BOOKS: STATISTICS

Do We Have to Count One by One?

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During my tenure as an employee of the U.S. Census Bureau, I wrote computer programs to address uncertainties in the proposed statistical adjustment of the 1990 census. At one point, a friend's father, who was a physics professor, asked me to describe my work. I explained that the unadjusted decennial census implicitly assumed that the attempted headcount was equally accurate everywhere, whereas the proposed adjustment assumed that the attempted headcount was equally accurate within broad population subgroups called poststrata. He promptly responded, "Oh, so it's like a first-order correction."

Who Counts? The Politics of Census-Taking in Contemporary America
by Margo J. Anderson and Stephen E. Fienberg
Russell Sage Foundation, New York, 1999. 329 pp. $32.50. ISBN 0-87154-256-0.

It comes as no surprise that a scientist, even one without special training in statistics, would immediately appreciate the logic of proposed census adjustments. For each of the last several U.S. censuses, members of minority groups have been missed about five percent more often than whites. Margo J. Anderson and Stephen E. Fienberg, in their new book *Who Counts?*, provide an important contribution to the ongoing discussion on how to address this persistent "differential undercount." Anderson is a social historian at the University of Wisconsin whose earlier work includes *The American Census: A Social History* (Yale University Press, New Haven, CT, 1988). Fienberg, a statistician at Carnegie Mellon University, has served on census review panels for the National Academy of Sciences and has testified in census litigation for the side favoring adjustments. The two have joined forces and achieved their goal of writing a narrative that provides context and perspective for future debates.

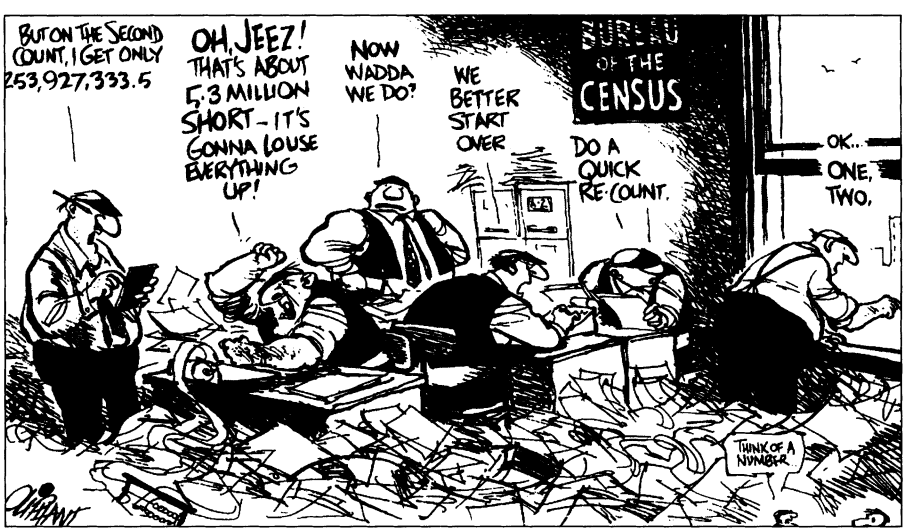
Who Counts? offers a fairly detailed description of the methodology for adjusting raw census data. It is aimed at an audience capable of understanding algebraic formulas but uninitiated in statistical methods for estimating the size of a mobile population. Although Anderson and Fienberg endeavor to be impartial, I would not expect any hard-core opponents of sampling-based adjustments to become converts upon reading this account. Nonetheless, their book should be widely read.

Basing their argument on equity considerations, Anderson and Fienberg present a strong case for why a society would want to perfect the art and science of census adjustment. I use the term "art" because the design of a post-enumeration survey, on which a statistical adjustment would be based, involves inherent trade-offs among bias, precision, and cost. In addition, the statistical model underlying any proposed adjustment involves inherent uncertainties. At a minimum, the model guides the definition of poststrata, but for the 1990 census it also included a number of complex statistical procedures.

These realities, along with the central role of the decennial census in apportioning political power as well as many billions of dollars in public funds, give rise to some fascinating questions at the intersection of science and public policy. Should an effort to count people ever resort to methods other than counting individuals one by one? Did the framers of the U.S. Constitution and Congresses past (who had the constitutional prerogative to "direct" the taking of the census) intend to allow the use of sophisticated statistical procedures to correct for differential undercount? If they did, who should decide whether to do so?

The authors provide a concise, yet richly informative, history of the census-adjustment controversy. Readers learn how, in contrast to the analogous figure for whites, the number of black males who registered for the armed services in the fall of 1940 far exceeded estimates based on the 1940 census. They learn how professional statisticians, both career employees of the Census Bureau and members of outside review panels, have overseen innovation in the census. They learn how large cities and other parties angered by disproportionate undercounts have aired their cases in the federal courts, which have taken their grievances seriously. And they learn how politics inevitably interacts with census-taking, because of the direct political implications of census results and because politicians have increasingly recognized that the jockeying for position on the next census begins early in the 10-year census cycle.

Anderson and Fienberg provide similarly concise and helpful reviews of dual-system estimation (the statistical method that underlies proposed sample-based adjustments) and of the political context of the debate over possible adjustments to the 1990 census. They describe the legal wrangling surrounding the 1990 Census, particularly the case of *City of New York, et al.* v. *U.S. Department of Commerce, et al.*, in which Fienberg testified. After considering expert testimony from both sides, a federal district court judge decided that, although he personally would probably have opted for adjustment, he could not find the decision against adjustment by then Secretary of Commerce Robert A. Mosbacher to be "arbitrary and capricious." A federal appeals court overruled this decision on a 2-1 vote, claiming that



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the standard for review should be whether the plaintiff's constitutional rights had been violated. The district court ruling, however, was reinstated by a 9-0 Supreme Court decision that supported the stronger arbitrary-and-capricious standard of review. In their critique of the Supreme Court opinion written by Chief Justice William Rehnquist, Anderson and Fienberg note inaccuracies in its discussion of statistical adjustment methods. Their comments serve as a good example of the colorful material in the book and provide a cautionary tale regarding the risk of leaving all decisions about census-taking to nonscientists.

The authors take aim at several "myths" about census adjustment, which they introduce in a prologue that is not easy to follow without knowing the scientific and political context. Their point is well taken, however, that many criticisms of statistical adjustments are based on misunderstandings or misrepresentations. Overall, the authors' short course in the facts and logic underlying adjustments succeeds in dispelling the myths they cite.

I noted two inaccuracies in Anderson and Fienberg's discussion of the debates over whether the proposed 1990 adjustment was appropriately specified in advance of conducting the post-enumeration survey. These may stem from an attempt to keep the text accessible to a lay audience. Clarifying the first point would require a more detailed treatment of advanced regression procedures than the authors provide, and clarifying the second point would require a more detailed consideration of the multistage cluster sample design of the post-enumeration survey.

Regression analysis refers to a family of statistical procedures for estimating the degree of association between an outcome variable of interest and one or more predictor variables. In the proposed 1990 adjustment, population counts in the various poststrata were to be multiplied by adjustment factors to correct for differential undercount. Specialized regression models (based on methodological innovations developed in the 1970s and 1980s) were used to "smooth out" variability in these factors. The basic idea was to take into account not only the best "point" estimates of adjustment factors but also how precisely each was estimated.

In an important contribution, Anderson and Fienberg discuss the role of mid-decade test censuses in the evaluation of new procedures. But because some mid-decade activities at the Census Bureau left no trail in the literature, the authors were apparently unaware of analyses of 1988 test census data that motivated "pre-smoothing" of variances before smoothing adjustment factors. Specifically, because large estimated undercounts were downweighted in regression models due to large associated variances, analyses without pre-smoothing of variances implied a massive shift of estimated undercount away from areas where it was observed, notably from minority to nonminority areas. The authors thus err in stating that smoothing was not specified in advance of the proposed 1990 adjustment. They correctly conclude, however, that the smoothing of variances led to a crisis in the spring of 1991. When variance smoothing was applied to the 1990 data, a previously unseen side effect of the method resulted in a few implausibly extreme undercounts. The Census Bureau thus was forced either to abandon the prespecification of adjustment procedures or to produce undercount estimates that lacked face validity. The bureau decided to implement a seemingly innocuous procedure for treating the few suspect poststrata as "outliers" whose variances would be left unsmoothed. Because this procedure was not specified before the census, it gave rise to understandable misgivings—even among those who judged the 1990 adjusted counts to be more accurate for states and congressional districts.

The authors do not discuss another technical problem arising from enumeration errors that affect many households at once, such as when an entire apartment building is missed in the census. In the proposed 1990 adjustment, a few such errors were downweighted using another procedure that had not been specified prior to the census.

Opponents of adjustment will understandably object to the limited attention the authors give to a processing error in the adjustment procedures that were proposed for the 1990 census. The error, which was discovered only after the decision not to adjust the census had been made, would have shifted a Congressional seat. Given the compressed time frame available for developing 1990 adjustment procedures, concern over possible undetected errors in the 1990 adjustment was justifiable. With increased institutional experience and the open review of procedures by outside panels that has been encouraged by senior Census Bureau officials, a similar processing error seems less likely to occur in the 2000 census, but the possibility remains.

One topic that I would have emphasized more is the sample-based adjustments that were incorporated in the 1970 census. Anderson and Fienberg mention the 1970 National Vacancy Check, which led to the reclassification of 8.5% of all units initially labeled as vacant and the addition of over a million people nationwide. The authors also mention the 1970 Post-Enumeration Post Office Check, a follow-up sample of addresses originally missed by the census enumerators, which added almost a half million people to the 16 southern states in which the program was implemented. Although these programs were not as extensive as the sample-based adjustments contemplated for 1990 and 2000, I believe that the precedent they established has been underappreciated.

Despite the Postal Service program being restricted to a region that helped Nixon win the 1968 election, it strains credulity to believe these were partisan efforts to favor some constituencies while cheating others. It is more plausible that these were genuine efforts to improve census coverage. The use of sample-based adjustments hardly raised an eyebrow at the time, but in 1976 Congress did change the legislation governing sampling in Census Bureau activities. Differences in interpreting that law gave rise to the 5-4 split in the January 1999 Supreme Court decision that prohibited the use of sample-based adjustments for Congressional apportionment. The authors conclude their narrative there, with a chapter entitled "The Saga Continues"—which it most certainly will.

Anderson and Fienberg deserve particular credit for their discussion of racial and ethnic classifications in the census, especially the recent modification that allows respondents to identify themselves as belonging to one or more ethnic categories. They note that, with conventional methods, reliable estimates of undercount rates require the definition of fairly sizable poststrata. Thus efforts to eliminate ethnic classification, or to block the grouping of individuals with similar demographic characteristics, conflict with efforts to correct for differential undercount. The authors provide an excellent treatment of this concern, and their book seems to be the first to address the issue.

Anderson and Fienberg omit a number of technical details in exchange for brevity and simplicity. But they successfully avoid inflammatory rhetoric and offer a wealth of insight. For those interested in understanding the historical and scientific context of the census adjustment controversy, *Who Counts?* is absolutely essential reading.