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The 2020 Census and Political Representation in California

Technical Appendices

CONTENTS

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Appendix A: Data and Methods

Initial Demographic Forecasts for 2020

National forecasts for reapportionment

Anticipating the consequences of a census undercount for congressional reapportionment requires projecting the 2020 population by state for each demographic group covered by our undercount scenarios. Our forecasts start with the 2012 and 2016 Census Bureau American Community Survey (ACS) population estimates for the following demographic categories:

1. State
2. Sex
3. Age in years, with all ages over 85 coded together
4. Race, separated into non-Hispanic white, Latino, African American, native American/Alaska native, Asian, native Hawaiian/Pacific Islander, other/multiracial
5. Housing tenure, separated into home owner, renter, and group quarters resident

We use 2012 and 2016 because they are the first and last years for which the necessary ACS estimates are available. In addition to the five categories above, we also estimate whether the household contains at least one undocumented resident using the methodology described below, and for some analyses we estimate whether the household contains at least one noncitizen.

We estimate the number of households per state with at least one undocumented member by assigning likely immigration status to individual observations in the ACS, replicating the methodology from Bohn et al. (2013) to apply to all states. Note that this approach is similar in nature to that of Passel and Cohn (2009) and Warren and Warren (2013). First, we identify a pool of people in each year of the ACS who could potentially be undocumented, based on individual characteristics and immigration policy information. Then, using Center for Migration Studies estimates for state-level undocumented populations as controls, we randomly assign undocumented status to observations within the pool, by state. This allows us to flag households in the ACS with any undocumented members. For within-California estimates, we use county-level estimates of numbers of undocumented people as the control, as generated by Hill and Johnson (2011). See Bohn et al. (2013) for a complete description of the methodology for estimating undocumented populations.

We calculate the raw population change from 2012 to 2016 in each intersection of our demographic categories—adjusting for aging—and then add the same four-year change to the age-adjusted 2016 number to produce an initial estimate for 2020. We assign a floor of zero for these projections: any cells that end up with a negative value are reassigned to zero. This approach worked better than exponential growth, which often produced implausible projections for cells with small population totals. Given our calibration to official population estimates (see below), this decision does not affect the numbers we use for age, sex, race, or states. It only affects the proportional division of those age/sex/race/state categories into housing tenure and undocumented person in the household.

For example, in 2012 California was home to 47,678 25-year-old Latina renters without an undocumented person in their household. By 2016 this same group had turned 29 and now included 48,945 women, suggesting that a combination of migration and death had produced a net increase of 1,267. We then add 1,267 to 48,945 to produce a projected 2020 population of 50,212 for this demographic category. This approach keeps the raw

change constant, yet because this raw change is added to a larger base (e.g., 1,267 is 2.65% of 47,678, but only 2.59% of 48,945) it assumes a modest diminishing *rate* of growth over the next four years.

To project four years in the future we need to project the number of children younger than four who will be born between 2016 and 2020. For this purpose we use the child-woman ratio (CWR) for 2016 (Swanson et al. 2010). The CWR is the ratio of children of the analytically relevant ages (ages 0–3 in this case) divided by the total number of women of childbearing age (defined as ages 15–44). We multiply the CWR for 2016 by our projected number of women ages 15 to 44 in 2020 to obtain our 0–3 projection. This assumes that fertility rates for women of childbearing age will remain constant between now and 2020.

Calibration to Other Forecasts

Nationwide forecasts for reapportionment

For our main reapportionment estimates, we calibrate our projections to official Census Bureau projections in two ways. The Census Bureau projects the national population in 2020 by age, race, and sex.[1] These projections offer highly sophisticated estimates for these demographic groups and for the total population of the nation at large. But House apportionment is critically dependent on the *relative* populations of each state, and these Census Bureau projections offer no state-level information. Demographic groups might grow at different rates in different states, leading to variation by state that is consequential for reapportionment forecasts.

To incorporate information on state-level trends, we first calculated the average monthly population change for both the nation as a whole and each individual state over the 84 months from July 2010 through July 2017.[2] We then projected that monthly change an additional 33 months into the future to reach April 2020. Finally, we calibrated each state to the Census Bureau's national forecast by multiplying that state's number by the ratio of the national Census Bureau forecast to our national population forecast. More formally, the pre-calibration raw population forecast for each state s and for the nation as a whole N is defined as:

$$p_{s,2020} = p_{s,2017} + 33/84\left(p_{s,2017} - p_{s,2010}\right) \qquad [A1]$$

$$p_{N,2020} = p_{N,2017} + 33/84\left(p_{N,2017} - p_{N,2010}\right) \qquad [A2]$$

These projections were then calibrated to the Census Bureau's own national projection ($p_{N,2020}^{Census}$):

$$\tilde{p_{s,2020}} = \left(p_{N,2020}^{Census}/p_{N,2020}\right)p_{s,2020} \qquad [A3]$$

To calibrate our state-level demographic projections with this information, we treated the statewide population projections and the national demographic projections as population parameters for raking weights. Raking is a process of weighting an estimate to a series of population parameters in an iterative process that gradually converges on the set of weights that minimizes the difference between the estimate and *all* the parameters jointly. In this case, the raking first weighted our projections to match the statewide projections described in Equations A1–A3, then adjusted those weights to match the national demographic projections. It then further adjusted the weights to correct any deviations from the statewide projections that had been introduced by the effort to match the national demographic projections, and so on back and forth until the procedure converged on the best possible weights. This raking procedure was conducted with the **rake** function in R. All R code for this project is available from the authors upon request.

[1] These forecasts can be found in the Census Bureau's "Population Projection Tables." Accessed August 29, 2018.
[2] The data for these forecasts can be found in the Census Bureau's webpage, "National Population Totals and Components of Change: 2010-2017." Last updated May 7, 2018. Accessed August 19, 2018.

The raking produced population projections for 2020 that perfectly matched all values of $p^{\sim}_{s,2020}$ and deviated from the Census Bureau's national age by sex by race projections by a maximum of 0.03%.

We also repeated this process by replacing $p^{\sim}_{s,2020}$ with statewide projections from the University of Virginia's Demographic Research Group in the Weldon Cooper Center for Public Service.[3] Unlike our projections, the UVA projections assume exponential population growth and do not calibrate to US Census Bureau projections for 2020. They begin by relating the April 2010 census populations by state to the ACS state populations in July 2015. Since this represents a total change of 5.25 years, they connect these two numbers through the following exponential formula:

$$p^{Census}_{s,2015} = p^{Census}_{s,2010} * e^{r_s * 5.25} \qquad [A4]$$

Solving for r_s this becomes

$$r_s = ln\left(p^{Census}_{s,2015} / p^{Census}_{s,2010}\right)(1/5.25) \qquad [A5]$$

They then project to April 2020 using this estimated value of r_s and the new time difference of 4.75 years:

$$p^{UVA}_{s,2020} = p^{Census}_{s,2015} * e^{r_s * 4.75} \qquad [A6]$$

This method places California population growth in a more favorable light relative to other states. However, their projection for California is still only about 400,000 people (approximately 1%) higher than our baseline projection. That suggests that, absent a bad census count, California's chances of gaining a seat or standing pat rest on a knife's edge.

California forecasts for redistricting

To understand the consequences of a census undercount for redistricting within California we want to map the geography of the undercount at the greatest level of detail we can. We use ACS data at the PUMA (public use microdata area) level. (Because there is a PUMA that is shared between part of Monterey County and all of San Benito County, we merge these two counties into a single PUMA.) We then replicate the process described above, except we use the California Department of Finance (DOF) county/race/sex/age 2020 estimates in place of the national Census Bureau demographics. We also need a way of calibrating housing tenure and undocumented household, since the DOF does not provide that information. First we aggregate our PUMA data to the state level by housing tenure and undocumented household, and calibrate these numbers to the DOF projected statewide total 2020 population as in equations A1–A3 above. These become our population targets for those two variables. Then we use these targets combined with the DOF data to produce raking weights. In addition to combining Monterey and San Benito Counties in the DOF data, we also combine counties that share a PUMA. This process again produced a good match between the weights and the population parameters.

The only significant difference between this process and the one for states is that the PUMA-level data have a number of zero or very-low-population cells. These low-population cells are too small to conduct reasonable population projections. Instead, we use the 2016 PUMA data without projection as the sample input for the raking weights. In addition, zero cells can create problems for the raking weight process, so we assigned a value of 1 for all the zero cells in the ACS data.

[3] These estimates can be found on the UVA Weldon Cooper Center for Public Service webpage, "National Population Projections." Updated May 2016. Accessed August 29 2018.

Reapportionment Formula

US House seats are reapportioned after every census according to a formula codified in law (Title 2, US Code). Every state is first assigned a single seat to ensure minimum representation. Then the population of every state is divided by the geometric mean of the number of seats it currently has and the number it would have if it were assigned another seat. If n_s is the number of seats state s has already been assigned and p_s is that state's population in the latest census, the state's priority value a_s for reapportionment is

$$a_s = p_s/\sqrt{n_s(n_s+1)} \qquad [A7]$$

The state with the largest value of a will receive the next seat, the value of n for that state will increase by one, and a will be calculated again for all states. For example, in the first iteration of the algorithm, every state has been assigned one seat, so $n_s = 1$ for all s and $a_s = p_s/\sqrt{1*2} \approx p_s/1.41$. In this iteration, California as the largest state will receive the first seat, after which its divisor will increase to $\sqrt{2*3} \approx 2.45$. This process is repeated until all 435 seats have been assigned.

The total number of seats in the US House is fixed by law at 435 so this process is dividing up a finite resource and the gains of one state must come at the expense of others (at least within the constraint that all states receive at least one seat). Thus, population growth by itself is not enough to ensure that a state will gain seats. Indeed, virtually every state will have gained at least some population between 2010 and 2020. States must grow *disproportionate to their current seat allocation* to increase their representation. For example, we estimate that California will have gained about 3.2 million residents between 2010 and 2020, second only to Texas's 4.3 million. But California already has substantially more congressional districts than every other state, so those extra residents are also spread out across a larger number of seats.

Undercount Simulations

Our undercount simulations start with the population projections for 2020 described above, which are estimated for demographic subgroups defined by age, sex, race/ethnicity, housing tenure, and presence of immigrants for each state. These estimates assume that the enumeration in 2020 will be as good as it was in 2010. To simulate an undercount, we use information from past censuses and the research literature on the undercount rate for specific demographic subgroups. These are described in turn below. After adjusting the state populations for an undercount we recalculate reapportionment and compare the number of seats to our baseline estimates.

Low-accuracy census simulation

As the report explains, the 1990 Census is a useful benchmark because it exhibited a relatively high undercount of the population and the Census Bureau conducted detailed analyses of the undercount after the fact. This allows us to simulate a plausible undercount for 2020 in a robust manner.

Table A1 shows the 1990 undercount rates by demographic subgroup that we utilize for our simulation. Positive numbers indicate an undercount of the given subgroup while negative numbers indicate an overcount. We assume that children ages 0–17 are undercounted as below and individuals ages 18 and older are undercounted as given by the "total population" rates. This will tend to overestimate the undercount for adults because children are typically undercounted to a higher degree and will thus drive up the "total population" undercount rates. This is a relatively minor bias since adults are by far the majority of the population. Also, as we see in the report, even this high undercount scenario does not produce large effects on reapportionment.

To apply these undercount (and overcount) rates, we apply a weight equivalent to *1-undercount rate* to the 2020 population projection in a given subgroup. For example, white children in owner households in the West are

counted at a rate of *1-0.021=0.979* times the baseline population. The same group is overcounted in the North East, so we assume the new count there would be *1+.003 = 1.003* times the baseline.

Immigration-related undercount simulation

Our basic immigration-related undercount scenario assumes that those who live in a household with at least one undocumented resident will be undercounted by 10 percent. Mechanically, we multiply our population variable by 0.9 for those who live in such a household and by 1.0 otherwise.

Combination of low-accuracy census and immigration-related undercount

To estimate the combined effect of both a low-accuracy census and a low response rate in immigrant communities, we first create the weight described above that replicates the undercount from the 1990 Census. Then we multiplied the weight from the immigration-related scenario described above (0.9 for those in households with at least one undocumented resident) by the 1990 undercount weight. Conditional on the variables already used to determine the weights (e.g., age, renter status, undocumented in the household, etc.), this approach assumes no correlation between those who would be missed due to an inaccurate census and those who would be reluctant to respond due to immigration-related concerns. To the extent that the two are positively correlated this scenario will exaggerate the effect on census counts and apportionment.

TABLE A1

1990 Census undercount rates (%) by demographic group

	Children ages 0–17					All ages				
	North East	South	Midwest	West	Total	North East	South	Midwest	West	Total
Non-Hispanic White and Other	0.5 (0.66)	3.4 (0.59)	1.1 (0.62)	2.4 (0.69)	2.0 (0.32)	-0.3 (0.55)	1.3 (0.37)	0.2 (0.39)	1.3 (0.53)	0.7 (0.22)
Owner	-0.3 (0.65)	2.2 (0.61)	0.6 (0.77)	2.1 (0.85)	1.2 (0.36)	-1.5 (0.62)	0.5 (0.38)	-0.4 (0.43)	0.0 (0.41)	-0.3 (0.23)
Renter	2.6 (1.77)	6.3 (1.37)	2.7 (0.92)	3.0 (1.29)	4.0 (0.67)	2.5 (1.10)	3.6 (0.93)	2.0 (0.85)	3.9 (1.17)	3.1 (0.50)
Black	7.9 (1.97)	6.3 (1.19)	6.4 (1.40)	11.7 (3.29)	7.1 (0.87)	5.8 (1.13)	3.9 (0.76)	3.6 (0.85)	8.0 (1.80)	4.6 (0.53)
Owner	10.6 (4.56)	4.6 (1.28)	3.2 (1.17)	9.2 (5.19)	5.6 (1.16)	1.7 (1.72)	2.4 (0.73)	0.9 (0.74)	5.7 (1.72)	2.3 (0.56)
Renter	6.7 (1.93)	7.6 (1.74)	8.2 (2.04)	12.9 (4.04)	8.1 (1.16)	8.1 (1.50)	5.4 (1.30)	5.7 (1.43)	9.4 (2.47)	6.5 (0.82)
Non-Black Hispanic	4.2 (3.96)	5.6 (1.31)	2.5 (1.99)	5.1 (1.03)	4.9 (0.95)	5.4 (2.74)	5.5 (1.10)	2.8 (1.65)	4.9 (0.97)	5.0 (0.77)
Owner	-0.9 (6.44)	1.7 (1.40)	-3.8 (1.83)	2.1 (1.12)	1.2 (1.16)	0.9 (3.63)	2.2 (0.77)	-2.3 (1.73)	2.4 (0.74)	1.8 (0.67)
Renter	5.6 (4.49)	9.4 (2.09)	7.7 (3.10)	7.2 (1.51)	7.5 (1.33)	6.8 (3.18)	9.3 (1.92)	7.2 (2.47)	6.7 (1.51)	7.4 (1.18)
Asian and Pacific Islander	3.4 (2.12)	2.7 (2.05)	3.0 (2.07)	3.4 (2.11)	3.3 (2.09)	2.9 (1.45)	2.4 (1.35)	2.9 (1.44)	2.1 (1.32)	2.4 (1.36)
Owner	----------	----------	----------	----------	-0.5 (2.55)	----------	----------	----------	----------	-1.5 (1.50)
Renter	----------	----------	----------	----------	8.0 (3.54)	----------	----------	----------	----------	7.0 (2.52)
American Indians on Reservations	----------	----------	----------	----------	13.8 (5.00)	----------	----------	----------	----------	12.2 (4.73)

SOURCES: West and Robinson (1999), "What Do We Know About The Undercount of Children?" Population Division, US Census Bureau Working Paper No. 39.

NOTES: Standard errors in parentheses.

Appendix B: Detailed Tables

Each of the following tables contains the results of one of our 2020 Census scenarios. In each case, the "2010 Actuals" column is repeated for reference, and just shows the actual 2010 Census enumeration and corresponding House seat allocation. The "Baseline 2020 Projections" in each case shows the results using our own method of projection outlined above, with any corresponding undercount effects. The next column shows the same results once our projection for California has been replaced with the one from the California Department of Finance (DOF). The final column shows the same results once our state projections have been replaced with the ones from UVA. The final table in this appendix also includes an "undercount" column for the baseline, since the combined low-accuracy and immigration-related undercount scenario represented in that table serves as our main undercount scenario.

TABLE B1

State population totals and 2020 reapportionment estimates

	2010 actuals		Baseline 2020 projections			Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Alabama	4,779,736	7	4,915,698	6	-1	4,915,698	6	-1	4,931,806	6	-1
Alaska	710,231	1	750,827	1	0	750,827	1	0	764,911	1	0
Arizona	6,392,017	9	7,264,374	10	1	7,264,374	10	1	7,248,162	10	1
Arkansas	2,915,918	4	3,040,368	4	0	3,040,368	4	0	3,035,704	4	0
California	37,253,956	53	40,556,804	53	0	40,634,312	53	0	40,938,164	54	1
Colorado	5,029,196	7	5,833,836	8	1	5,833,836	8	1	5,874,462	8	1
Connecticut	3,574,097	5	3,595,663	5	0	3,595,663	5	0	3,606,144	5	0
Delaware	897,934	1	987,575	1	0	987,575	1	0	991,570	1	0
Florida	18,801,310	27	21,850,621	29	2	21,850,621	29	2	21,700,027	28	1
Georgia	9,687,653	14	10,723,849	14	0	10,723,849	14	0	10,716,537	14	0
Hawaii	1,360,301	2	1,454,323	2	0	1,454,323	2	0	1,499,329	2	0
Idaho	1,567,582	2	1,776,452	2	0	1,776,452	2	0	1,738,146	2	0
Illinois	12,830,632	18	12,802,052	17	-1	12,802,052	17	-1	12,886,619	17	-1
Indiana	6,483,802	9	6,744,394	9	0	6,744,394	9	0	6,745,069	9	0
Iowa	3,046,355	4	3,187,063	4	0	3,187,063	4	0	3,195,757	4	0
Kansas	2,853,118	4	2,938,159	4	0	2,938,159	4	0	2,965,624	4	0
Kentucky	4,339,367	6	4,501,348	6	0	4,501,348	6	0	4,504,111	6	0
Louisiana	4,533,372	6	4,744,836	6	0	4,744,836	6	0	4,798,577	6	0
Maine	1,328,361	2	1,340,798	2	0	1,340,798	2	0	1,330,204	2	0
Maryland	5,773,552	8	6,163,345	8	0	6,163,345	8	0	6,225,156	8	0
Massachusetts	6,547,629	9	6,984,075	9	0	6,984,075	9	0	7,025,717	9	0
Michigan	9,883,640	14	10,007,985	13	-1	10,007,985	13	-1	9,957,936	13	-1
Minnesota	5,303,925	8	5,687,915	7	-1	5,687,915	7	-1	5,663,175	7	-1
Mississippi	2,967,297	4	2,993,072	4	0	2,993,072	4	0	3,015,167	4	0
Missouri	5,988,927	8	6,167,258	8	0	6,167,258	8	0	6,170,685	8	0

	2010 actuals		Baseline 2020 projections			Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Montana	989,415	1	1,075,354	1	0	1,075,354	1	0	1,073,985	1	0
Nebraska	1,826,341	3	1,957,838	3	0	1,957,838	3	0	1,961,686	3	0
Nevada	2,700,551	4	3,117,782	4	0	3,117,782	4	0	3,074,545	4	0
New Hampshire	1,316,470	2	1,354,678	2	0	1,354,678	2	0	1,343,530	2	0
New Jersey	8,791,894	12	9,095,931	12	0	9,095,931	12	0	9,111,014	12	0
New Mexico	2,059,179	3	2,099,817	3	0	2,099,817	3	0	2,108,851	3	0
New York	19,378,102	27	20,048,057	26	-1	20,048,057	26	-1	20,181,453	26	-1
North Carolina	9,535,483	13	10,560,813	14	1	10,560,813	14	1	10,525,024	14	1
North Dakota	672,591	1	788,115	1	0	788,115	1	0	842,308	1	0
Ohio	11,536,504	16	11,719,602	15	-1	11,719,602	15	-1	11,683,458	15	-1
Oklahoma	3,751,351	5	4,002,995	5	0	4,002,995	5	0	4,061,960	5	0
Oregon	3,831,074	5	4,268,014	6	1	4,268,014	6	1	4,216,827	6	1
Pennsylvania	12,702,379	18	12,858,138	17	-1	12,858,138	17	-1	12,893,771	17	-1
Rhode Island	1,052,567	2	1,063,462	1	-1	1,063,462	1	-1	1,059,685	1	-1
South Carolina	4,625,364	7	5,183,250	7	0	5,183,250	7	0	5,154,774	7	0
South Dakota	814,180	1	891,734	1	0	891,734	1	0	900,612	1	0
Tennessee	6,346,105	9	6,865,722	9	0	6,865,722	9	0	6,839,046	9	0
Texas	25,145,561	36	29,543,479	39	3	29,543,479	39	3	29,755,854	39	3
Utah	2,763,885	4	3,234,025	4	0	3,234,025	4	0	3,222,596	4	0
Vermont	625,741	1	623,550	1	0	623,550	1	0	626,314	1	0
Virginia	8,001,024	11	8,655,193	11	0	8,655,193	11	0	8,744,273	11	0
Washington	6,724,540	10	7,675,985	10	0	7,675,985	10	0	7,599,119	10	0
West Virginia	1,852,994	3	1,802,920	2	-1	1,802,920	2	-1	1,836,143	2	-1
Wisconsin	5,686,986	8	5,843,803	8	0	5,843,803	8	0	5,848,732	8	0
Wyoming	563,626	1	585,890	1	0	585,890	1	0	607,219	1	0

SOURCES: Authors' calculations from US Census Bureau data.

TABLE B2

State population totals and 2020 reapportionment estimates, with low-accuracy count only

	2010 actuals		Baseline 2020 projections			Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Alabama	4,779,736	7	4,819,201	6	-1	4,819,201	6	-1	4,835,035	6	-1
Alaska	710,231	1	725,982	1	0	725,982	1	0	739,635	1	0
Arizona	6,392,017	9	7,085,624	9	0	7,085,624	9	0	7,069,968	9	0
Arkansas	2,915,918	4	2,981,792	4	0	2,981,792	4	0	2,977,250	4	0
California	37,253,956	53	39,421,783	53	0	39,487,526	53	0	39,792,975	53	0
Colorado	5,029,196	7	5,729,029	8	1	5,729,029	8	1	5,769,011	8	1
Connecticut	3,574,097	5	3,524,017	5	0	3,524,017	5	0	3,534,346	5	0
Delaware	897,934	1	967,272	1	0	967,272	1	0	971,197	1	0
Florida	18,801,310	27	21,334,636	29	2	21,334,636	29	2	21,187,918	28	1
Georgia	9,687,653	14	10,454,417	14	0	10,454,417	14	0	10,447,369	14	0
Hawaii	1,360,301	2	1,425,058	2	0	1,425,058	2	0	1,469,172	2	0
Idaho	1,567,582	2	1,748,908	2	0	1,748,908	2	0	1,711,223	2	0
Illinois	12,830,632	18	12,554,939	17	-1	12,554,939	17	-1	12,638,011	17	-1
Indiana	6,483,802	9	6,641,541	9	0	6,641,541	9	0	6,642,265	9	0
Iowa	3,046,355	4	3,145,908	4	0	3,145,908	4	0	3,154,518	4	0
Kansas	2,853,118	4	2,889,197	4	0	2,889,197	4	0	2,916,238	4	0
Kentucky	4,339,367	6	4,435,542	6	0	4,435,542	6	0	4,438,297	6	0
Louisiana	4,533,372	6	4,633,832	6	0	4,633,832	6	0	4,686,361	6	0
Maine	1,328,361	2	1,326,804	2	0	1,326,804	2	0	1,316,330	2	0
Maryland	5,773,552	8	6,024,109	8	0	6,024,109	8	0	6,084,564	8	0
Massachusetts	6,547,629	9	6,860,729	9	0	6,860,729	9	0	6,901,732	9	0
Michigan	9,883,640	14	9,857,773	13	-1	9,857,773	13	-1	9,808,559	13	-1
Minnesota	5,303,925	8	5,612,517	8	0	5,612,517	8	0	5,588,160	8	0
Mississippi	2,967,297	4	2,922,125	4	0	2,922,125	4	0	2,943,721	4	0
Missouri	5,988,927	8	6,069,054	8	0	6,069,054	8	0	6,072,475	8	0
Montana	989,415	1	1,056,439	1	0	1,056,439	1	0	1,055,119	1	0
Nebraska	1,826,341	3	1,924,608	3	0	1,924,608	3	0	1,928,417	3	0
Nevada	2,700,551	4	3,037,407	4	0	3,037,407	4	0	2,995,327	4	0
New Hampshire	1,316,470	2	1,338,998	2	0	1,338,998	2	0	1,327,990	2	0
New Jersey	8,791,894	12	8,894,588	12	0	8,894,588	12	0	8,909,461	12	0
New Mexico	2,059,179	3	2,034,812	3	0	2,034,812	3	0	2,043,615	3	0
New York	19,378,102	27	19,538,258	26	-1	19,538,258	26	-1	19,668,595	26	-1
North Carolina	9,535,483	13	10,333,470	14	1	10,333,470	14	1	10,298,571	14	1
North Dakota	672,591	1	770,633	1	0	770,633	1	0	823,650	1	0
Ohio	11,536,504	16	11,537,912	15	-1	11,537,912	15	-1	11,502,410	15	-1
Oklahoma	3,751,351	5	3,907,039	5	0	3,907,039	5	0	3,964,692	5	0

	2010 actuals		Baseline 2020 projections			Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Oregon	3,831,074	5	4,196,187	6	1	4,196,187	6	1	4,145,916	6	1
Pennsylvania	12,702,379	18	12,664,053	17	-1	12,664,053	17	-1	12,699,272	17	-1
Rhode Island	1,052,567	2	1,040,743	1	-1	1,040,743	1	-1	1,037,064	1	-1
South Carolina	4,625,364	7	5,083,632	7	0	5,083,632	7	0	5,055,744	7	0
South Dakota	814,180	1	872,626	1	0	872,626	1	0	881,344	1	0
Tennessee	6,346,105	9	6,742,594	9	0	6,742,594	9	0	6,716,452	9	0
Texas	25,145,561	36	28,793,577	39	3	28,793,577	39	3	29,000,921	39	3
Utah	2,763,885	4	3,186,073	4	0	3,186,073	4	0	3,174,860	4	0
Vermont	625,741	1	616,660	1	0	616,660	1	0	619,398	1	0
Virginia	8,001,024	11	8,486,451	11	0	8,486,451	11	0	8,573,864	12	1
Washington	6,724,540	10	7,545,601	10	0	7,545,601	10	0	7,470,133	10	0
West Virginia	1,852,994	3	1,782,410	2	-1	1,782,410	2	-1	1,815,264	2	-1
Wisconsin	5,686,986	8	5,758,425	8	0	5,758,425	8	0	5,763,342	8	0
Wyoming	563,626	1	576,222	1	0	576,222	1	0	597,209	1	0

SOURCES: Authors' calculations from US Census Bureau data.

TABLE B3

State population totals and 2020 reapportionment estimates, with immigration-related undercount only

	2010 actuals		Baseline 2020 projections			Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Alabama	4,779,736	7	4,899,772	6	-1	4,899,772	6	-1	4,919,045	6	-1
Alaska	710,231	1	748,693	1	0	748,693	1	0	763,175	1	0
Arizona	6,392,017	9	7,208,461	10	1	7,208,461	10	1	7,203,580	10	1
Arkansas	2,915,918	4	3,026,534	4	0	3,026,534	4	0	3,024,677	4	0
California	37,253,956	53	40,040,275	53	0	40,119,163	53	0	40,521,433	53	0
Colorado	5,029,196	7	5,790,481	8	1	5,790,481	8	1	5,839,591	8	1
Connecticut	3,574,097	5	3,571,696	5	0	3,571,696	5	0	3,586,937	5	0
Delaware	897,934	1	980,825	1	0	980,825	1	0	986,156	1	0
Florida	18,801,310	27	21,711,792	29	2	21,711,792	29	2	21,589,839	28	1
Georgia	9,687,653	14	10,650,897	14	0	10,650,897	14	0	10,658,305	14	0
Hawaii	1,360,301	2	1,440,065	2	0	1,440,065	2	0	1,487,583	2	0
Idaho	1,567,582	2	1,767,819	2	0	1,767,819	2	0	1,731,400	2	0
Illinois	12,830,632	18	12,714,071	17	-1	12,714,071	17	-1	12,815,872	17	-1
Indiana	6,483,802	9	6,722,130	9	0	6,722,130	9	0	6,727,289	9	0
Iowa	3,046,355	4	3,174,615	4	0	3,174,615	4	0	3,185,789	4	0
Kansas	2,853,118	4	2,920,823	4	0	2,920,823	4	0	2,951,649	4	0
Kentucky	4,339,367	6	4,491,508	6	0	4,491,508	6	0	4,496,248	6	0
Louisiana	4,533,372	6	4,730,651	6	0	4,730,651	6	0	4,787,122	6	0
Maine	1,328,361	2	1,339,095	2	0	1,339,095	2	0	1,328,853	2	0
Maryland	5,773,552	8	6,113,139	8	0	6,113,139	8	0	6,184,636	8	0
Massachusetts	6,547,629	9	6,948,713	9	0	6,948,713	9	0	6,997,291	9	0
Michigan	9,883,640	14	9,984,169	13	-1	9,984,169	13	-1	9,939,002	13	-1
Minnesota	5,303,925	8	5,665,283	7	-1	5,665,283	7	-1	5,645,175	7	-1
Mississippi	2,967,297	4	2,987,642	4	0	2,987,642	4	0	3,010,798	4	0
Missouri	5,988,927	8	6,151,791	8	0	6,151,791	8	0	6,158,324	8	0
Montana	989,415	1	1,074,768	2	1	1,074,768	2	1	1,073,517	2	1
Nebraska	1,826,341	3	1,945,110	3	0	1,945,110	3	0	1,951,503	3	0
Nevada	2,700,551	4	3,080,142	4	0	3,080,142	4	0	3,044,882	4	0
New Hampshire	1,316,470	2	1,351,165	2	0	1,351,165	2	0	1,340,749	2	0
New Jersey	8,791,894	12	9,007,947	12	0	9,007,947	12	0	9,040,597	12	0
New Mexico	2,059,179	3	2,086,704	3	0	2,086,704	3	0	2,098,322	3	0
New York	19,378,102	27	19,899,822	26	-1	19,899,822	26	-1	20,062,221	26	-1
North Carolina	9,535,483	13	10,507,930	14	1	10,507,930	14	1	10,482,933	14	1
North Dakota	672,591	1	786,029	1	0	786,029	1	0	840,527	1	0
Ohio	11,536,504	16	11,700,542	15	-1	11,700,542	15	-1	11,668,283	15	-1
Oklahoma	3,751,351	5	3,983,642	5	0	3,983,642	5	0	4,046,275	5	0

	2010 actuals		Baseline 2020 projections			Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Oregon	3,831,074	5	4,243,531	6	1	4,243,531	6	1	4,197,509	6	1
Pennsylvania	12,702,379	18	12,821,329	17	-1	12,821,329	17	-1	12,864,290	17	-1
Rhode Island	1,052,567	2	1,057,294	1	-1	1,057,294	1	-1	1,054,775	1	-1
South Carolina	4,625,364	7	5,164,916	7	0	5,164,916	7	0	5,140,214	7	0
South Dakota	814,180	1	889,382	1	0	889,382	1	0	898,715	1	0
Tennessee	6,346,105	9	6,839,528	9	0	6,839,528	9	0	6,818,211	9	0
Texas	25,145,561	36	29,183,372	38	2	29,183,372	38	2	29,466,012	39	3
Utah	2,763,885	4	3,212,653	4	0	3,212,653	4	0	3,205,588	4	0
Vermont	625,741	1	623,214	1	0	623,214	1	0	626,045	1	0
Virginia	8,001,024	11	8,598,583	11	0	8,598,583	11	0	8,698,596	11	0
Washington	6,724,540	10	7,623,848	10	0	7,623,848	10	0	7,557,883	10	0
West Virginia	1,852,994	3	1,800,945	2	-1	1,800,945	2	-1	1,834,536	2	-1
Wisconsin	5,686,986	8	5,825,003	8	0	5,825,003	8	0	5,833,705	8	0
Wyoming	563,626	1	584,147	1	0	584,147	1	0	605,775	1	0

SOURCES: Authors' calculations from US Census Bureau data.

TABLE B4

State population totals and 2020 reapportionment estimates, with low-accuracy and immigration-related undercount

	2010 actuals		Baseline 2020 projections				Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	# undercounted	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Alabama	4,779,736	7	4,803,815	6	-1	111,883	4,803,815	6	-1	4,819,624	6	-1
Alaska	710,231	1	723,917	1	0	26,910	723,917	1	0	737,535	1	0
Arizona	6,392,017	9	7,031,668	9	0	232,706	7,031,668	9	0	7,016,191	9	0
Arkansas	2,915,918	4	2,968,490	4	0	71,878	2,968,490	4	0	2,963,996	4	0
California	37,253,956	53	38,929,281	52	-1	1,627,523	38,996,637	52	-1	39,296,293	53	0
Colorado	5,029,196	7	5,687,452	8	1	146,384	5,687,452	8	1	5,727,211	8	1
Connecticut	3,574,097	5	3,501,136	5	0	94,527	3,501,136	5	0	3,511,425	5	0
Delaware	897,934	1	960,772	1	0	26,803	960,772	1	0	964,681	1	0
Florida	18,801,310	27	21,201,726	29	2	648,895	21,201,726	29	2	21,056,053	28	1
Georgia	9,687,653	14	10,384,254	14	0	339,595	10,384,254	14	0	10,377,362	14	0
Hawaii	1,360,301	2	1,411,141	2	0	43,182	1,411,141	2	0	1,454,840	2	0
Idaho	1,567,582	2	1,740,650	2	0	35,802	1,740,650	2	0	1,703,156	2	0
Illinois	12,830,632	18	12,470,311	17	-1	331,741	12,470,311	17	-1	12,552,947	17	-1
Indiana	6,483,802	9	6,620,267	9	0	124,127	6,620,267	9	0	6,621,028	9	0
Iowa	3,046,355	4	3,134,047	4	0	53,016	3,134,047	4	0	3,142,646	4	0
Kansas	2,853,118	4	2,872,454	4	0	65,705	2,872,454	4	0	2,899,367	4	0
Kentucky	4,339,367	6	4,426,116	6	0	75,232	4,426,116	6	0	4,428,882	6	0
Louisiana	4,533,372	6	4,620,284	6	0	124,552	4,620,284	6	0	4,672,685	6	0
Maine	1,328,361	2	1,325,153	2	0	15,645	1,325,153	2	0	1,314,694	2	0
Maryland	5,773,552	8	5,975,830	8	0	187,515	5,975,830	8	0	6,035,858	8	0
Massachusetts	6,547,629	9	6,826,798	9	0	157,277	6,826,798	9	0	6,867,637	9	0
Michigan	9,883,640	14	9,834,725	13	-1	173,260	9,834,725	13	-1	9,785,655	13	-1
Minnesota	5,303,925	8	5,590,822	8	0	97,093	5,590,822	8	0	5,566,591	8	0
Mississippi	2,967,297	4	2,916,933	4	0	76,139	2,916,933	4	0	2,938,501	4	0
Missouri	5,988,927	8	6,054,104	8	0	113,154	6,054,104	8	0	6,057,540	8	0
Montana	989,415	1	1,055,860	2	1	19,494	1,055,860	2	1	1,054,541	2	1
Nebraska	1,826,341	3	1,912,471	3	0	45,367	1,912,471	3	0	1,916,279	3	0

	2010 actuals		Baseline 2020 projections				Alternate 2020 estimates (DOF projection)			Alternate 2020 estimates (UVA projection)		
	Pop.	Seats	Pop.	Seats	Diff.	# undercounted	Pop.	Seats	Diff.	Pop.	Seats	Diff.
Nevada	2,700,551	4	3,001,336	4	0	116,446	3,001,336	4	0	2,959,795	4	0
New Hampshire	1,316,470	2	1,335,625	2	0	19,053	1,335,625	2	0	1,324,651	2	0
New Jersey	8,791,894	12	8,810,528	12	0	285,403	8,810,528	12	0	8,825,366	12	0
New Mexico	2,059,179	3	2,022,022	3	0	77,795	2,022,022	3	0	2,030,779	3	0
New York	19,378,102	27	19,397,030	26	-1	651,027	19,397,030	26	-1	19,526,601	26	-1
North Carolina	9,535,483	13	10,282,850	14	1	277,963	10,282,850	14	1	10,248,209	14	1
North Dakota	672,591	1	768,649	1	0	19,467	768,649	1	0	821,533	1	0
Ohio	11,536,504	16	11,519,631	16	0	199,971	11,519,631	16	0	11,484,216	15	-1
Oklahoma	3,751,351	5	3,888,403	5	0	114,592	3,888,403	5	0	3,945,813	5	0
Oregon	3,831,074	5	4,172,674	6	1	95,340	4,172,674	6	1	4,122,724	6	1
Pennsylvania	12,702,379	18	12,628,609	17	-1	229,529	12,628,609	17	-1	12,663,788	17	-1
Rhode Island	1,052,567	2	1,034,837	1	-1	28,625	1,034,837	1	-1	1,031,186	1	-1
South Carolina	4,625,364	7	5,066,030	7	0	117,220	5,066,030	7	0	5,038,271	7	0
South Dakota	814,180	1	870,372	1	0	21,362	870,372	1	0	879,071	1	0
Tennessee	6,346,105	9	6,717,430	9	0	148,292	6,717,430	9	0	6,691,431	9	0
Texas	25,145,561	36	28,448,108	38	2	1,095,371	28,448,108	38	2	28,653,345	39	3
Utah	2,763,885	4	3,165,412	4	0	68,613	3,165,412	4	0	3,154,307	4	0
Vermont	625,741	1	616,346	1	0	7,204	616,346	1	0	619,083	1	0
Virginia	8,001,024	11	8,432,031	11	0	223,162	8,432,031	11	0	8,518,976	11	0
Washington	6,724,540	10	7,495,359	10	0	180,626	7,495,359	10	0	7,420,462	10	0
West Virginia	1,852,994	3	1,780,503	2	-1	22,417	1,780,503	2	-1	1,813,325	2	-1
Wisconsin	5,686,986	8	5,740,394	8	0	103,409	5,740,394	8	0	5,745,327	8	0
Wyoming	563,626	1	574,538	1	0	11,352	574,538	1	0	595,465	1	0

SOURCES: Authors' calculations from US Census Bureau data.

TABLE B5

County population totals and estimated undercount rates, with low-accuracy and immigration-related undercount

	Baseline 2020 projections		
	Projected population	Counted population	Percent undercounted
Alameda	1,703,660	1,632,069	4.2%
Alpine, Amador, Calaveras, Inyo, Mariposa, Mono, and Tuolumne	188,337	184,587	2.0%
Butte	230,701	224,628	2.6%
Colusa, Glenn, Tehama, and Trinity	131,343	127,285	3.1%
Contra Costa	1,178,639	1,137,227	3.5%
Del Norte, Lassen, Modoc, Plumas, and Siskiyou	130,605	127,447	2.4%
El Dorado	189,576	186,410	1.7%
Fresno	1,033,095	986,329	4.5%
Humboldt	137,711	134,263	2.5%
Imperial	195,814	184,044	6.0%
Kern	930,885	887,988	4.6%
Kings	154,549	146,624	5.1%
Lake and Mendocino	155,477	149,724	3.7%
Los Angeles	10,435,036	9,906,832	5.1%
Madera	162,990	154,926	4.9%
Marin	265,152	257,001	3.1%
Merced	286,746	271,177	5.4%
Monterey and San Benito	514,666	485,364	5.7%
Napa	143,800	138,202	3.9%
Nevada and Sierra	102,677	101,379	1.3%
Orange	3,260,012	3,123,732	4.2%
Placer	397,368	391,001	1.6%
Riverside	2,500,975	2,409,992	3.6%
Sacramento	1,572,886	1,521,084	3.3%
San Bernardino	2,230,602	2,131,544	4.4%
San Diego	3,398,672	3,263,984	4.0%
San Francisco	905,637	873,768	3.5%
San Joaquin	782,662	747,750	4.5%
San Luis Obispo	284,126	276,739	2.6%
San Mateo	792,271	762,557	3.8%
Santa Barbara	460,444	437,161	5.1%
Santa Clara	2,011,436	1,925,364	4.3%
Santa Cruz	282,627	271,130	4.1%
Shasta	180,198	176,652	2.0%
Solano	453,784	436,748	3.8%
Sonoma	515,486	497,778	3.4%

	Baseline 2020 projections		
	Projected population	Counted population	Percent undercounted
Stanislaus	572,000	548,325	4.1%
Sutter and Yuba	180,505	173,535	3.9%
Tulare	487,733	463,435	5.0%
Ventura	869,486	834,351	4.0%
Yolo	229,023	219,758	4.0%

SOURCES: Authors' calculations from US Census Bureau data.

NOTES: Estimates of percent undercounted assume that demographic groups are undercounted at the same rates across all counties.

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