CENSUS COVERAGE EVALUATION: IMPLICATIONS OF THE PAST AND PLANS FOR THE FUTURE

Howard Hogan and Kirk M. Wolter, Bureau of the Census[1]
Statistical Research Division, Washington, D.C. 20233

I. INTRODUCTION

During the past year, there have been several important developments related to the population undercount in the United States Census. The report of the coverage of the 1990 Census was published in February. The 1980 New York lawsuit was settled. The focus of our work has changed from census correction to census evaluation. We have begun detailed planning for 1990. Thus, we stand at a point to look back at what we have learned and forward to what we hope to learn. This paper, then, gives the background of the problem. It discusses the effects of undercount on some uses of census data, mainly using the results of the 1980 studies. It then discusses how we plan to measure the undercount in 1990 and what we plan for the 1990 report.

A. History of Problem

As measured by the net undercount, census-taking accuracy shows a steady improvement. One series of estimates shows the 1950 undercount was over 4 percent, the 1960 just over 3 percent, and the 1970 undercount just under 3 percent. The 1980 undercount was approximately one and a half percent. (U.S. Bureau of the Census, 1988).

In 1980, the census undercount became a political and legal issue, as well as a statistical one. The implications of the Supreme Court's "one-man-one-vote" decisions for state redistricting were well understood. The federal government was distributng money to local areas based, in part, on population through programs such as General Revenue Sharing, Urban Block Grants, and Urban Mass Transit.

The result of these trends was a number of court suits challenging the Census Bureau to correct the original enumeration for undercount. The Census Bureau answered that the methods it had available were not sufficiently accurate to improve the original enumeration. In the one suit that has been settled on its merits, the court decided that the Bureau had a reasonable basis for deciding that an accurate adjustment was not possible for the 1980 Census. (Cuomo vs. Baldrige, 1987).

On October 30 of last year, the Department of Commerce, the department to whom the Census Bureau reports organizationally, announced a policy decision not to correct the 1990 enumeration for coverage error. See U.S. Department of Commerce (1987). In light of this decision, we will be discussing the undercount and its measurement in terms of a census evaluation.

B. Two Aspects of Coverage Error

Census evaluation serves three main purposes:

* Advising users of the probable magnitude of the error in the major census statistics so that these statistics can be used properly;
* Advising the producers of the census statistics of the sources of the major errors so that steps can be taken to reduce these errors in future work;
* Helping statisticians to make more accurate intercensal estimates of population.

In addition, specific census activities are evaluated with respect to their effect on coverage.

In 1980 the net undercount was about one and a half percent. For 1990, the Department of Commerce is predicting that the undercount will be under one percent (U.S. Department of Commerce, 1987). Even with undercount so low, census coverage evaluation still has an important role to play. This is because focusing on the net national undercount misses two important aspects of coverage error:

* It is differential across groups.
* It is made up of larger gross errors.

1. Differential

Underlying the steady improvement in the national average undercount is a persistent differential undercount. We define the differential undercount rate as the difference between the undercount rate for a group or area and the undercount rate for the national as a whole in a given census. Table 1 gives the differential undercount rate by race and sex for each of the past four censuses. The minus sign denotes differential overcounts, i.e., how much better a group was counted than the nation as a whole.

The undercount of Black Americans has been approximately 5 percent higher than the national average for every census since World War II. The undercount of Black males has been 7 or more percentage points higher than the national undercount for these four censuses.

Other differentials in coverage exist. Central cities of large metropolitan areas seem to have higher undercounts. The 1980 coverage evaluation program produced estimates of the undercount for 16 central cities. There were several estimates produced for each city based on a range of assumptions. The Census Bureau was quite concerned about the bias of the estimates. The twelve sets are based on different data and different assumptions in an attempt to show the sensitivity of the estimates to possible violations of assumption. The Census Bureau decided that none of these was sufficiently accurate for adjusting the census. However, we can look at the differential undercount implied for each set of estimates. Subtracting the estimated national undercount removes any uniform bias from the sets, but will leave any bias that is

differential between areas.

Table 2 gives the difference between the cities' estimated undercount and the national undercount for each city and set of estimates. Many of the individual estimates are not significant at the 90 percent level. However, if cities as a group have the same undercount as the nation as a whole, one would expect that by chance the estimates of only two of the sixteen cities would be significant at the 90 percent level ($0.1 \times 16 < 2$). This outcome is only seen for the "14-8" estimates. For the other series four or more cities exhibit a statistically significant undercount.

Another approach is to compare estimates from the different series for each city. One must remember that the April estimates (Sets 2, 3, 14) are highly correlated with each other, as are the August estimates (5, 10), while the correlation between April and August estimates is weak, with a correlation coefficient of only .2 or .3. Leaving aside the biases, certain patterns tend to emerge. The 1980 PES showed no differential undercount for Boston, Indianapolis, or San Diego. The pattern for such cities as Milwaukee, San Francisco, St. Louis, Detroit and Washington is weak but suggestive of a differential undercount. The pattern for Baltimore, Chicago, Cleveland, Dallas, Houston, Los Angeles, New York, and Philadelphia is largely consistent with the idea that coverage for these cities was below the national average. So while caution must be used, both in terms of bias and variance, there is evidence in the 1980 PES to support the idea of a differential undercount for central cities of large metropolitan areas.

Undercounts may be higher for some ethnic groups, such as Hispanics. Table 3 gives the estimated differential undercounts for Hispanics as well as Blacks from the 1980 PES estimators mentioned above. Again, a differential undercount is shown. Rural areas also have high undercounts.

There is evidence that the undercount is higher for the poor, for the single, and for the unemployed. Undercount is higher for those who rent than for those who own their home. (Isaki, et al. 1987). Differences have been shown with many other social variables as well. See Fein and West (1988) for a discussion with respect to the 1986 Census of East Central Los Angeles County.

2. Net

Looking at net undercount hides half the story. Net undercount equals gross omissions less gross erroneous inclusions. Beneath the pattern of net differential undercount is a pattern of omissions and a pattern of people counted more than once, falsifications by census enumerators, and other errors.

For example the net undercount in 1980 was on the order of 1.4 percent or 3.2 million people. According to the 1980 evaluation at least 2.7 million people were counted more than one time (Cowan and Fay, 1984; Jones, 1986)[2]. This implies that at least 5.9 million people were omitted.

The result is to remove millions of real people from the data, and add in many enumerations that should not be there. The implications for the data user are more serious than implied by a net undercount of 1.4 percent.

The problem of gross overcount and gross undercount is related to the problem of differential net undercount. For example, most of the duplicated housing units occurred in pre-list areas (Bureau of the Census, 1985), that is, outside the large metropolitan areas. The overenumeration rate of occupied housing units in rural areas (1.36%) was far higher than that for urban (0.70%). In those areas of the country enumerated conventionally (i.e., not mail-out-mail-back) the overenumeration rate was extremely low (0.11%).

The Bureau has taken steps that should reduce the number of housing units duplicated in the census. These steps include the new geography and map system (TIGER) and the automated address control files.

II. USES

One role of coverage evaluation is to inform data users of the implications. What are the effects of the undercount on data users? We might roughly divide the uses of census data into four categories:

* Political
* Statutory
* Social science
* Planning .

A. Political

The political uses of the census results have received the most attention. These are:

* Congressional Apportionment
* Congressional Redistricting
* Local and state redistricting .

As is well known, the Congress is apportioned on the basis of the census counts. The way the formula works is highly complex, making it nearly impossible to predict accurately which states, if any, might be affected by the undercount. All that can be said is that small states are less likely to be affected than large states (Gilford, 1986). Of course, the effect on a small state, when it does occur, would be proportionally greater. If the 1980 PES results can be believed, the undercount might have shifted a congressman from California to Tennessee.

Redistricting is another matter. The constitutional requirement of equal congressional districts seems quite strict. (See Carlucci, 1980; Kracher v. Dagget). Areas with large undercount relative to the rest of their state clearly lose political representation, both in Congress and in the state legislature. Indeed, parts of cities with large undercount relative to the rest of their city lose political representation in the city council.

B. Statutory

Many government programs use population as part of the formula to distribute federal money. This is less true now than a few years ago, but over the years we have looked at some of these programs to see the effects of undercount.

Revenue sharing showed little sensitivity to undercount at the state level. The county allocations showed more sensitivity. The most significant changes occurred for the so-called "constrained counties". These counties' allocations decreased in proportion to their respective population undercounts. The community block-grant program showed great sensitivity to undercount. This occurred because population could enter the formula either as a positive, that is in terms of population proportion, or as a negative, that is in the calculation to measure declining populations. Urban mass transit programs showed relatively little effect except in a few communities. The communities that were most sensitive were those pushed below a population threshold. Although absolute population undercount generally has little effect on allocations, it becomes significant when there are threshold levels that determine eligibility. (Steinberg and Hogan, 1984).

In looking at the 1980 programs we discovered that it was difficult to predict the effects of undercount on allocation. The programs are complex. What these programs may be like in the 1990's, and how undercount might affect them is almost impossible to say.

There are other legal uses of population counts besides fund allocation. The number of people in an employment area for different race groups can play an important part in court cases over job discrimination. Decennial census data are commonly used to address whether the jury selection system in a particular jurisdiction is representative. Race is the most common characteristic, but some challenges have specified sex, age, occupation, education, and/or poverty level. (See Rolph, 1986).

C. Social Science

Census data play an important role, directly or indirectly, in much social science research. Looking at just a few uses gives an idea of the importance of understanding census undercount. We will look at the effects of census undercount on:

* Demographic rates
* Expectations of life
* Sex ratios
* Growth rates
* Geographic distributions
* Measures of crowding and poverty
* Survey controls.

Demographic rates are calculated as events divided by population, often used as a proxy for person-years lived. The numerators for these rates might come from vital statistics, from education statistics, from the FBI's Uniform Crime Report, etc. All of these can be affected by undercount.

For example, if we look at the ratio of observed Black male crude death rate (CDR) in 1980 to the observed white male CDR then we get a 5% excess (1.05). The true ratio will equal the observed ratio times the ratio of the census coverage rate for Black males (.923) to the rate for white males (.981) or:

$$.923/.981 = .94$$

The ratio of the true rates will be 1.05 * .94 = 0.99.

The National Center for Health Statistics has at times included instructions in the vital statistics reports on how to correct the rates for census undercoverage and provided the necessary factors (U.S. Department of Health and Human Services, 1981).

A common measure of the extent of social problems is the prevalance rate: that is the number of events per person. The analysis here is similar to that of crude death rates, except it is no longer always safe to assume accurate reporting of the event. The event may be more poorly reported than the population. AIDS cases may be badly underreported. Still, a researcher interested in the prevalance of AIDS in certain inner city populations would do well to take census coverage into account.

Expectation of life is a more complex measure of mortality than crude death rate. It turns out that the undercount does not greatly influence either the expectation of life at birth or expectation of life at age 65. Table 4 gives the estimated decrease in observed expectation of life from the last three censuses. Perhaps this is because expectation of life at birth is highly influenced by the infant mortality rate, while expectation of life at age 65 is obviously driven by estimated mortality at the older ages. Expectation of life at age 65 may also be influenced by age mis-reporting problems rather than census undercoverage.

The results would be different if one was looking at expectation of life at, say, age 20, where in 1980 correcting for Black male undercoverage would raise expectation of life by more than one year.

Census sex ratios can be misleading. The census misses more males than females. This is especially true among Black adults. If we look at the census and estimated true sex ratios given in Table 5 we can see the effects.

What is the effect on our perceptions of Black problems, Black social patterns, Black living quarters? One small ethnographic study of a Black neighborhood in 1970 found that while Census Bureau data indicated that 72 percent of households were headed by females, only 12 percent actually were. On the basis of this finding, the ethnographers argued that biased census data create and support a distorted image of the female-headed Black household. (See Hainer et al., 1988).

In an article on Black marriage patterns Goldman, et al. (1984) were forced to deal with this issue.

"Because of the severity of the problem among Black males, we have adjusted the whole unmarried population, specific for race, age, and sex.... Since the undercount is probably greater in the unmarried population, there may be further underrepresentation of men, especially Black men, in our estimates of the marriage market."

Their results would have been different if they had ignored the issue.

Measured intercensal growth rates are affected by the undercount. The resident population of the United States increased between 1970 and 1980 by 11.4 percent based on official census counts. When the comparison is based on the estimated true population, the growth rate is only 9.7 percent for this decade. The same distortion is no doubt occurring at the local and state level as well.

Measures of geographic distribution can be distorted due to undercount. For example, if Blacks living in suburban mixed neighborhoods are more willing to be counted than Blacks living in central city Black areas, then measures of segregation will be distorted.

At least in the city, it seems likely that many people who are missed are actually living in counted housing units. In this case, measures of crowding such as people per room can be badly distorted as we have the right number of rooms but too few people. Statistics on households and household composition can be distorted. If the chances of being missed are related to poverty, employment, and other social variables, then our perceptions of conditions and trends are distorted. (See Fein and West, 1988).

The census is used as a sampling frame for other surveys, such as the Current Population Survey, CPS. Since only the housing units are sampled, the undercount of people in the census does not directly affect the sample. However, these surveys have undercoverage problems of their own. Overall, CPS coverage is about 7 percent lower than the census coverage. Undercoverage of Black males is 17 percent lower than the census and Black males 20-24 are 27 percent worse. (Hainer, et al., 1988). One of the uses of the Census is to correct for coverage problems in other surveys. The Bureau statistically controls the CPS to agree with the projected census data. So the undercoverage of the Census is carried into the CPS.

Census data are also used to correct undercoverage in private and university surveys. Small area decennial census data are used to impute characteristics to subjects where only an address is known. Alternatively, they are used for "carrying down" aggregate estimates if other attributes of the subjects are known. For example, iterative proportional fitting or some other technique might be used to estimate the racial composition of the sample (Clogg, 1986).

D. Planning

One should not focus too much attention on current programs and current needs. The census is used to plan for the future. To quote Senator Moynihan:

> At one point in the course of the 1950's John Kenneth Galbraith observed that it is the statisticians, as much as any single group, who shape public policy, for the simple reason that societies never really become effectively concerned with social problems until they learn to measure them (Moynihan, 1980).

Or as a congressional staffer put it "If we don't have the right numbers, we don't know whether the money is getting to the people who need it." (Terri Ann Lowenthal, quoted in Sun (1988)).

The use of census data by the private sector is extensive and no doubt as important as the uses by the government. The impact of undercount there has not gone unnoticed. To quote Mayor Richard Berkeley of Kansas City (1988) "It can happen in the private sector as well, where in fact, people make advertising buys and things of that nature based on the population in a community or in a region". The undercount can affect decisions of advertisers to buy time on, for example, Spanish language stations.

III. 1990 CENSUS COVERAGE EVALUATION PROGRAM

We have talked so far about how the undercount might affect some uses of census data. Again, it might not. For many groups and many areas the undercount is rather small. For 1990, the Census Bureau is committed to a program of coverage evaluation aimed at informing users of the types of errors and where they occured.

We will use two major methods to measure the coverage of the 1990 enumeration:

Demographic Analysis
Post-enumeration Survey (PES)

Each has its own strengths and weaknesses. Together, they provide the information needed to evaluate the census enumeration. In addition, we will have a program of participant observation to help us evaluate census coverage in selected hard-to-enumerate areas.

A. Demographic Analysis

The demographic analysis estimates use statistics on births, deaths and immigration to form alternative estimates of the U.S. population by age, race and sex. Many of the results we have quoted are the result of demographic analysis.

Demographic analysis has three principal weaknesses.

* It is available only for those groups for which vital records are separately kept. This basically excludes any estimates for Hispanics as a separate group.
* Demographic analysis estimates are

generally available only at the national level. The lack of statistics on internal migration prevent reliable estimates for sub-national areas.

* Finally, the estimates are aggregate. They tell us nothing about the characteristics of the missed people. Demographic analysis tells us nothing about gross omissions or gross overcount. It can only estimate net undercount.

Still, for broad racial groups, at the national level, demographic analysis estimates may be the most reliable data available. Further, demographic analysis provides important information on the structure of the population. Thus, even if there is uncertainty about the exact number of births, the ratio of males to females may be accepted as highly accurate.

Demographic analysis results will be available in early 1991 for 5-year age groups up to age 75+, and by sex. The results will be available separately for Blacks and non-Blacks. Preliminary estimates of population will be available by October 1990. However, the construction of undercount estimates must await the receipt of the census results. Estimates of the total undercount can be made by December 31, 1990. However, estimates of the undercount by age, race, and sex must await the creation of the final edited census file, which will not be complete before February 1991. Preliminary demographic estimates of census coverage by age, sex, and modified race will be available by April 1991. For the first time, these will include error intervals, reflecting the uncertainty of this model.

The components of error and the total error in the estimates from demographic analysis will be evaluated through analyses of the data used in making the estimates. The analyses of the components of error will assess how well the assumptions of the methodology hold. The components are: error in the birth registration completeness estimates, error in the estimates of net immigration of undocumented aliens, error in the estimated births from 1915 to 1935, error in the estimates of the population over age 65, error in the estimated number of emigrants, and other smaller components combined. The analyses of the components of error will provide information required to assess the total error in the estimates from demographic analysis.

B. Post-enumeration Survey

The Post-enumeration Survey really consists of two surveys. One survey measures census omissions. It consists of a sample of people who should have been counted in the census. This is called the P-sample. This sample must be representative of the population as a whole. We then search census records to see whether they were actually counted. A sample of census enumerations, or E sample, is used to measure erroneous inclusions.

The advantage of the PES is its ability to give estimates for sub-national areas. Further, it provides data on the characteristics of the people who are missed.

Plans for 1990 now call for a sample size of 150,000 housing units. This sample will be derived from a sample of approximatley 5,000 blocks. The sample size is allocated to give a coefficient of variation of 0.7% in each of 54 major geographic areas. We investigated the possibility of subsampling the blocks so as to include the same number of housing units, but located in 10,000 blocks. The idea was to reduce sampling variability. We rejected this approach.

The use of 10,000 blocks implies subsampling the majority of blocks to meet the constraint of 150,000 housing units, whereas the use of 5,000 blocks implies subsampling only a small minority of blocks. Using the larger number of blocks would be more expensive. More important, we felt that the main sources of uncertainty in past dual-system estimates have been nonsampling errors rather than sampling errors. With extensive subsampling, non-sampling errors would increase because of several factors.

* Computerized and clerical matching are more accurate when the same geographic areas are easily identified in both the PES and census. Such geographic identification is easy with the use of whole blocks, but difficult when blocks are subsampled.
* It is difficult to select overlapping P and E samples and to ensure that the samples remain unbiased when subsampling of blocks is performed.
* The quality of listing and interviewing would decrease if the larger number of blocks were used, due to increased control problems in the field.
* The use of the smaller number of blocks should result in a lower noninterview rate because interviewers will be able to conduct more call-backs and also become more familiar with neighborhoods.

The sampling strata represent a geographic partition of the U.S. into areas that are thought to be homogeneous with respect to the undercount mechanism. Each stratum is an aggregate of 1980 Census tracts and block numbering areas (BNA's) where they existed, and of places and county remainders where neither tracts nor BNA's existed. Tracts within a stratum are often, though not always, contiguous. For the 1990 PES, we will select a probability sample of blocks within each stratum. The sampling will be independent from one stratum to the next.[3]

In developing these strata we are looking at the following factors:

Race: As we have seen, demographic analysis and the post-enumeration surveys indicate differential undercount between Blacks and, non-Blacks. The 1980 PES also indicated an Hispanic differential with non-Black/non-Hispanics. During the sampling, the race will be based on the predominate race in the area at the time of the 1980 Census.

Place/Size: Central cities of small, medium and large PMSA's make up categories because of the

results of the 1980 PES as well as earlier research. A fourth category was formed from the areas outside the central city. Places with a population of 10,000 formed another, with smaller cities and towns and rural areas forming a sixth category.

Census division: This accounts for general geographical differences. We probably do not want to group rural areas of Georgia with rural Vermont.

Tenure: Movers are felt to be associated with the undercount. A proxy variable for movers is renters. When modelling 1980 net undercount, the percent minority renter was the variable most highly correlated with undercount. This has held up in the 1986 Test Census in Los Angeles as well.

The cross-classification by the nine census divisions and the six place type-and-size categories yields the 54 major geographic areas. These will serve as major sampling strata. The next step involved creating additional sampling strata within these areas by grouping geographic units with high concentrations of the race-origin-tenure groups corresponding to the poststrata for that geographic area. After grouping geographic units, a total of 101 sampling strata were defined.

We also plan to divide the country into estimation strata, or poststrata. Poststrata represent the finest level of detail for which we will produce direct PES estimates of the 1990 undercount. By direct PES estimates, we mean estimates produced using the Petersen or dual-system estimator. Poststrata are defined by characteristics of the people enumerated in the PES and are as homogeneous as possible with respect to the census undercount mechanism. In developing these poststrata we are looking at age and sex in addition to the sampling factors. Both demographic analysis and the PEP suggest differential undercount by sex and by age. We have chosen the groupings 0-9, 10-19, 20-44, 45-64, 65+ to follow the patterns laid down by the demographic analysis results. For estimation, we will have the actual reported race in the 1990 Census.

We have decided to exclude certain groups from the PES. We feel that the dual-system model does not apply in these situations.

Institutional populations: We feel that since the census has gathered the list of people to include from the administrative records of the institution, it makes little sense for the PES to return and conduct an "independent" interview based on the same administrative records.

Group quarters Military: Again the list of individuals to include would be derived from administrative records in both the census and the PES. The dual system model does not apply.

Street and Shelter enumeration: The reasoning here is different. The dual system model would apply if matching were possible. However, matching, which would be difficult enough, is made impossible by the decision of the census to accept enumerations based on "observation", e.g., without obtaining name or characteristics from the person.

Rural Alaska: The census is conducted by flying in to the village in a plane, conducting the interviews and leaving. The enumeration takes place in winter when the people are still relatively stationary. We feel that, given the isolation of these villages and their suspicion of outsiders, an "independent" visit is not realistic.

We will also make extensive use of participant observers. That is, we will hire ethnographers who are or will become familiar with who actually lives in neighborhoods. We use this program in very hard-to-count groups where even a traditional PES tends not to pick up many of the people missed. We hope to have 50 such observers scattered through the United States.

The components of error and the total error in the estimates from the PES will be evaluated through analyses of data collected during the PES and in two special operations. The evaluations of the components of error will assess how well the assumptions underlying the PES methodology hold in this application. The components of error are response correlation bias, clerical mathcing error, accuracy of the Census Day address reported in the PES interview, fabrication in the P sample, error in measurement of erroneous enumerations, error in balancing the estimates of the gross overcount and the gross undercount, missing data, and sampling variance. The results of the evaluations of the components of error provide the information required for assessing the total error.

The two special operations are the Evaluation Follow-up and the Matching Error Study. The Evaluation Follow-up measures the accuracy of the reported Census Day address by re-interviewing a sample of the P-sample non-matches who reported that their current address was their Census Day address. The Matching Error Study measures the error in the PES matching operation by conducting an independent re-match of a sample of blocks. Other studies will be conducted as appropriate.

C. Best Combined Estimate

The final estimates of the census undercount will be based on both the demographic analysis estimates and the post-enumeration survey. The PES will give us the geographic distribution and also the characteristics of the missed people. Demographic analysis will allow us to validate the results and help us improve the estimates. For example, we can use the national sex ratios, known from demographic analysis, to improve the estimate for young Black males. From both these sources we will derive one combined estimate.

The combined estimate will take into account not only the measured undercount for an area, but also what is known about the error structure, both variance and bias, of the PES and demographic analysis.

D. Carrying Down

We will assume that the same undercount rate applies to all people within the poststrata. We call these assumed rates the "factors." We will smooth these factors to reduce the effects of sampling variability using Bayesian models. The smoothing is done by regressing the adjustment factors against indicator variables for age, sex, race, and strata plus the number of census substitutions for that cell. The smoothed value is the weighted average of the observed cell and the prediced value with the weights being inversely proportional to the sampling error and the model error respectively.

E. Tabulation and Publication

The Census Bureau has not yet decided upon the exact content of the evaluation reports. We are considering two reports: one aimed primarily at outside users of the data and one aimed more at census planners and others for census research.

Report 1 would be finished in late Spring 1991. It would cover the basic evaluation results for major political jurisdictions. The contents would be the number missed, the estimated total population and the undercount rate from demographic analysis, the post-enumeration survey and from the best combined estimator.

Report 2 would come out later, perhaps around 1993. The main audience is census planners and other researchers. It would address the covariates of the undercount. For example, it might address the undercount by farm/non-farm or the type of collection office. By classifying people by the characteristics of the area in which they live, the report can address the relation between undercount and the income group, percent foreign-born, percent female headed households or by crowding. Obviously, the details will be worked out over the next few years.

IV. CONCLUSION

Net census undercount is a complex subject, the result of both census misses and erroneous inclusions. Its occurrence is differential across groups and among areas. Similarly, its impact is differential for different uses. The methods we use to measure it are complex and subject to errors of their own. In planning for 1990, we have put together a multifaceted program. Demographic analysis and the post-enumeration survey are the twin pillars. In addition, we have developed a program to evaluate our coverage measurement program itself, and a program of participant observation to give us insight into the coverage of the very hardest-to-enumerate groups. Together, these studies should provide both the data user and the student of census methods accurate measures of census coverage.

References

BERKELEY, Richard (1988). Interview on Morning Edition, National Public Radio, January 20, 1988.

CLOGG, Clifford; MASSAGLI, Michael; and ELIASON, Scott (1986), Population Undercount as an Issue in Social Research. Bureau of the Census. Proceedings, Second Annual Research Conference, pp. 335-343.

COWAN, Charles; and FAY, Robert (1984) "Estimates of Undercount in the 1980 Census," Proceedings of the American Statistical Association Annual Meetings.

CARLUCCI, Carl P. (1980). "The Impact of an Adjustment to the 1980 Census on Congressional and Legislative Reapportionment," pp. 145-152. Conference on Census Undercount: Proceedings of the 1980 Conference.

CUOMO vs. BALDRIGE (1987) 674 F. Supp 1089 SDNY 1987.

FEIN, David and WEST, Kirsten (1988). "Towards a Theory of Census Undercount: An Exploratory Assessment of Data from the 1986 Los Angeles Test Census," Proceedings of the Fourth Annual Census Research Conference.

GILFORD, Lee (1986). "Undercount Adjustment and Apportionment." Unpublished manuscript.

GOLDMAN, Noreen; WESTOFF, Charles F.; and HAMMERSLOUGH, Charles (1984). "Demography of the Marriage Market in the United States," Population Index, Vol. 50, No. 1.

HAINER, Peter, et al. (1988). "Research on Improving Coverage in Household Surveys, Fourth Annual Research Conference Proceedings.

ISAKI, C.T., SCHULTZ, L.K., SMITH, P.J., DIFFENDAL, G.J., (1987). "Small Area Estimation Research for Census Undercount: Progress Report," Small Area Statistics, An International Symposium, John Wiley, New York.

JONES, Charles D. (1986). Memorandum for Barbara Bailar, "Duplicate Enumerations," October 7, 1986.

Kracher vs Daggett, 103. CT 2653.

MOYNIHAN, Daniel P. (1980). "Congressional Perspective," Conference on Census Undercount: Proceedings of the 1980 Conference, 49.

ROLPH, John. "Discussion". Proceedings of the Second Annual Research Conference, pp. 344-346.

STEINBERG, Barbara and HOGAN, Howard, (1984). "The Effects of Population Adjustment on the Allocation of Three Government Programs." Proceedings of the American Statistical Association Annual Meeting.

SUN, Marjorie, (1988). "Plan to Assess Census Undercounting Dropped," Science Magazine,

January 29, 1988, p. 457.

U.S. Bureau of the Census (1985). The Coverage of Housing in the 1980 Census, PHC 80-E1.

U.S. Bureau of the Census, (1988). The Coverage of Population in the 1980 Census by Robert Fay, Jeffrey Passel, J. Gregory Robinson, and Charles D. Cowan, PHC 80-E4.

U.S. Department of Commerce, (1987), News, "Statement of Robert Ortner", October 30, 1987.

U.S. Department of Health and Human Services, 1981, Vital Statistics of the United States 1977, Volume II, Part A, Technical Appendix and Table 6-4.

Footnotes

1 The views expressed are attributed to the authors and do not necessarily reflect those of the Census Bureau.

2 This estimate is derived by adding the 2492.9 thousand people duplicated identified in the PEP to 214.0 thousand people duplicated in the Whole Household Usual Home Elsewhere Coverage Improvement Program. The PEP only measured duplicates within a search area around the enumeration. The estimate thus does not include post-census day movers who may have been counted once at their census day address and a second time at their new address.

3 Members of the Census Bureau's technical staff have developed a document, "Preliminary Stratification Schemes for the 1990 Census Coverage Measurement Programs," which describes the sample design in detail. It is available upon request from Howard Hogan, Statistical Research Division, Bureau of the Census, Washington, D.C. 20233.

Table 1: Undercount Rate and Differential Undercount by Race and Sex: 1940-1980

	Percent Net Underenumeration				
	1980	1970	1960	1950	1940
All Classes	1.4	2.9	3.3	4.4	5.6
Black	5.9	8.0	8.3	9.6	10.3
Male	8.8	10.6	10.4	11.7	12.6
Female	3.1	5.6	6.2	7.5	8.0
White and Other	0.7	2.2	2.7	3.8	5.1
Male	1.5	2.8	3.0	4.0	5.3
Female	0.0	1.7	2.4	3.6	4.9

	Percent Net Differential Underenumeration				
	1980	1970	1960	1950	1940
Black	4.5	5.1	5.0	5.2	4.7
Male	7.4	7.7	7.1	7.3	7.0
Female	1.7	2.7	2.9	3.1	2.4
White and Other	-0.7	-0.7	-0.6	-0.6	-0.5
Male	0.1	-0.1	-0.3	-0.4	-0.3
Female	-1.4	-1.2	-0.9	-0.8	-0.7

Note: Based on demographic analysis with an assumption of 3 million undocumented residence in 1980, and corresponding amounts for 1970 and 1960.

Table 2
Estimates of Differential Undercount for 16 Cities from 1980 Post-Enumeration Program

	Series										Stan. Errors	
	2-8	2-9	3-8	3-9	5-8	5-9	3-20	10-8	14-8	14-9	2,3,14	5,10
Baltimore	4.7	4.6	4.4	4.3	2.9	2.8	4.8	2.4	4.2	4.0	1.7	1.7
Boston	-1.9	0.8	-2.0	0.7	-0.3	2.6	0.7	0.1	-4.3	-1.5	4.1	7.2
Chicago	2.5	3.9	3.4	4.8	2.1	3.6	4.9	1.8	-0.6	0.8	1.5	1.8
Cleveland	3.6	3.5	3.9	3.8	5.5	5.4	3.5	5.0	2.7	2.5	2.2	2.5
Dallas	5.9	6.7	4.9	5.7	3.0	3.9	5.8	3.0	-0.6	0.2	2.0	1.8
Detroit	2.2	2.8	2.1	2.7	1.9	2.5	3.1	0.4	1.4	2.0	2.3	1.8
Houston	3.7	4.3	3.6	4.2	6.4	7.0	4.7	5.2	-2.5	-1.8	2.6	2.8
Indianapolis	-0.8	-1.2	-1.2	-1.6	4.1	3.7	-1.8	2.9	-1.5	-2.0	2.1	2.7
Los Angeles	4.2	6.0	3.6	5.4	1.6	3.4	5.3	1.6	1.8	3.5	1.4	1.2
Milwaukee	2.1	1.7	2.1	1.7	0.3	-0.1	1.5	1.0	2.2	1.7	1.4	1.4
New York	5.3	5.9	5.0	5.6	1.5	2.1	5.8	1.7	1.8	2.3	1.2	1.0
Philadelphia	4.8	4.9	3.7	3.8	1.1	1.3	3.8	1.2	2.5	2.5	1.9	1.5
St. Louis	2.0	2.1	2.1	2.2	3.0	3.1	3.2	1.0	1.3	1.3	2.1	2.8
San Diego	-2.1	-1.0	-2.0	-0.9	-1.7	-0.6	-0.3	-0.9	-1.0	0.0	2.3	2.4
San Francisco	3.2	3.7	3.6	4.1	0.6	1.1	4.6	-0.8	1.0	1.4	2.9	1.9
Washington, D.C.	2.9	4.4	2.6	4.2	-1.2	0.4	5.0	-1.1	2.4	3.9	1.6	2.2

Table 3. Estimated Differential Undercount as Estimated by 1980 Post-Enumeration Program

Series	Black	Non-black Hispanic
2-8	5.0	3.6
3-8	4.7	3.5
2-9	5.8	4.3
3-9	5.5	4.2
14-9	2.8	1.7
2-20	5.9	4.2
3-20	5.7	4.2
14-20	3.0	1.7
5-8	2.8	4.9
10-8	2.5	3.4
5-9	3.6	5.7
14-8	2.1	1.0*
Approx s.e.		
(Sets 2,3,14)	0.6	0.8
(Sets 5,10)	0.6	1.0

* Not significant at 90% confidence level

Table 4: Decrease in observed expectation of life due to census undercount

	Age			
	Males		Females	
	0	65	0	65
Whites				
1980	.2	.0	.2	.2
1970	.3	.1	.4	.3
1960	.3	.1	.5	.4
Black & Other				
1980	.7	-.1	.2	.2
1970	1.5	-.1	.8	.4
1960	.9	-.6	.6	-.4

Table 5: Sex Ratio by Age Blacks, 1980

	Census	Estimated	Difference
20-24	91.4	97.5	-6.1
25-29	86.9	96.8	-9.9
35-44	83.1	95.8	-12.7
45-54	81.5	94.9	-13.4
55-64	80.6	87.6	-7.0

(U.S. Bureau of the Census, 1988)