DEMOGRAPHIC ANALYSIS: AN EVALUATION
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The Census Bureau used three methods to determine the nation's population in 2000: the traditional headcount, the post-enumeration survey (Accuracy and Coverage Evaluation or A.C.E.), and Demographic Analysis (DA). The three estimates produced significantly different and confounding results. The divergence among the three — especially, the discrepancy between DA and the A.C.E. — is considered the primary reason the Census Bureau recommended against adjusting the 2000 Census.

What is Demographic Analysis?

DA is one of the two techniques used by the Census Bureau to measure coverage of Census 2000. DA involves first constructing an estimate of the population using demographic techniques applied to data from sources essentially independent of Census 2000. As described by the Census Bureau, the 2000 DA estimate is computed as:

$$P_{2000} = P_{1990} + B - D + I - E$$

or,

Estimated population at the Census 2000 date (P_{2000}) equals

Population at the 1990 Census date (P_{1990}) plus

Births during the interval (B) minus

Deaths during the interval (D) plus

Immigrants during the interval (I) minus

Emigrants during the interval (E).

For the 2000 adjustment decision, the Census Bureau constructed DA estimates for the Black and the non-Black populations by sex for four age groups. Then, the estimated net undercount (or overcount) from DA for a group is the difference between the DA estimate and the census count:

$$U_i = P_{i,\ 2000} - C_{i,\ 2000}$$

where,

Undercount for group i (U_i) equals

Estimated population in group i at the Census 2000 (Pi, 2000) minus

Census 2000 count for group i ($C_{i,\ 2000}$).

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[1] The views and opinions expressed are the authors' and do not necessarily represent nor should they be attributed to the Urban Institute, its staff, officers or trustees, or any organizations providing financial support.

Unlike survey-based measures of census coverage, DA does not measure components of census undercount, such as gross omissions and erroneous enumerations, but only the net undercount. In addition, when comparisons are made for subgroups of the population, the DA measure includes not only coverage errors, but also reporting and classification errors. Thus, the reported DA undercounts for race groups include, as part of the census "error," differences in race reporting between Census 2000 and the historical data used to construct the DA estimate. Similarly, for age groups, the reported DA undercounts include age misreporting as part of the error.

DA Estimation Methods for 2000. The DA estimates for 2000 consist of two main "pieces" — the population under age 65 and the population aged 65 and over. The estimates for the older group were constructed with data on the population enrolled in Medicare with a correction for underenrollment. For the population under age 65, the DA estimates begin with the DA estimates for the population under age 55 in 1990 and update the estimates with the following demographic components of population change between April 1, 1990 and April 1, 2000:

> Births, adjusted for underregistration (+);
>
> Deaths (-);
>
> Legal immigration, except refugees (+);
>
> Refugee arrivals (+);
>
> Emigration of legal foreign-born residents (-);
>
> Emigration of U.S. natives (-);
>
> Puerto Rican migration (+);
>
> Net change in temporary residents, i.e. nonimmigrants (+);
>
> Net undocumented immigration (+);
>
> Net civilian citizen migration, mainly government (+);
>
> Net change in Armed Forces overseas (-).

Most of these components employ the same data used for the Census Bureau's on-going national estimates program with updates and refinements. (See Robinson 2001b for a description of the DA methods and Robinson 2001c for estimates of the components.) For the preliminary DA estimates initially supplied by the Census Bureau (Robinson 2001a), the population aged 65 and over was estimated with the same component method as the younger group rather than adjusted Medicare data.

Although this description of methods focuses on the change since 1990, the underlying method is actually a good deal more complicated because the 1990 DA estimate is based on a considerable amount of historic demographic data. The DA estimate for ages 65 and over in 1990 is based on Medicare enrollments corrected for underregistration. For ages under 55 in 1990, the DA estimates begin with registered births for 1935–1990 corrected for underregistration using factors derived from birth registration tests conducted for 1940, 1950, and 1964–68. The corrected births are carried forward to 1990 with estimates of the same demographic components noted above covering the period from 1935 through 1990. The intermediate group, ages 55–64 in 1990 begins with corrected births from 1925–1935 for whites, the estimated 1960 population aged 25–34 for Blacks, and an interpolated population estimate in 1990 for the other races. Finally, for undocumented immigrants, an estimate

of the number of residing in the country in 1990 is added, rather than estimating this component for each time interval. (See Robinson et al. 1993.)

Historical Development of DA. Demographic estimates of net census undercount were first developed by the Census Bureau following the 1970 Census, for both the 1960 and 1970 Censuses (Siegel 1974). The methods paralleled those described above: (1) births corrected for underregistration from 1935 to 1970, carried forward with demographic components of change; (2) Medicare enrollments corrected for underregistration in 1970 for ages 65 and over, with "backward survival" to 1960 for ages 55 and over; and (3) estimates of the intermediate group aged 35–64 in 1970 using specialized demographic techniques.

Whereas the results from the birth registration tests of 1940 and 1950 had been used to evaluate census coverage for infants, there had not been a full demographic evaluation of census coverage prior to the 1970 Census. Several important developments aided Siegel's pioneering effort. First, the implementation of the Medicare program in the mid-1960s provided a means for measuring coverage of the population aged 65 and over without relying on historical demographic data from the 19th century and early 20th century, periods when the official U.S. data were incomplete in terms of both geographic and population coverage. Second, newly developed techniques of mathematical population modeling had been applied to historical data for whites (Coale and Zelnik 1963) and for Blacks (Coale and Rives 1973) to provide estimates of population and undercount through 1960 for persons born between 1905 and 1935 (ages 35–64 in 1970). Third, a new birth registration test (U.S. Bureau of the Census 1973) provided evidence to complete the series of births through 1970.

Several gaps remained in the demographic series, but these were deemed to be sufficiently small as to not affect the overall results. Specifically, there were no available measures of undocumented immigration nor were there reliable measures of emigration since the 1950s. However, both of these components were thought to be small and, further, were thought to approximately offset one another. Subsequent research proved those assumptions to be essentially correct.

Following the 1970 Census, Census Bureau demographers worked within the framework of the estimates developed by Siegel and introduced a number of improvements and refinements. In developing the estimates for the 1980 Census, Passel and Robinson were able to "backwards survive" the DA estimates to 1950 and 1940 (Fay et al. 1988). This work provided a consistent, integrated set of demographic population and undercount estimates for every census since 1940. With the complete series of estimates, Passel (1991) and Robinson et al. (1990) introduced some further corrections to estimates for Blacks born between 1935 and 1945.

In comparison with the estimates for the intermediate cohorts (i.e., born before 1935), the Medicare-based estimates for the elderly and the birth-based estimates for the younger age groups (born since 1935) are thought to be more reliable because they draw on more recent data and fewer mathematical models. The simple passage of time has lessened the importance of these middle age groups, limiting them to ages 45–64 in 1980, ages 55–64 in 1990, and eliminating the need for them entirely in 2000. In addition, further research and comparisons with the Medicare-based estimates permitted the substitution of estimates based on births for whites between 1925 and 1935 (Whelpton 1950) into the estimates for 1990.

The emergence of large-scale undocumented immigration in the 1970s greatly complicated DA because the assumption of offsetting emigration and undocumented immigration was no longer satisfactory. This component remains the most elusive and, with emigration, is at the heart of much of the

uncertainty surrounding DA estimates of coverage for recent censuses. The initial DA estimates undercount for 1980 showed no "measured" undercount in large part because DA assumed that there were no undocumented immigrants in the country or in the 1980 Census (Fay et al. 1988). Subsequent work by Warren and Passel (1987) showed that about *2 million undocumented immigrants* were included in the 1980 Census. Ultimately, the DA estimates for 1980 included about 3 million undocumented immigrants (Fay et al. 1988). As will be discussed below, the uncertainty in the estimate of this population for 1990 at 3.3 million (Robinson et al. 1993) and for 2000 remain the major issue in resolving the discrepancy between the DA and A.C.E. estimates for Census 2000.

Demographic Analysis Results

Historical Results for 1940–1990. Table 1 displays the DA estimates of census coverage for 1940 through 1990. The DA estimates show a steady pattern of improvement in census coverage from 1940 (5.4 percent net undercount) through 1980 (1.2 percent) but a worsening of coverage in 1990 (1.8 percent). The same pattern of change is apparent for both the minority Black population and the balance of the U.S. population (largely the majority white population). However, the difference in undercoverage between the Black and non-Black population shows no such trend; in fact, the 4.4 percentage point difference in coverage in the 1990 Census is the highest shown.

The series of undercount estimates from DA show other strong and persistent patterns over the series of six censuses. Undercount rates for males have been generally higher than for females. For Blacks, the male-female difference has been in the range of 4-6 percentage points; for non-Blacks, the difference was less than 1 percentage point through 1960 and has gradually widened to about 1.4 percentage points (Robinson et al. 1993: Table 2). For both groups, the principal source of the sex differentials is significantly higher undercount rates for adult males (roughly ages 25–64). Undercount rates for the youngest children (under age 5) tend to be high and did not experience any reduction from 1970 through 1990. For older children, each successive age group through 15–19 years has a lower undercount rate than the next younger one.

Preliminary Results for 2000. The initial DA estimate for 2000 showed a total population for the United States of 279.6 million. This figure was about 1.8 million *lower* than the census count of 281.4 million, implying an *overcount* of 0.65 percent. In other words, according to the DA estimate, Census 2000 counted more people than there were in the country. This result was inconsistent with the A.C.E. results which showed a total population of 284.7 million or an *undercount* of 3.3 million or 1.13 percent (Table 2). Both the A.C.E. and preliminary DA suggested a reduction in the undercount rate for the Black population. Further, according to both measures the difference in undercount rate between the Black and the non-Black populations was in the 1–2 percentage point range, a difference considerably smaller than in previous censuses.

The nature of the inconsistency between the A.C.E. and DA differs considerably from previous censuses. The Census Bureau has conducted coverage measurement surveys in conjunction with the censuses of 1950 through 1990 although none was as extensive as the A.C.E. Historically, the difference in measured undercount between DA and the coverage measurement surveys was not nearly as large as the difference between the preliminary DA results and A.C.E., generally only a few tenths of a percentage point, not almost 2 percentage points, and never approaching 5 million people. Further, the coverage measurement surveys tended to produce *lower* undercount estimates than DA, a pattern usually attributed to correlation bias in the surveys and/or their inability to reach all segments of the population. One pattern from previous studies did occur in 2000. The coverage measurement surveys in

the past have not found a significantly higher undercount rate for adult males than adult females, especially among the Black population — a persistent pattern in the DA estimates that is strongly supported by sex ratio analyses (Robinson et al. 1993). In the preliminary DA estimates for 2000, Black males aged 18–49 had an undercount rate almost 8 percentage points higher than Black females. In the A.C.E., the difference was only about 1 percentage point.

The Census Bureau's investigation of the A.C.E.-DA discrepancy has included studies of both DA and A.C.E.. Several indications in analysis of the DA results pointed toward problems in measuring some components of immigration, particularly undocumented immigration (Robinson 2001b). In addition, a smaller share of the difference may also be related to the adjustments for undercoverage in the Medicare data. Ultimately, the Census Bureau was unable to reconcile the difference of 5.1 million between the two estimates to its satisfaction. The low DA estimate proved to be a significant factor, perhaps the most significant factor, in the recommendation not to employ an adjustment based on the A.C.E.. Below are possible modifications to the DA estimates based on current research on measuring immigration. The results suggest that DA and A.C.E. are considerably more consistent with one another than the initial analyses suggest. Finally, some recommendations for future work at the Census Bureau are presented.

Strengths and Weaknesses of Demographic Analysis

Demographic Analysis does not merely measure census coverage. Rather, it provides a structured estimate of the U.S. population classified by age, sex, and race. Further, it provides this information at different points in time, not just the census date. Thus, if a discrepancy arises between the DA estimate and other measures or between DA and expected patterns, the inherent demographic structure both across time and across the population provides a means for assessing the source of the anomaly and either explaining or resolving it.

In contrast, coverage measurement surveys provide considerably more detail about census coverage, especially in terms of geographic variation, components of under- and overcounts, and for groups defined by social or economic rather than basic demographic characteristics. However, each coverage measurement survey is an entity unto itself. There is no necessity that results are consistent across space and time. (In fact, they tend not to be because of variations in survey operations and improvements in survey and matching methods.)

The demographic structure inherent in DA also means that some measures from DA are considerably more robust than equivalent measures from the census or A.C.E.. For example, the sex ratio in an age group (i.e., the ratio of males to females or males per 100 females), is a function of the sex ratio of the group at birth, changes since birth attributable to sex differences in mortality, and changes driven by migration. The sex ratio at birth varies little over time (and somewhat more across race groups). For young cohorts especially, mortality-induced changes in sex composition tend to be small and predictable in size and direction; the latter is true in general for all cohorts. Similarly, migration changes are limited by the magnitude and sex balance of migration. Thus, sex ratios from DA are relatively robust with respect to estimation problems. Further, differences between adjacent age groups are constrained to be small by the continuous nature of demographic change. These structural limitations make sex ratio analyses extremely useful in identifying both coverage differences in the census and potential measurement problems in the A.C.E. (See Passel 1993 for further discussion of these issues.)

The limitations of DA generally have to do with the ability to produce precise estimates, that is estimates with relatively small bands of error, rather than the ability to produce accurate or unbiased estimates. Because the ultimate purpose of DA is the assessment of census coverage, the DA estimates must conform to categories available in the census. Further, because it is the difference between the DA estimate and the census that is important, the potential error in the DA estimate must be smaller than this difference.

Demographers are generally able to produce estimates for any demographic group or any level of geography. For example, the Census Bureau produces monthly estimates of the U.S. population by age and sex for four major race groups (white, Black, American Indian and Alaska Native, and Asian or Pacific Islander) and for the Hispanic and non-Hispanic population. In addition, it produces annual estimates for states with the same demographic detail as well as annual population estimates for every county and almost all places in the country. Nonetheless, in producing estimates of census coverage with demographic techniques, the Census Bureau uses only two race groups — Black and non-Black — and produces only national estimates. This limitation is related to the ultimate purpose of the measurement, comparison with the census. The Census Bureau, thus, recognizes that estimating population for subnational levels of geography requires measuring internal migration and locating the destinations of immigrants, factors that generally have larger ranges of variation (and larger errors) than the potential undercounts. For alternative race groupings (beyond Black and non-Black), the estimates suffer from other measurement limitations (discussed below).

The Census Bureau has attempted to assess the degree of potential error in the DA estimates and to provide measures somewhat analogous to statistical confidence intervals. (See Robinson et al. 1993.) These measures have focused on the problems in measuring each of the various components of population change and the ability to reduce errors in measurement. As such, they have produced some useful results. However, the measures are limited. The lack of fully appropriate models of estimation error tends to produce intervals that are too narrow, thus, implying more precision in the DA estimates than may actually exist. On the other hand, none of the current models fully incorporate the robustness implied by demographic structures relating to age and sex composition. This factor works in the opposite direction and leads to intervals that are too wide, thus understating the precision in the demographic estimates.

Current and Future Limitations. Changes in the demographic composition of the U.S. population over the last generation have made the development of DA estimates of census coverage more difficult and introduced new limitations. Since the 1950s, the racial/ethnic composition of the country's population has changed considerably. In 1950, the United States was basically a "Black and white" country with the "majority" population (i.e. white non-Hispanic population) representing just under 90 percent of the population. Blacks were about 10 percent of the population and represented almost 90 percent of the racial/ethnic "minority" population (Passel and Edmonston 1994). By 2000, the white non-Hispanic population accounted for less than 70 percent of the population and Blacks represented only about 40 percent of the minority population. Aside from the measurement difficulties induced by these changes (discussed below), the compositional factors mean that the difference between Black and non-Black undercount rates, the central comparison available from DA, is no longer a comparison of the undercount of virtually all of the racial/ethnic minority population with the undercount of the majority population. In fact, according to the results from Census 2000, between 20 and 25 percent of the DA non-Black population consists of racial/ethnic minorities.

Changing definitions and conceptions of race and ethnicity together with increasing prevalence of marriage and childbearing across racial/ethnic lines has further complicated the construction and interpretation of DA estimates. Because DA uses historical data on births, deaths, and immigration, the categories of the estimates are limited by the available data. Further, comparisons with census figures must be for groupings that are the same or nearly the same; if the comparison groups are defined differently, then one component of the difference, and possibly a major component, is definitional change. Complicating such comparisons even more is the new method of collecting race data in Census 2000 which allows respondents to select more than one race, an option that was not available when the historical series of birth and death data were collected.

Intermarriage rates are particularly high for the Hispanic and American Indian populations with moderate levels in the Asian population (Edmonston et al. 2000). Further, intermarriage rates and multiracial childbearing for Blacks have increased considerably in the last 30 years. As recently as 1970, only about 1–2 percent of births with one Black parent had a non-Black parent; during the 1990s, this figure was in the 10–15 percent range. In Census 2000, almost 5 percent of respondents identifying as Black also gave another racial response. For DA, these patterns introduce a considerable amount of uncertainty as to whether individuals classified as Black in the historical statistics on births are identifying themselves as Black in Census 2000 and, conversely, whether the Black population as measured by Census 2000 is accurately represented by the historical time series. As difficult as these issues are for the Black population, they loom considerably larger in trying to measure census coverage of the American Indian and Asian populations with demographic techniques. In fact, application of DA to the American Indian population shows that most of the increase in the American Indian population between 1960 and 1990 was attributable to "non-demographic" factors such as individual changes in racial identity and classification (Passel 1996). In response to measurement problems such as these, the Census Bureau groups the American Indian and Asian populations together with whites in the DA estimates even though all of the requisite data on demographic components are produced for all of the race groups.

Measurement of the Hispanic population encounters similar difficulties but is further complicated by the fact that the definition of this group is separate from racial classifications. National data on the components of population change for Hispanics (e.g., births and deaths) are not complete until the 1980s. Consequently, a full demographic estimate is not possible for this group using the same methods as for race groups. An additional complication for DA is introduced by the response patterns of Hispanics to the race item in Census 2000. Almost 15 million Hispanics or more than 40 percent of the Hispanic population did not select one of the specific races listed but chose the "other" category. In historical vital statistics data, there is no such category. Thus, to make the census data consistent with the DA categories, it is necessary to "re-cast" or reclassify the census data. This reclassification involves not only choosing how to assign persons who gave more than one race response, but also how to assign specific races to the persons choosing "other" race. The choice of reclassification method can obviously have an impact on the measured undercount. For the DA comparison, the Census 2000 Black population is 37.1 million or about 700,000 persons more than the figure used for the A.C.E. comparison (Table 2). From a measurement perspective, none of the race classification issues is fatal. In particular, they have no impact on the measured population total (or the age-sex totals). They do, however, affect the race group comparisons by introducing more imprecision into the population estimates, the modified census totals, and the undercount measures. Further, by using reclassified census populations for DA, the undercount estimates from DA do not relate to any of the populations appearing in standard tabulations or publications.

Immigration in Demographic Analysis. The generational changes in the U.S. population noted above are related to substantial increases in the level of international migration and the origins of the migrants over the last three decades. Measuring immigration flows accurately and completely has become a critical factor in demographic analysis where it was not in 1970. According to the 1970 Census, there were fewer than 10 million immigrants living in the country, accounting for less than 5 percent of the U.S. population (Passel and Fix 2001); further, the foreign-born population had changed little since 1940, *decreasing* slightly. By 2000, the immigrant population had reached 30 million and represented about 11 percent of the population. Even more important for DA, the role of immigration in population change had grown substantially. The total number of births during the 1960s and the 1990s was about the same — just under 39 million registered in the 1960s versus a little over 40 million in the 1990s. However, the magnitude of immigration flows differed considerably. The 1970 Census included about 3 million immigrants who had arrived in the 1960s. In contrast, the Census 2000 Supplementary Sample (C2SS) has more than 13 million immigrants who arrived in the previous 10 years. Obviously, accurate measurement of immigration flows is much more critical to assessing the size (and composition) of the U.S. population in 2000 than it was when DA was first developed.

Further complications are introduced into DA by the nature of the immigration flows and the data available. By the 1990s, a significant portion of immigration was occurring outside of the normal process of admitting legal immigrants and refugees for permanent residence in the United States. The best known and most important aspect of this problem is undocumented immigration. According to the Census Bureau's estimates used in the preliminary DA, more than 25 percent of immigrants arriving during the 1990s were undocumented. This figure is clearly too low; from the data presented below, a better estimate would be 40 percent. Regardless of the exact figure, it is clear that this one component introduces a considerable amount of uncertainty and imprecision into the DA estimate. In contrast, the best available evidence suggests that virtually none of the immigrants enumerated in the 1970 Census were undocumented (Passel 1999).

Another less well-known measurement problem concerning immigration surrounds aliens admitted on a temporary basis for residence in the United States, known as "nonimmigrants" in the terminology of the Immigration and Naturalization Service (INS). The nonimmigrant population includes foreign students and various kinds of "guest workers" such as specialized technical workers (H-1B visas), intracompany transfers (L-1), and agricultural workers (H-2A). The number of nonimmigrant admissions and the resident nonimmigrant population have grown considerably during the last decade. Unfortunately, there is only a small amount of data on these groups and there are no "official" estimates of the number of residents made by any agency (Passel 1997). In the preliminary DA estimates, the Census Bureau allows for increases during the 1990s in the number of H-1B workers and the number of foreign students (F-1 visas), but omits a considerable number of legal temporary aliens, at least hundreds of thousands and possibly more.

Yet another complication relates to the assignment of immigrants to race groups. Most of the data on immigration comes from INS information on the number of legal immigrants admitted. These data are classified by country of birth, but not by race. The Census Bureau assigns the legal immigrants to race groups based on responses from the previous census or more recent data, if available. For other immigrant groups, similar procedures are used. Thus, not only are some of the immigration statistics quite old, they all suffer because the race classification is not based on responses from the immigrants themselves.

The difficulties surrounding measurement of immigration obviously have seriously affected the quality of the DA estimates. All of these issues affect the precision of the DA estimates because they introduce potential sources of error in classification. In addition, unlike many of the limitations noted above, problems related to measuring immigration can bias the DA estimates. In the case of the preliminary estimates, underestimation of immigration has led to underestimating the overall level of the undercount. Below, we assess the potential impact of this understatement.

Alternative Measures and Impact on Demographic Analysis

In its "Report of the Executive Steering Committee for Accuracy and Coverage Evaluation Policy (ESCAP)" and the supporting Memorandum B-4 on "Accuracy and Coverage Evaluation: Demographic Analysis Results" (Robinson 2001b), the Census Bureau focused its primary attention on the measure of undocumented immigration during the 1990s. Comparison of the DA components with research results on immigration flows strongly supports the view that the Census Bureau underestimated undocumented immigration during the decade, possibly by a substantial amount. In addition, there is direct as well as indirect evidence that the DA assumptions understated other immigration components, but to a lesser degree than undocumented immigration.

This section includes a discussion of the various immigration components and suggests corrections based on available research. In addition, some estimation issues on other components are presented. Correcting the estimate of net undocumented immigration during the 1990s increases the DA estimate by 2.6 million. Two other changes to the immigration components add another 750,000 to the DA estimate from the legal nonimmigrant or temporary immigration flow (500,000) and the entry of legalized farmworkers (250,000). In addition, there are indications that the estimate for the elderly population based on Medicare data adjusted for underregistration could be too low by 500,000. Taken together, these corrections add 3.9 million or possibly more to the DA estimate of the total population, bringing it to 283.5 million (Table 5). With these assumptions, DA shows an undercount of 2.1 million or 0.7 percent (Table 6). This estimate differs by about 1.2 million or only 0.4 percent from the A.C.E. estimate, a figure only slightly greater than the DA-PES difference in 1990.

Undocumented Immigration. The base DA estimate implicitly assumes that there are 6.1 million undocumented immigrants living in the United States as of April 1, 2000 — 3.3 million from the 1990 DA estimate plus a net increase during the 1990s of 2.8 million. The net increase, based on the work of Warren (1997), is extrapolated from trends for 1992–1996 and assumes an annual net increase of 281,000 for 1990-1992 and 275,000 for the rest of the decade (Robinson 2001b). In its report on DA, the Census Bureau produced an "alternative" DA estimate that arbitrarily doubled the increase in undocumented immigration during the 1990s (Robinson 2001b). This alternative figure produced population estimates that were more consistent with the A.C.E. results, but the Census Bureau did not adopt the alternative because it had not developed empirical evidence to support the higher figure. Although the Bureau's lower estimate of undocumented migration comported well with what had been a widely-accepted consensus on the "conventional wisdom" regarding the numbers of undocumented immigrants, at least through September or October 2000, *data available from several sources since then supports a significantly higher estimate.*

Residual Estimates of the Undocumented Population. Virtually all of the estimates of the size of the undocumented immigrant population currently available use some form of residual estimation. (See Passel 1999 for a discussion of the method and some examples. See also Bean et al. 2001 and Warren 2000 for variants.) This method basically involves making an estimate of legal foreign-born residents

and subtracting it from a measure of the total foreign-born population, usually measured with a survey or census. The difference (or residual) is treated as an estimate of the undocumented population. Variations on the method involve different definitions and computations for the legal population and assumptions regarding the coverage of the legal and undocumented populations in the census or survey.

The residual method employs data on the foreign-born population classified by country of birth and period of entry, and ideally by age and sex. Generally, the most detailed and best data for such estimates come from the decennial census itself. Since the sample data from Census 2000 will not be available until 2002, alternative data sources are necessary. The principal data now available for measuring undocumented migration come from the March Supplements to the Current Population Survey (CPS). For evaluating Census 2000, the March 2000 CPS Supplement has been available since October 2000. However, the March 2000 CPS is weighted to population estimates very similar to the preliminary DA estimates. As such, the survey does not adequately represent the population enumerated in Census 2000, particularly for the Hispanic and Asian populations that are immigrant-dominated. For purposes of measuring undocumented immigration, the population weights for the March 2000 CPS have been adjusted to agree with the appropriate population figures from Census 2000.[2]

Another useful data source is the Census 2000 Supplementary Survey (C2SS). C2SS is a 700,000 household survey that was conducted during 2000 using essentially the same questionnaire as Census 2000. This survey is weighted to agree with the household population from Census 2000 on a state-by-state basis. Because the C2SS sample is almost 15 times the size of the CPS, the age-sex-country detail from this survey is potentially a much better representation of the population than the CPS. Unfortunately, the C2SS data currently available outside the Census Bureau are quite limited — the foreign-born population by citizenship for states is cross-classified separately by period of entry and by region of birth, but not by both and not by country of birth. For the analysis presented here, the publicly-available data from C2SS are combined with tabulations from the re-weighted March 2000 CPS to provide more detailed data.

Estimates of Legal Residents. The legally-resident immigrant population for April 2000 is estimated by carrying forward the legally-resident population of March 1995 with demographic components of change.[3] This initial population is subdivided by 35 countries and regions of birth, six periods of entry (1990-1995, 1985–1989, 1980–1984, 1975–1979, 1970–1974, pre-1970), five-year age groups, and sex for the six largest immigrant states (California, New York, Texas, Florida, Illinois, New Jersey, and the balance of the country). New immigrants are added each year; the total is the number of refugee and parolee arrivals derived from Office of Refugee Resettlement (ORR) data plus the number of INS admissions of legal permanent residents, excluding those who have already been counted as refugees or parolees. INS data on date of arrival, state of intended residence, age, and sex by coun-

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[2] The Census Bureau reweighted the March 2000 CPS using Census 2000 data for its ESCAP evaluation (Robinson 2001a), but did not use it in re-estimating undocumented immigration flows. The Bureau did not release either the weights or the necessary tabulations until August 20, 2001 — too late to be used for this report. The analysis in this report is based on reweighting done according to Census Bureau specifications using approximations to the required population totals based on available data from Census 2000 and other Census Bureau estimates (Passel 2001a). Comparison of the approximation to the Census Bureau's weights shows that the two data sets are extremely close. The foreign-born populations differ by only 5,000 persons or about .02 percent% — 30.081 million from the Census Bureau versus the approximation of 30.087 million. Differences for specific countries and periods of entry also tend to be small in

[3] See Passel 1999 for a detailed description of the 1995 estimate and data used to develop it. Passel 2001b contains a more detailed description of the estimation techniques and components of change for 1995–2000.magnitude, but percentage differences are larger; none of the differences are substantively important for the estimates presented here.

try of birth are used to distribute the new arrivals across the demographic-geographic categories. Deaths are estimated for each year with race-specific life tables and emigration is estimated by applying a set of age-specific emigration rates derived from the work of Ahmed and Robinson (1994). Finally, movement of legal immigrants between states is estimated using in- and out-migration rates and the age distribution of interstate migrants derived from annual CPS data (Passel and Zimmermann 2001). The estimated legally-resident immigrant population in April 2000 is about 22 million (Table 3, row *d*).[4]

The next step in the estimation procedure is to determine the number of legal foreign-born residents who are represented in the surveys (March 2000 CPS, reweighted March 2000 CPS, C2SS). This step requires measuring or estimating the coverage of legal immigrants. Because there are no direct measures of coverage of immigrants, legal or otherwise, it is necessary to introduce some assumptions. The basic premise is that recently-arrived legal immigrants are more likely to be missed than the general population because of language difficulties, fear or discomfort of governmental contact, and less regular living conditions. (See also Bean et al. 2001) Accordingly, the undercount rates assumed for legal immigrants are a multiple of the appropriate age-sex-race specific undercount rates estimated from the 2000 A.C.E. for Hispanics, Blacks, whites, and Asian/Pacific Islanders combined.[5] Immigrants arriving in the 1990s are assumed to have undercount rates equal to 1.5 times the A.C.E. rates; those arriving in the 1980s are assigned the A.C.E. undercount rates. With these assumptions, immigrants arriving after the mid-1970s have an undercount of about 1.5 percent in the data systems (Table 3, row *e*).

Undocumented Immigrants Enumerated. The foreign-born population in the CPS or census includes three different populations: (1) enumerated legal residents, estimated with the methods described above; (2) enumerated legal temporary foreign-born residents or legal nonimmigrants; and (3) enumerated undocumented immigrants. The number of legal temporary residents enumerated is estimated by matching the characteristics of CPS respondents, such as date of arrival, occupation, and living arrangements with the legal requirements for various nonimmigrant visa categories (Passel and Clark 1998). Individuals in the CPS who appear to meet the admission criteria are assumed to be legal nonimmigrants. Based on these procedures, the March 2000 CPS is estimated to contain about 842,000 legal nonimmigrants and the reweighted March 2000 CPS, about 900,000 (Table 3, row *b*). These detailed methods cannot be applied to the C2SS yet, because the requisite public-use data on individuals have not been released. For the estimates presented here, the C2SS is assumed to contain somewhat more legal nonimmigrants than the CPS because of better outreach and housing unit coverage, or just over 1.0 million (Table 3).[6]

The number of undocumented immigrants represented in the CPS or C2SS is computed as the total foreign-born population from the survey minus the estimate of legal immigrants enumerated minus the estimate of legal temporary residents enumerated. For the March 2000 CPS, the

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[4] The estimates of legal foreign-born residents in 2000 differ for comparison with each data source. The component estimation procedure described in the text is used only for immigrants arriving after the mid-1970s. For earlier arrival cohorts, the number of legal residents in 2000 is assumed to be equal to the number in the survey. In other words, the procedure assumes that of immigrants who came to the country before the mid-1970s, none remains in an undocumented status in 2000.

[5] Rates for race groups are for non-Hispanics. Each country or region of birth is assigned rates for a race/Hispanic group based on the predominant race/Hispanic group in the CPS data.

[6] The C2SS figures for legal nonimmigrants are assumed to be 20 percent higher than the reweighted CPS for those entering from 1995–2000 and 10 percent higher for those entering before 1995. It is important to stress that these estimates are for legal nonimmigrants represented in the survey, not the total number in the country. For DA estimates of census coverage, the latter figures are required, however.

method yields an estimate of 5.9 million undocumented immigrants included in the survey. For the reweighted CPS, the estimate is considerably larger at 7.3 million. The reweighted estimate is 1.4 million larger because the overall foreign-born population is almost 1.7 million. Finally, the still larger foreign-born population in the C2SS yields an even larger estimate of undocumented immigrants enumerated in the survey — 7.9 million. In all of the various estimates, more than 50 percent of the enumerated undocumented immigrants are from Mexico (Table 3).

Total Undocumented Population and Change Since 1990. The procedures outlined to this point yield an estimate of the undocumented population in the CPS or C2SS, but the DA estimates require an estimate of the total number of undocumented immigrants in the United States, not just the number in the survey. To arrive at such an estimate, it is necessary to know what proportion of the undocumented population appears in the survey. Again, without direct measures of coverage for this group it is necessary to use indirect measures or assumptions based on other evidence. Recent studies (reported in Bean et al. 2001, Van Hook and Bean 1997) using data from Mexico and other sources, suggest that omission rates for undocumented immigrants are approximately three times that of legal immigrants. The estimates shown in Table 3 assume that undercount rates for undocumented immigrants entering in the 1990s are three times the corresponding rates for legal immigrants; for those entering in the 1980s, twice the rate of legal immigrants. For the CPS-based estimates, age-sex specific rates are computed with these assumptions; for the C2SS estimates, the period-specific rates from the CPS estimates are used because detailed information by age and sex is not available. These assumptions imply that 8–12 percent of undocumented immigrants are missed by the CPS and C2SS (Table 3, row *i*).

From the C2SS, these methods yield an estimate of 8.6 million undocumented immigrants in the United States. From the CPS, the estimates are lower — 6.6 million from the March 2000 CPS and 8.3 million from the reweighted CPS. Both the reweighted CPS and C2SS yield estimates that are considerably higher than the estimate implied by DA of 6.1 million.

The component actually used in the DA estimates is "change in the undocumented population since 1990," so the estimated undocumented population in 1990 of 3.3 million (Woodrow 1991) must be subtracted from the estimates for 2000. For the "base DA" estimates, the Census Bureau incorporated estimated change of just less than 2.8 million people. The C2SS estimates imply almost twice as much change in the undocumented population during the decade or 5.3 million and the reweighted CPS implies 5.0 million.

Refinement of the DA estimates for the undocumented immigration component also requires changing the age-sex structure of "net undocumented immigration." The figures used in DA assume that the age-sex distribution of undocumented immigrants is the same as "persons who acquired legal status under the provisions of the Immigration Reform and Control Act (IRCA)" of 1986 (Robinson 2001b). While this is a reasonable assumption for the characteristics of *undocumented immigrants entering the country,* it fails to recognize the demographic properties of the actual DA component. The DA component should represent *change in the undocumented population,* not the number of new undocumented immigrants. As undocumented immigrants get older, many either leave the United States, die, or transition to the legal immigrant population. All of these demographic changes should be included in the DA component conceptually, but are omitted from the actual DA component. The correct basis for estimating the DA component is to take the difference in the estimates undocumented immigrant population at two points in time on an age-by-age basis. Table 4 shows the results of such a calculation based on the estimated undocumented immigrant population for 2000. Even if the

level of change incorporated in DA were maintained, the appropriate estimation methodology yields a substantially larger change for the groups aged 18–29 years in 2000 and much smaller changes for ages 30–49 years and 50 years and over; in fact, for the oldest age group, the change in the undocumented population should be negative. These changes bring both the DA estimates and the Census Bureau's postcensal estimates more in line with the Census 2000 and A.C.E. results by reducing the extremely large shortfall in the estimates at young adult ages for Hispanics (Robinson 2001b).

While it is likely that a full analysis of the long-form data from Census 2000 will yield better estimates of the undocumented population than either the CPS or the C2SS, there is no reason not to incorporate these new results into DA since they are based on empirical analysis of data through the year 2000 whereas DA assumptions are extrapolations based on data through 1996 only. ***Incorporation of the C2SS-based estimate into DA reduces the discrepancy between DA and A.C.E. by about half.***

Temporary Migrants. There is a large, but unknown number of foreign-born persons living in the United States legally with temporary visas. According to the residence rules used in the census, many of these individuals should be enumerated in the census and, in fact, many are. For DA, it is necessary to determine which categories of nonimmigrants are to be considered U.S. residents and estimate the number in the country for each category. The DA estimates for 2000 incorporate 1990–2000 change for two large groups of nonimmigrants — foreign students (F-1 visa holders) and the "hi-tech guest workers" (or H1-B visa holders). Both groups grew substantially during the 1990s and the DA estimates incorporate estimated change of 374,000.[7]

While these estimates seem accurate, they omit a number of potentially significant categories. The major categories of nonimmigrants which could possibly account for a significant number of U.S. residents include:

A (foreign diplomatic personnel)

E (treaty traders & investors)

G (international organizations or foreign governments)

 H-1A (registered nurses)

 H-2 (temporary workers)

 J-1 (exchange visitors, including)

  Physicians

  Scholars

  Au pairs

  Exchange students

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[7] The estimates for foreign students are based on data from the Institute of International Education (2001) and for H-1B visa holders on the work of Lowell (2000).

L-1 (intracompany transfers)

N (NATO workers)

O-1 (workers with extraordinary ability or achievement)

P-1 (internationally recognized athletes or entertainers)

Q-1 (cultural exchange)

R-1 (religious workers)

T (NAFTA workers)

Dependents of principals in these and other various visa categories

One indicator of growth is the increasing number of admissions of nonimmigrants. Between 1990 and 1998, *annual* admissions other than tourists, students, and H-1B's grew by 75 percent from 750,000 to 1.3 million. A basic problem in estimating the nonimmigrant population is that while INS counts admissions by visa category, it does not keep track of departures from the country, transitions to other categories, or multiple arrivals of the same individual.

There are no widely-accepted estimates of nonimmigrants or techniques for developing them. One possible approach uses INS information on duration of stay of departing nonimmigrants (INS 1996) to translate the arrival data into estimates of the number of nonimmigrants residing in the U.S. long enough to be considered U.S. residents for census purposes (generally 6 months or more). Applying the proportions of these longer-term stays from the INS study to admissions for 1990 and 1998 and then extrapolating to 2000 yields an estimate of approximately 500,000 additional U.S. residents in 2000 beyond the DA assumptions. More up-to-date and more detailed data might yield different estimates, but the base DA assumption of no change in the nonimmigrant population since 1990 other than students and H-1B workers is clearly too low and larger numbers should be incorporated into the DA estimate.

In addition to the proposed revisions for additional *change* in the nonimmigrant population between 1990 and 2000, it is possible that the estimate of the resident nonimmigrant population in 1990, the base for the 2000 DA estimate, is too low. To derive the total number of nonimmigrants residing in the country in 1990, the Bureau apparently used the work of Word (1995) who estimated that the 1990 Census included approximately 450,000 legal nonimmigrants. As an estimate of the total resident nonimmigrant population, this figure could be low by several hundred thousand, because it represents those counted in the census. If this is indeed the source of the DA estimate for 1990, then both the 1990 and 2000 DA estimates would need to be increased. The alternative DA estimates presented below do not deal with this component because the evidence supporting a revision is not compelling enough to warrant an increase in the estimate at this.

Legal Immigration and Emigration. Every one of the components of immigration poses measurement problems for DA, but net undocumented immigration and legal temporary residents appear to be the ones with the largest measurement problems during the 1990s. There are two others that bear mentioning, however: legal emigration and another that the Census Bureau has not included in its estimates at all, movement of persons admitted for residence but not living in the United States. The lat-

ter is particularly problematic for base DA estimates. Research conducted by Mexican and U.S. demographers for the Mexico-United States Binational Migration Study showed that the number of Mexicans living in the United States as legal residents increased during the 1990s more than indicated by data on legal admissions. (See Bean et al. 2001.) This increase occurred because many Mexicans who were granted the right to become legal U.S. residents as a result of the Immigration Reform and Control Act of 1986 actually lived in Mexico when they acquired legal U.S. residency. This phenomenon was especially prevalent among the special agricultural workers (SAWs) who did not have to prove that they had *lived* in the United States, but merely had to show that they had *worked* in U.S. agriculture for 90 days to acquire temporary legal status. Approximately 900,000 of the 1.1 million SAWs who eventually acquired legal status were from Mexico.[8]

For the residual estimates, what is required is an estimate of the number of SAWs residing legally in the United States at the time of the estimate. Without firm data, many analysts employed a range of assumptions for this group and most assumed that a significant fraction of the Mexican SAWs, possibly as many as half of them, did not live in the United States in the late 1980s or early 1990s (e.g., Woodrow 1991; Woodrow and Passel 1990; Clark et al. 1994). More recently, studies conducted in Mexico have supplied more definitive information on SAWs, specifically the number living in Mexico and, by extension, the number living in the United States. Bean et al. (2001) place the number of Mexican SAWs in the U.S. in the mid-1990s at 580,000–690,000. These figures imply larger numbers than were included in the DA estimates for 1990 (Woodrow 1991). This increase is not accounted for in any of the other components of DA. Thus, the DA estimates for 2000 are too low by the increase in the number of Mexican SAWs residing in the United States since 1990; there should include an allowance for this component in DA. The available evidence puts this increase at about 250,000 for the decade of the 1990s.[9]

The DA estimates of legal emigration are computed by multiplying a set of age-specific emigration rates times the estimated legal foreign-born population. The emigration rates used are derived from the work of Ahmed and Robinson (1994) for the 1980s. This method, then, assumes implicitly that the rate of emigration from the U.S. for legal immigrants remained the same during the 1980s and the 1990s. Evidence to validate this assumption is essentially lacking. However, given the very strong U.S. economy of the mid-to-late 1990s and the indications of increased attractiveness of the U.S., as evidenced by the greatly increased level of undocumented immigration, it would seem reasonable that emigration rates could have *decreased* during the 1990s. A decrease in the estimate of emigration leads to an increase in the DA estimate of the population. If emigration rates during the 1990s were only 10 percent less than in the 1980s, then the DA estimate in 2000 would increase by 270,000. Because of the more speculative nature of potential changes in the emigration component, they are not incorporated in the illustrative revised DA estimates shown below.

Medicare. The base DA estimate for the population aged 65 and over in 2000 (34.5 million) is almost 600,000 or 1.7 percent less than the estimate the Census Bureau obtained by carrying forward the 1990 population aged 55 and over with demographic components of change (Robinson 2001a, 2001c). This demographic method is used for all groups below age 65 in 2000, but the elderly population is estimated for the base DA by adjusting the number of persons enrolled in Medicare for underenroll-

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[8]   As an indicator that many SAWs were not U.S. residents when they applied, more than 100,000 of the Mexican SAWs applied for legal status at the U.S.-Mexico border after coming from the interior of Mexico.

[9]   This component was also included in the new residual estimates of undocumented immigrants. If fewer SAWs are assumed to be in the United States, then the revised estimates of undocumented immigrants would be larger by roughly the same amount.

ment. The available data and information supplied by the Census Bureau do not permit a detailed, thorough review of this adjustment. However, part of the underenrollment is the newly-arrived immigrants who are not eligible for Medicare. It seems very possible that the adjustment for Medicare underenrollment could be slightly higher than the Census Bureau employs. This component clearly warrants further investigation. In the illustrative estimates shown in the next section, the previous Census Bureau estimates based on components (Robinson 2001a) are used, in part, because more demographic detail on race and ethnic origin is available for them.

In terms of size, the most important demographic components of change for the 1990s are births and deaths; for the full DA estimates, these same two components prior to 1990 are also the largest. Rather small percentage revisions in these components could thus translate into larger changes than those discussed above. However, the historical data on births and deaths have been analyzed in detail several times and are less problematic. Accordingly, no changes to these components are incorporated into our illustrative estimates, but continuing attention to them is clearly warranted.

Comparison with A.C.E. Results. It is very difficult to compare DA with the A.C.E. results under the best of circumstances. The two sets of data use different definitions of race groups and refer to different populations — A.C.E. to the household population and DA to the total population. Further, some of the data needed to try to align the two datasets have not been released by the Census Bureau.[10] Nonetheless, it is possible to piece together some comparisons from the available data. DA estimates for the Hispanic population and the non-Hispanic Black population were computed by updating the 1990 DA population to 2000 using the base DA components supplied by the Census Bureau in detailed age, sex, detailed race, and Hispanic categories (Robinson 2001c).[11] The A.C.E. estimates of both the adjusted and unadjusted household population were added to figures from Census 2000 for the group quarters population[12] to develop population and undercount figures by age, sex, and race/ethnic group using the A.C.E. definitions. For these versions of DA, A.C.E., and Census 2000, the definitions of the Hispanic population, the non-Hispanic Black population, and the balance of the population are sufficiently close that the results can be readily compared.

From the base DA population (incorporating the component estimate for ages 65 and over), a "revised DA" figure was developed by adding the additional undocumented immigration estimated using the C2SS data, the additional change in legal nonimmigrants, and the extra population from migration of SAWs into the United States. With the revisions, the new DA estimate for the total population in 2000 is 283.5 million, implying an undercount of 2.1 million (Tables 5 and 6). The new DA population is substantially closer to the A.C.E. population of 284.6 million than the Base DA population — only 1.2 million less rather than 4.5 million less.[13] The revised DA undercount rate of 0.7 percent is only 0.4 percentage points less than the A.C.E. rate of 1.1 percent.

As can be seen in the table below and in Table 6, the revised DA estimates agree fairly closely with the level and pattern of the A.C.E. estimates. The highest undercount rates in both are for the Hispanic population with non-Hispanic Blacks significantly higher than the balance of the population but lower

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[10] Examples include the group quarters population classified according to the A.C.E. race/ethnic groups and fully detailed demographic estimates of the Hispanic population consistent with the DA estimates

[11] The 1990 population carried forward to 2000 for these modified DA estimates incorporates the results for race/Hispanic groups from the 1990 PES while retaining the population totals from the basic 1990 DA estimates for Blacks and non-Blacks by age and sex.

[12] Some approximations were required to convert the race and Hispanic groups as tabulated into the groups used in A.C.E., but these were small.

[13] The true "base DA" from Robinson (2001b) is 5 million less than the A.C.E. because it uses the adjusted Medicare estimates for the elderly.

than the Hispanic population. The differences across groups are larger in the revised DA, with the DA undercount rate (and population estimate) for Hispanics exceeding the A.C.E. estimate.

Percent Undercount

Group	Base DA	Revised DA	A.C.E.	Revised Diff.
Total	-0.4	0.7	1.1	0.4
Black, not Hispanic	1.9	1.9	2.1	0.1
Hispanic	-3.8	3.6	2.8	-0.8
Balance of population	-0.3	0.0	0.7	0.7

Source: Table 6

The major effect of the suggested revisions to DA is a substantial increase in the estimated Hispanic population. The addition of 2.6 million Hispanics to the DA estimate converts the base DA estimated *over*count of 3.8 percent into an estimated *under*count of 3.6 percent. In addition, the Base DA versus A.C.E. difference for Hispanic males is reduced from 9.3 percentage points to 0.2 percentage points.

While the revised DA estimates are much closer to the A.C.E. than were the original DA estimates for the total population and for race/ethnic totals, the two sets of estimates still do not give the same picture of sex differences in coverage. The DA estimates tend to show much greater percentage point differences in male and female coverage rates within each race/ethnic group than do the A.C.E. estimates. For non-Hispanic Blacks, the revised DA estimates show a 4.9 percentage point difference in coverage for the sexes (4.5 percent undercount for males versus 0.4 percent overcount for females), whereas the A.C.E. estimates show only a 0.6 percentage point difference. For the non-Black non-Hispanic population, the revised DA shows a sex differential of 1.9 percentage points and the A.C.E., a 0.6 percentage point difference. For Hispanics, the direction is reversed with DA showing a 0.5 percentage point difference and the A.C.E., 1.7 percentage points.

The revised DA estimates bring the A.C.E. and DA figures into approximate agreement as to the amount of undercount and the race/ethnic differences. The two systems should not be expected to give exactly the same estimates of coverage and, indeed, demographic analysis and survey estimates of coverage have always shown some difference in the United States. The principal area of disagreement remaining between the two estimates is the sex difference in undercount. This pattern is quite similar to the results for 1990 comparisons of DA with the 1990 post-enumeration survey (PES) and for 1980 comparisons. A more detailed assessment of the DA components, including more refined estimates of undocumented immigration, a fuller assessment of the nonimmigrant population, and further study of foreign-born emigration would probably bring the two sets of estimates into even closer alignment for 2000, but such work is beyond the scope of this study.

Conclusion and Recommendations for the Future of Demographic Analysis

Two broad, related trends in American society over the past generation or so have made the application of demographic analysis to measuring census coverage considerably more difficult and severely

limited its utility. The rise of large-scale immigration and the emergence of undocumented immigration as a significant factor in population change have greatly increased the problems in accurately measuring the size of the U.S. population. Related to the first trend is the substantial increase in the size of the racial/ethnic minority population, particularly the portion that is not Black. With the current DA methods limited to producing estimates of coverage for the Black and non-Black populations, the utility of DA is severely circumscribed.

Individual identification with a single race/ethnic group in the United States has lessened due to increasing rates of intermarriage. The racial/ethnic changes brought about by immigration and intermarriage have blurred the linkage of historical data (from both census and non-census sources) with contemporary census race/ethnic categories. This blurring is further exacerbated by changes in collection methods permitting multiple responses to the census race question. Accordingly, the interpretation of even the existing DA estimates has become more problematic as the reference population requires the construction of race categories increasingly more removed from the collection and tabulation categories used in census data.

As a consequence of these trends, even improved DA estimates (along the lines recommended below) will suffer from serious limitations. Nonetheless, DA should remain an essential part of any census evaluation program. The age and sex structure of the population can be specified with high precision using DA. Thus, DA can be used to judge the quality of both the census data and results from coverage measurement studies, such as A.C.E. However, race estimates from DA are likely to become even more imprecise in the future as immigration, intermarriage, and changing individual identification continue. But, DA estimates can be used as guides to the changes that are occurring and to the quality of census and survey data.

Expansion of DA to groups other than Blacks would enhance the utility of the data. However, given the increased imprecision in measuring race and ethnicity caused by the changing nature of American society, the race/ethnic-specific estimates from DA for future censuses should probably not be held to the same standards as coverage measurement surveys. Disagreements between DA and the surveys in terms of relative coverage of race/ethnic groups would need to be "explained" in demographic or sociological terms, but failure to agree should not be treated as prima facie evidence that coverage has not been adequately measured or that adjustment is not warranted.

Measurement of Immigration. The failure of DA to incorporate estimates of immigration based on the best available information — estimates of undocumented immigration consistent with measures from the reweighted CPS, nonimmigrants from all categories based on INS data, and increased SAW populations — changed the nature of the ESCAP decision on adjustment. Had the "base DA" estimate been 2.1 million greater than the census rather than 1.8 million less and had it been only 1.2 million below the A.C.E. rather than 5 million, there would have been more attention to the A.C.E, more attention to the areas of agreement rather than disagreement between the two measures, and more attention to the potential deficiencies in Census 2000 itself.

The problems with measuring immigration in DA relate directly to the Census Bureau's national population estimates. The Census Bureau's measures of undocumented immigration and nonimmigrants during the 1990s were drawn entirely from outside the agency. It is essential that the Census Bureau develop greater capacity to measure immigration. More attention needs to be paid to developing current estimates of undocumented immigration and to measuring changes in the flow. Although data and methods have improved recently, the available methods remain somewhat limited, but promising

approaches are under investigation. However, virtually none of the current research is being done at the Census Bureau. Greater focus on this topic from the Census Bureau with its own staff and in cooperative efforts with outside researchers could greatly improve the Bureau's ability to measure undocumented immigration and various other components of immigration.

The nonimmigrant population has also increased in numerical importance. It has proved difficult to measure, but the Census Bureau has devoted almost no attention to this component. Here again, more research is required. Increasingly, changes in immigration laws and regulations have affected the flows of people into the country and changed the size and composition of the U.S. resident population. During the 1990s, modifications to the Census Bureau's estimates resulting from such changes were serendipitous rather than the result of careful planning and investigation of data and methods. It is essential that the Census Bureau develop the capacity to monitor changes in immigration laws and regulations for their potential effect on the U.S. population. Attention to all aspects of immigration should become a regular part of the estimates program together with an on-going research program to incorporate regulatory and legislative changes national and subnational population estimates.

Race and Hispanic Origin. The measurement of race in Census 2000 and other data systems, as directed by the Office of Management and Budget, represents a historic disjuncture for the country. The explicit recognition of persons identifying with more than one race group is a reflection of the current demographic reality in the United States and permits the census to better capture the characteristics of the population. However, the new categories and data do not fit neatly into the categories used in historical data, both from previous censuses and non-census sources. As a consequence, the DA estimates for race/ethnic groups should be considered only as approximations to the contemporary census data, at best. The current approach of DA has been to re-cast the census data into historical categories. This approach is certainly reasonable and is probably the simplest to implement. However, it limits the interpretation of DA results because they do not relate clearly to categories of data as collected and published.

The Census Bureau needs to devote more research to developing methods to "map" historical data for race/ethnic categories into the current ones. This approach will require developing more historical data on intermarriage patterns than currently exists. Further, it also requires study of response patterns to the race and Hispanic origin items on the part of persons with multiple backgrounds. The Bureau is currently pursuing such research, but it must be integrated into the population estimates and DA programs.

The Census Bureau should also devote more attention to developing DA estimates for more detailed race/ethnic categories (i.e., other than Black). Such estimates are likely to be considerably less precise than the estimates for Blacks, probably too imprecise to be used for census adjustment. Nonetheless, such estimates should be an integral part of the demographic assessment of every census and should enter adjustment decisions in at least an advisory role.

Table 1. Demographic Analysis Estimates of Percent Net Census Undercount, by Race, for the United States: 1940–1990

Race	1990	1980	1970	1960	1950	1940
Total	1.8	1.2	2.7	3.1	4.1	5.4
Black	5.7	4.5	6.5	6.6	7.5	8.4
Not Black	1.3	0.8	2.2	2.7	3.8	5.0
Black-Not Black Difference	4.4	3.7	4.3	3.9	3.6	3.4

Source: Table 2, Robinson et al.1993.

Table 2. Population and Percent Net Census Undercount, by Race According to Alternative Measures, for the United States: 2000

Race and Measure	Census 2000	Preliminary DA (Base)	A.C.E.*
Total population**	281.4	279.6	284.7
Undercount	—	-1.8	3.3
Pct. Undercount	—	-0.65%	1.15%
Black (tabulated)	36.4	—	37.2
Black (modified)	37.1	37.5	—
Undercount	—	0.3	0.8
Pct. Undercount	—	0.93%	2.08%
Not Black (tabulated)	245.0	—	247.5
Not Black (modified)	244.3	242.1	—
Undercount	—	-2.2	2.5
Pct. Undercount	—	-0.90%	1.01%
Black-Not Black			
Difference	—	1.83%	1.07%

Source: Appendix Table 2, Robinson 2001b.

Notes:
** All populations in millions.
* Figures for A.C.E. include groups quarters population from Census 2000 and assume, in effect, that the group quarters population was enumerated without error. Census populations by race differ because of the treatment of persons who marked the "other race" category. For the DA comparison, these persons are reassigned to a specific race category (including Black) for consistency with the historical demographic data used to construct the DA estimates. For the A.C.E. comparison, these persons are grouped with the non-Hispanic white category, part of the "Not Black" category in the table.Table 3. Components of estimates of undocumented immigrant population based on different data sources, for the all undocumented immigrants and those born in Mexico: 2000

Table 3. Components of Estimates of Undocumented Immigrant Population Based on Different Data Sources, For All Undocumented Immigrants and Those Born in Mexico: 2000

Population (in thousands)	All countries of birth			Born in Mexico			
	March CPS	Rewgtd. CPS	C2SS	March CPS	Rewgtd. CPS	C2SS	
Total Foreign-born in census/survey	28,381	30,088	30,523	7,841	8,388	8,774	*a*
Legal Nonimmigrants in census/survey	842	898	1,026	23	27	32	*b*
Total Immigrants in census/survey	27,539	29,191	29,497	7,818	8,361	8,743	*c=a-b*
Estimated Total Legal Immigrants	21,878	22,081	21,791	4,642	4,648	4,511	*d*
Undercount for Post-1970s Percent	1.5%	1.5%	1.4%	2.1%	2.1%	1.9%	*e*
Amount	229	229	214	68	68	61	*f=e*d*
Estimated Legal Immigrants in census/survey	21,649	21,852	21,577	4,574	4,581	4,451	*g=d-f*
Enumerated Undocumented in census/survey	5,890	7,339	7,920	3,244	3,780	4,292	*h=c-g*
Percent Undercount for Undocumented	10.5%	11.8%	8.4%	10.1%	15.3%	10.4%	*i*
Total Undocumented Immigrants	6,581	8,323	8,650	3,608	4,462	4,789	*j=h/(1-i)*

Notes:

See text and Passel 2001b for methods. All computations carried out for detailed groups — 35 countries and regions by age, sex, and period for legal immigrants and CPS data; 8 regions and Mexico by period for C2SS.

b. Based on methods from Passel and Clark (1998). C2SS assumed to have 20% better coverage for 1995–2000 entrants and 10% for 1990–1995 entrants.

d. Estimates of immigrants entering before the mid-1970s come from census or survey.

e. Assumed undercount rates: 150% of A.C.E. rates for 1990s entrants; 100% for 1980s entrants; 50% for late 1970s; none for earlier. Rates from reweighted CPS applied to C2SS.

i. Assumed undercount rates: 1990s entrants — 3 times rates for corresponding legals; 1980s entrants — 2 times; 1970s entrants — 1 times. Rates from reweighted CPS applied to C2SS.

Source: Passel 2001b.

Table 4. Alternative Estimates of Change in the Undocumented Population, for the United States: 1990 to 2000 (in thousands)

Sex and Age in 2000	Change Based on C2SS	Preliminary DA (Base)	DA Total with C2SS Distribution	Difference: Adjusted DA minus Base
Both sexes, total	5,317	2,765	2,765	0
Under 18 years	1,231	576	640	64
18-29 years	3,318	1,207	1,726	519
30-49 years	1,065	844	554	-290
50 years and over	-297	139	-154	-293
Males, total	3,171	1,453	1,649	196
Under 18 years	707	287	368	80
18-29 years	2,062	675	1,072	397
30-49 years	479	434	249	-185
50 years and over	-77	56	-40	-96
Females, total	2,147	1,312	1,116	-196
Under 18 years	524	289	272	-16
18-29 years	1,256	531	653	122
30-49 years	586	410	305	-105
50 years and over	-219	83	-114	-197

Source: Demographic estimates — data supplied by Census Bureau (Robinson 2001c);
C2SS estimates — derived from Passel 2001b.

Table 5. Suggested Modifications to "Base" Demographic Analysis Estimate, A.C.E., and Census 2000, by Sex and Race/Ethnicity (in millions)

Sex and Race/ Hispanic	Base DA (Mod.)	Revised Undoc. Change	Revised Nonimm. & SAWs	Revised DA	A.C.E.	Census (unadj.)
Total	280.2	2.6	0.7	*283.5*	284.6	281.4
Male	138.2	1.7	0.5	*140.5*	140.1	138.0
Female	141.9	0.8	0.2	*143.0*	144.5	143.4
Black*	35.8	0.0	0.0	*35.8*	35.9	35.1
Male	17.4	0.0	0.0	*17.4*	17.1	16.7
Female	18.4	0.0	0.0	*18.4*	18.8	18.5
Hispanic	34.0	2.3	0.3	*36.6*	36.3	35.3
Male	17.2	1.4	0.3	*18.9*	18.8	18.2
Female	16.8	0.8	0.1	*17.7*	17.4	17.1
Balance**	210.4	0.3	0.4	*211.1*	212.5	211.0
Male	103.6	0.3	0.3	*104.2*	104.2	103.2
Female	106.8	0.0	0.1	*106.9*	108.3	107.8

Notes and sources:
  * Not Hispanic.
  * Non-Hispanic, non-Black population.

"Base DA" population uses component estimates for all ages. Under 65 is identical to "Base DA" from ESCAP supporting report (Robinson 2001b); 65 and over uses preliminary components from Robinson 2001a.

"Revised Undocumented Change" is the difference between the estimates of change in the undocumented population from 1990 to 2000 based on the C2SS analysis and the "Base DA" estimate of change. See Table 4 and text.

"Revised Nonimmigrants and SAWs" includes the additional 491,000 estimates change in legal temporary residents other than students and H-1B's plus the additional 250,000 movement of SAWs into the country. See text for explanation.

"Revised DA" equals the Base DA plus the two revised components. The Hispanic estimate from DA uses the adjusted 1990 population plus components of change from Robinson (2001c).

"A.C.E." is the estimated (adjusted) household population from A.C.E. plus the unadjusted group quarters population. The Black, not Hispanic population includes persons responding to the race question as Black either alone or in combination with other race groups. The Hispanic population excludes American Indians, as defined by A.C.E.

"Census 2000 (unadjusted)" is the unadjusted A.C.E. household population plus the unadjusted group quarters population.

Table 6. Amount and Percent Net Census Undercount based on "Base" Demographic Analysis, A.C.E., and Modified Demographic Analysis, by Sex and Race/Ethnicity: Census 2000

Sex and Race/ Hispanic	Amount of Net Undercount (millions)					Percent Net Undercount				
	Base DA	A.C.E	*Rev. DA*	A.C.E minus Base	DA Rev.	Base DA	A.C.E	Rev. DA	A.C.E minus Base	DA Rev.
Total	-1.2	3.3	2.1	4.5	1.2	-0.4%	1.1%	0.7%	1.6%	0.4%
Male	0.3	2.1	2.5	1.9	-0.4	0.2%	1.5%	1.8%	1.3%	-0.3%
Female	-1.5	1.1	-0.4	2.6	1.6	-1.0%	0.8%	-0.3%	1.8%	1.1%
Black*	0.7	0.7	0.7	0.1	0.0	1.9%	2.1%	1.9%	0.2%	0.1%
Male	0.8	0.4	0.8	-0.4	-0.4	4.4%	2.4%	4.5%	-2.0%	-2.1%
Female	-0.1	0.3	-0.1	0.4	0.4	-0.5%	1.8%	-0.4%	2.3%	2.2%
Hispanic	-1.3	1.0	1.3	2.3	-0.3	-3.8%	2.8%	3.6%	6.6%	-0.8%
Male	-1.0	0.7	0.7	1.7	0.0	-5.7%	3.6%	3.8%	9.3%	-0.2%
Female	-0.3	0.3	0.6	0.6	-0.2	-1.9%	1.9%	3.3%	3.8%	-1.4%
Balance**	-0.6	1.5	0.1	2.1	1.4	-0.3%	0.7%	0.0%	1.0%	0.7%
Male	0.5	1.0	1.0	0.6	0.0	0.5%	1.0%	1.0%	0.5%	0.0%
Female	-1.1	0.5	-0.9	1.5	1.4	-1.0%	0.4%	-0.9%	1.4%	1.3%

Notes and sources:
  * Not Hispanic.
  * Non-Hispanic, non-Black population.

Computed from populations in Table 5. Net undercount is estimate minus census; negative sign indicates estimated net overcount. Base of percent is estimated population. See Table 5 and text for definitions and sources.

References

Ahmed, Bashir and J.G. Robinson. 1994. "Estimates of Emigration of the Foreign-Born Population: 1980–1990." Technical Working Paper 9, Population Division. Washington, DC: U.S. Bureau of the Census. December.

Bean, Frank D. Rodolfo Corona, Rodolfo Tuiran, Karen A. Woodrow-Lafield, and Jennifer Van Hook. "Circular, Invisible, and Ambiguous Migrants: Components of Difference in Estimates of the Number of Unauthorized Mexicans in the United States." *Demography* 38 (3, August): 411–422.

Clark, Rebecca L., Jeffrey S. Passel, Wendy N. Zimmermann, and Michael E. Fix. 1994. *Fiscal Impacts of Undocumented Aliens: Selected Estimates for Seven States.* Washington, DC: Urban Institute. September.

Coale, Ansley J. and Melvin Zelnik. 1963. *New Estimates of Fertility and Population in the United States.* Princeton, NJ: Princeton University Press.

Coale, Ansley J. and Norfleet W. Rives, Jr. 1973. "A Statistical Reconstruction of the Black Population of the United States, 1880–1970: Estimates of True Numbers by Age and Sex, Birth Rates, and Total Fertility." *Population Index* (January).

Edmonston, Barry, Sharon M. Lee, and Jeffrey S. Passel. 2000. "Recent Trends in Intermarriage and Immigration and Their Effects on the Future Racial Composition of the U.S. Population." Paper presented at conference on "Multiraciality: How Will the New Census Data Be Used?" at the Jerome Levy Economics Institute at Bard College, New York, September 22–23. Forthcoming in a volume edited by Perlmann and Waters for Russell Sage.

Fay, Robert E., Jeffrey S. Passel, J. Gregory Robinson. 1988. *The Coverage of Population in the 1980 Census.* Evaluation and Research Reports, Series PHC80-E4. Washington, DC: U.S. Bureau of the Census. February.

Institute of International Education. 2001. *Open Doors 2000.* Washington, DC.

Lowell, B. Lindsay. 2000. "The Temporary Specialty H-1 Visa: Legislative History and Demographic Features." Institute for the Study of International Migration, Georgetown University, Washington, DC.

Passel, Jeffrey S. 2001a. "Methods Used to Reweight the March 2000 CPS to Census 2000 Marginal Totals." Unpublished Memorandum for the Record. Washington, DC: The Urban Institute. August.

Passel, Jeffrey S. 2001b. "Estimates of Undocumented Immigrants Living in the United States: 2000." Washington, DC: The Urban Institute. August.

Passel, Jeffrey S. 1999. "Undocumented Immigration to the United States: Numbers, Trends, and Consequences." In Haines, David W. and Karen E. Rosenblum (eds.), *Illegal Immigration in America: A Reference Handbook.* Westwood, CT: Greenwood Press.

Passel, Jeffrey S. 1997. "Immigration Statistics: No Longer Neglected, But Still Inadequate." Working Paper Series of the Council of Professional Associations on Federal Statistics. Alexandria, VA.

Passel, Jeffrey S. 1996. "The Growing American Indian Population, 1960–1990: Beyond Demography." In Sandefur and Cohen (eds.), *Changing Numbers, Changing Needs: American Indian Demography and Public Health.* Washington, DC: National Academy Press.

Passel, Jeffrey S. 1993. "Comment on 'Estimation of Population Coverage in the 1990 United States Census Based on Demographic Analysis.'" *Journal of the American Statistical Association* 88 (423, September): 1074–1077.

Passel, Jeffrey S. 1991. "Age-Period-Cohort Analysis of Census Undercount Rates for Race-Sex Groups, 1940–1980: Implications for the Method of Demographic Analysis." *Proceedings of the Social Statistics Section of the American Statistical Association, 1991:* 326–331.

Passel, Jeffrey S. and Rebecca L. Clark. 1998. *Immigrants in New York: Their Legal Status, Incomes and Tax Payments.* Washington, DC: The Urban Institute. April.

Passel, Jeffrey S. and Barry Edmonston. 1994. "Immigration and Race: Recent Trends in Immigration to the United States." In Edmonston and Passel (eds.), *Immigration and Ethnicity: The Integration of America's Newest Arrivals.* Washington, DC: The Urban Institute Press.

Passel, Jeffrey S. and Michael Fix. 2001. "U.S. Immigration at the Beginning of the 21st Century." Testimony before the U.S. House of Representatives Committee on the Judiciary, Subcommittee on Immigration and Claims Hearing on "The U.S. Population and Immigration." Washington, DC. August 2.

Passel, Jeffrey S. and Wendy Zimmermann. 2001. "Are Immigrants Leaving California? Settlement Patterns of Immigrants in the Late 1990s" Washington, DC: The Urban Institute. April.

Robinson, J. Gregory. 2001a. "Components Used to Develop Preliminary Demographic Analysis Estimates of the U.S. Resident Population for April 1, 2000." Unpublished handout. Washington, DC: U.S. Census Bureau. January 30.

Robinson, J. Gregory. 2001b. "Accuracy and Coverage Evaluation: Demographic Analysis Results." DSSD Census Procedures and Operations Memorandum Series B-4. Washington, DC: U.S. Census Bureau. March 2.

Robinson, J. Gregory. 2001c. "Description of the Components of Change (1990 to 2000) Used to Produce the National Postcensal Population Estimates during the 1990's." Unpublished handout. Washington, DC: U.S. Census Bureau. March 19.

Robinson, J. Gregory, Bashir Ahmed, Prithwis Das Gupta, and Karen A. Woodrow. 1993. "Estimating Coverage in the 1990 United States Census Based on Demographic Analysis." *Journal of the American Statistical Association* 88 (423, September): 1061–1071.

Robinson, J. Gregory, Prithwis Das Gupta, and Bashir Ahmed. 1990. "A Case Study in the Investigation of Errors in Estimates of Coverage Based on Demographic Analysis: Black Adults Aged 35 to 54 in 1980." *Proceedings of the Social Statistics Section of the American Statistical Association,* 1990: 187–192.

Siegel, Jacob S. 1974. *Estimates of Coverage of Population by Sex, Race, and Age: Demographic Analysis.* Evaluation and Research Program, 1970 Census of Population and Housing, Report PHE(E)-4. Washington, DC: U.S. Bureau of the Census. February.

U.S. Bureau of the Census. 1973. *Test of Birth Registration Completeness, 1964 to 1968.* Evaluation and Research Program, 1970 Census of Population and Housing, Report PHE(E)-2. Washington, DC.

U.S. Immigration and Naturalization Service. 1996. *Duration of Stay of Nonimmigrants Departing the United States.* Office of Policy and Planning, Statistics Branch. Washington, DC.

Van Hook, Jennifer and Frank D. Bean. 1997. "Estimating Underenumeration among Unauthorized Mexican Migrants to the United States: Applications of Mortality Analyses." Technical Appendix in *Binational Study of Migration between Mexico and the United States.* Washington, DC: Commission on Immigration Reform. July.

Warren, Robert E. 1997. *Estimates of the Undocumented Immigrant Population Residing in the United States: October 1996.* Washington, DC: U.S. Immigration and Naturalization Service. August.

Warren, Robert E. 2000. *Annual Estimates of the Unauthorized Immigrant Population Residing in the United States and Components of Change: 1987 to 1997.* Unpublished document released by Hon. Lamar Smith (D-TX). Washington, DC: U.S. Immigration and Naturalization Service.

Warren, Robert E. and Jeffrey S. Passel. 1987. "A Count of the Uncountable: Estimates of Undocumented Aliens Counted in the 1980 United States Census." *Demography* 24 (3, August 1987): 375–393.

Woodrow, Karen A. 1991. "Preliminary Estimates of Undocumented Residents in 1990." Demographic Analysis Evaluation Project D2, Population Division, U.S. Bureau of the Census

Woodrow and Passel. 1990. "Post-IRCA Undocumented Immigration to the United States: An Assessment Based on the June 1988 CPS." In Bean, Edmonston, and Passel (eds.), *Undocumented Migration to the United States: IRCA and the Experience of the 1980s.* Washington, D.C.: The Urban Institute Press.

Word, David L. 1995. Estimates of nonimmigrants in the United States in the 1990 Census. Unpublished, personal communication. Washington, DC: U.S. Bureau of the Census.

Whelpton, Pascal K. 1950. "Births and Birth Rates in the Entire United States, 1909 to 1948." *Vital Statistics, Special Reports* 33: 137–162.