups of coders as follows:

1. General coding--the coding of responses on rent; utilities; relationship; race; place of birth of respondent, mother, and father; language spoken as a child; place or State of residence on April 1, 1965; date of marriage; and income.

2. Place-of-work coding--the coding of information on where the respondents worked the week prior to the census data.
3. Industry and occupation coding--the coding of information on occupation, industry, and class of worker for the latest job held since 1960 and for April 1965.

Although quality was monitored throughout the coding operations by the use of quality control procedures designed to identify poor coders and poorly coded work units (the questionnaires for one or more enumeration districts (ED's)), no reliable estimate of the average outgoing quality of coding could be obtained.

The main purpose of this study was to estimate the quality of each type of coding by independently recoding a sample of questionnaires. Additional studies which will be of assistance in planning future coding operations included the determination of consistency indexes for industry and occupation codes, the development of clerks' learning curves for coding quality and production, and the investigation of the relationships between production and quality of the coding as determined by the studies and that indicated by the various administrative records. A brief outline of these projects follows:

1. Determination of Average Outgoing Quality of Coding.--A sample of questionnaires was selected for independent recoding by two sets of coders. The codes assigned by one coder in each set were compared to the code assigned by the census coder and quality estimated as a result of these code comparisons.

The questionnaires were selected from ED's chosen in two phases. In the first phase, ED's were selected systematically at the rate of 1 in 25. The total number of households in the ED's selected in this phase, excluding those ED's with fewer than 10, were cumulated. In the second phase, each ED in which the cumulated number of households was a multiple of 1,000 was selected for sampling questionnaires. Two questionnaires were selected from each of these ED's, one at about one-third the distance from the top and another at about one-third the distance from the bottom of the ED carton. In the first ED and every other one, two 15-percent sample questionnaires were selected. In the second ED and every other one, one 5-percent and one 15-percent sample questionnaire were selected. The questionnaires were copied photographically with the code assigned by the census coder physically covered so it would not show on the photocopy. Using the copies of questionnaires, clerks with coding experience in the 1970 decennial census determined the appropriate codes and entered them on a separate coding form, not on the questionnaire copy. A second set of clerical coders repeated the coding process, using the same questionnaire copy and entering the codes on a second coding form. Coding was independent since these two sets of coders had no knowledge of either the production codes or the codes assigned by each other. The three codes were compared and a code was considered to be in error if it did not agree with at least one of the other two codes. (This was the same operational standard which was used in the quality control of coding in the

1960 decennial census.) Three-way differences were adjudicated by subject-matter coding experts.

2. Determination of Learning Curves and Correlations.--Preliminary studies which might lead to further research were conducted relating to the development of some criteria to assist in training, personnel planning, and in the establishment of standards. Information was obtained on a small sample of industry and occupation coders for a pilot study to investigate the relationships among the following variables:

- a. Civil service rating, which is in part composed of two tests--
 - (1) Test 800 (clerical and mathematical skills)
 - (2) Test 801A (verbal comprehension)
- b. Coder training test scores.
- c. Cumulative error rates.
- d. Cumulative production rates.

To use these measurements to predict a coder's performance, a sample of coding verification records for coders who started coding after November 1970 was selected. Data from these records on quality and production and the test scores for these coders were subjected to standard simple and multiple regression and correlation techniques to determine if any statistically significant relationships exist.

The data on quality of coding by this same sample of coders were used for determining the type of mathematical relationship that exists between quality and length of time in coding. The mathematical relationship between production and time also was determined for each type of coding using data collected during actual census coding.

3. Determination of Consistency Indexes for Industry and Occupation Codes.--Industry and occupation coding consisted of assigning numeric or alphabetic codes to the responses to questions concerning job held. The reliability of codes assigned was dependent on the quality of responses, coder training and experience, coding instructions, and the coding aids used.

A measure for determining the degree of reliability of codes assigned, i.e., the index of consistency, was developed for use with the quality control data from the industry and occupation coding in the 1960 decennial census. The index ranged from 0 to 1, with higher values indicative of the more reliable codes. Although the index is not considered a true measure of quality, it can point to problem coding areas.

Since quality control in 1970 differed from that used in 1960, a new formulation of the index of consistency, having the same properties, was defined for use with the data from quality control of industry and occupation coding in 1970. The quality control records for approximately one-fifth of the coders in industry and occupation from November 1970 through the end of coding were the data source for this study.

Evaluation of Place-of-Work Data--Project E25--The journey-to-work question asked in the 1960 census was

expanded in the 1970 census to collect a detailed address where the person worked. These work addresses were then clerically coded and those in address coding guide areas were assigned tract and block codes in the tabulations.

Project E25 was designed to estimate the overall quality of place-of-work data and to estimate the various major components of error--respondent error, clerical coding error, FOSDIC error, and errors in geographic allocation by computer due to inaccuracies in the address coding guide--which contributed to inaccuracies in the place-of-work data.

This evaluation was based on the responses on 15-percent questionnaires for about 4,000 persons in the sample for the CPS-Census Match--Project E3 (see p. 4) who lived in SMSA's. Census reports on place of work were compared to employers' reports (obtained in the Employer Record Check--Project E12) to identify potential response errors, which then were reconciled. The estimate of clerical coding error was based on work done for the Evaluation of Coding Quality in the Census--Project E16. Finally, the place-of-work addresses reported for sample persons were checked in the field to determine the correct tract and block codes for each case; these codes then were checked against the final census codes to identify errors attributed to FOSDIC error or computer misallocations caused by inaccuracies in the address coding guide.

Radio/TV Survey

Radio/TV Survey--Project E24.--Preceding and during the field operations of the 1970 decennial census, the various communications media--magazines, newspapers, radio and TV stations--as well as local community groups helped publicize the census and encourage cooperation with it. Coverage in the printed media and national network exposure had been well documented. In order to have a complete picture on publicity given the 1970 decennial census, the Bureau wanted to learn about publicity provided by local radio and television stations as well.

A sample of about 600 radio stations and about 700 television stations were requested to provide data on (1) local programs (interviews, features, editorials, news stories, etc.) aired to publicize the decennial census and (2) the number of public service spots about the 1970 census, as well as the dollar value of these spots if they had been treated as paid commercials.

Randomization Study

Enumerator Variance Study--Project E18.--Enumerator variance studies were carried out in the 1950 and 1960 decennial censuses in order to estimate the enumerator contribution to the response variance of selected statistics. (For an explanation of response variance, see p.2.) It was thought that the extensive use of self-enumeration in the 1960 census would reduce the role of the enumerator and, consequently, reduce this component of response variance. This proved to be true. The response variability differed from item to item, but the over-all level of response variability attributable to the enumerators in the 1960 census was about one-fourth to one-third of the corresponding level in the

1950 census. However, for some characteristics the enumerator contribution was still quite large; for example, some items on nativity, migration, housing, and educational attainment had response variances even larger than the sampling variances on the same items. Thus, even in 1960, it was found that the response variance caused by the census enumerators had a considerable effect on the statistics.

For the 1970 census it again was deemed important to measure the enumerators' contribution to the total variance of census statistics. New procedures and specifications were used in the census, and it was believed that the enumerators' new role in the editing of census materials might have changed the enumerators' impact. The more contact the enumerators had with the questionnaires, the larger their effect might be.

The 1970 Enumerator Variance Study was confined to the decentralized mail areas, on the grounds that these areas contained about one-half of the population of the United States and that this type of census procedure (in which the enumerator edited--i.e., checked for completeness--his own questionnaires) seemed likely to be followed in the future. Thirty-five of the 167 decentralized mail area district offices across the country were selected for inclusion in the study. Within each of the 35 offices two crew leader districts were chosen. All enumeration assignments within these selected crew leader districts were included in the study. There were a total of 1,036 enumeration assignments in the experiment out of approximately 59,926 enumeration assignments in all of the decentralized mail areas.

Estimates were made from this study of the enumerator's contribution to the total response variance for many different census statistics. In addition, estimates of the correlated component of response variance attributable to enumerators were possible for cross-classifications of census data, such as occupation by education (of the U.S population). This was not feasible in the 1960 experiment. In addition to the overall estimates, estimates of the correlated component of response variance were made by classes of enumerator. Estimates of the effect of the correlated component of response variance on multivariate statistics (e.g., for persons by age, sex, and race) are another result of this study.

Experimental Study

Mail extension Test--Project E1.--In determining the parts of the United States to be covered by mail census procedures in 1970, certain limitations were imposed to restrict the mail census to areas of high population density. The mail census techniques had been developed through pretests conducted in medium to large size metropolitan areas whose inhabitants' social and economic backgrounds were different from those in the rural, less densely populated areas in the nation. There were certain unknown factors involved with enumerating rural areas by mail census techniques, such as logistics for the field offices and the completeness and accuracy of rural mailing lists.

In order to provide factual information on these subjects for use in planning future censuses, a test of extending the mail census into rural areas was integrated into the 1970 census. Ten district offices, arranged in

five pairs, were designated for the experiment. While the five sets covered a wide range of possible situations, the two within each pair were as homogeneous as possible, since pairings were made by a controlled selection process whereby the pair-member offices were determined to have similar population densities, proportions of white to Negro and other races, and ratios of agriculture-non-agriculture activities. Within each pair, one randomly selected district office was designated for mail procedures (test) and the other for conventional procedures (control). Comparisons between the mail and conventional pair members were then made of such factors as cost, completeness of coverage, coordination and control of the census-taking process and, to some extent, the quality of the data. These comparisons are briefly described below:

1. Coverage.--The comparison of coverage completeness was restricted to estimating missed housing units. No estimates were made of population coverage between the pair members. The coverage analyses were based on a sample of segments of approximately 30 housing units each from 440 of the enumeration districts. Evaluation interviewers visited the segments to make complete listings of the number of housing units in each segment. The evaluation listings were compared with the census records, and differences were reconciled by another interviewer.

2. Costs.--The major factors considered in this analysis were total enumeration costs, district office

costs, Post Office costs for reviewing the accuracy of the census mailing list and for delivering and returning the mail questionnaires, and the cost of developing address coding guides for geographic tabulation of the data.

3. Allocation rates.--The extent to which complete-count or sample data had to be allocated--i.e., supplied to complete items left blank on the questionnaires--was analyzed and compared for the mail and nonmail offices.

4. Sample bias.--Extensive quality checks on the census sample were made during processing to identify ED's (enumeration districts) with serious sample biases. Summaries were prepared of the number of such ED's in mail and nonmail areas and their effect on the total sample size in these two types of areas.

5. Coordination and control.--Administrative concerns were a major consideration for limiting the mail census in 1970. The more complex mail census technique demands a greater number of qualified persons and requires the control of several simultaneous census operations, the successful completion of one phase often being dependent on the successful completion of another. As a result of the experimental design in this project, it was possible to observe the handling of mail and conventional census operations by local staffs in the rural areas and to compare their experiences.

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