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Authors
Bailey, Martha J
Currie, Janet
Schwandt, Hannes

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The COVID-19 baby bump in the United States

Martha J. Bailey[a,b], Janet Currie[b,c,1], and Hannes Schwandt[b,d]

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We use natality microdata covering the universe of US. births for 2015 to 2021 and California births from 2015 through February 2023 to examine childbearing responses to the COVID-19 pandemic. We find that 60% of the 2020 decline in US fertility rates was driven by sharp reductions in births to foreign-born mothers although births to this group comprised only 22% of all US births in 2019. This decline started in January 2020. In contrast, the COVID-19 recession resulted in an overall "baby bump" among US-born mothers, which marked the first reversal in declining fertility rates since the Great Recession. Births to US-born mothers fell by 31,000 in 2020 relative to a prepandemic trend but increased by 71,000 in 2021. The data for California suggest that US births remained elevated through February 2023. The baby bump was most pronounced for first births and women under age 25, suggesting that the pandemic led some women to start families earlier. Above age 25, the baby bump was most pronounced for women aged 30 to 34 and women with a college education. The 2021 to 2022 baby bump is especially remarkable given the large declines in fertility rates that would have been projected by standard statistical models.

COVID-19 | fertility | baby bump

Significance

We show that US fertility rates fell by much less than predicted by standard economic models in 2020, masking two separate patterns. The number of births to foreign-born women fell sharply in early 2020, while US-born women saw little decline in percentage terms and experienced a "baby bump" in 2021. Data from California suggest that the postpandemic increase in fertility among US-born women continued through February 2023. Not only was this the first recession in recent history not followed by a baby bust, but the 2021 baby bump marked the first reversal in declining fertility rates since the Great Recession. Increases in first births and births to college-educated mothers were especially large in 2021.

Between 2007 and 2020, the US total fertility rate (TFR), a commonly used measure of the expected number of children over a woman's lifetime, declined from 2.1 to 1.6 (1).[*] The 2020 figure set a new record for the lowest US fertility rate and prompted widespread concerns about the future of the American family, the strength of the labor force, and the solvency of public programs that rely on the contributions of younger generations.

The COVID-19 pandemic and skyrocketing unemployment rates served to heighten these concerns (Fig. 1*A*). Based on over a century of research describing the negative relationship between fertility rates and unemployment (2–12), demographers expected the pandemic and unemployment to reduce fertility rates significantly. For example, a calculation based on Currie and Schwandt's (9) analysis of the previous four recessions suggests that US births should have fallen by 199,481 more than the prepandemic trend (Fig. 1*B*). The red dotted line shows that the 9-mo lagged unemployment rate predicts that the decline in birth counts should have been on trend for most of 2020, followed by a dramatic decline in 2021.[†] Early in the pandemic, prominent projections by Kearney and Levine (13, 14) found that there might be as many as 300,000 to 500,000 fewer births in 2021, if unemployment stayed high. Wilde (15) predicted a decline in childbearing of 15% by 2021—a decline twice as large as during the Great Recession.

By early 2021, data from the Centers for Disease Control appeared to confirm that a baby bust was in progress. These figures were widely reported (1). The *New York Times* noted that, "The U.S. Birthrate Has Dropped Again. The Pandemic May Be Accelerating the Decline" (16) and *FiveThirtyEight.com* provocatively asked, "How Low Can America's Birth Rate Go Before It's a Problem?" (17).

But the baby bust quickly evaporated. Kearney and Levine later found that an initial reduction in births of 62,000 in 2021 was followed by a rebound and that birth declines were larger in places with greater economic contractions due to pandemic lockdowns and in places with more COVID deaths (18, 19). Consistent with findings by Cohen (2021), one of their more puzzling findings was that over half of the missing births in 2020 appeared to reflect missing conceptions from the period before the COVID pandemic and lockdowns began (20).[‡]

[*]The TFR is the total number of children that a woman would have if she experienced the current period's age-specific fertility rates for the entirety of her childbearing years. While this measure does not reflect the experience of any cohort, it provides a succinct and easily interpretable measure of age-adjusted fertility rates at a point in time.

[†]See *Materials and Methods* for additional details. An alternative version of Fig. 1, which plots the predicted changes in births net of the 2015 to 2019 linear trend and changes in unemployment is shown in *SI Appendix*, Figs. B1 and B2.

[‡]Cohen noted early in the pandemic that births had begun to decline in California and Florida during the summer of 2020, which is too early to have reflected changes in conceptions due to the onset of the pandemic. (See https://osf.io/z5b46, accessed April 1, 2023).

Author affiliations: [a]Department of Economics, University of California, Los Angeles, CA 90024; [b]National Bureau of Economic Research, Cambridge, MA 02138; [c]Center for Health and Wellbeing, Princeton University, Princeton, NJ 08544; and [d]School of Education and Social Policy, Northwestern University, Evanston, IL 60208

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The authors declare no competing interest.

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[1]To whom correspondence may be addressed. Email: jcurrie@princeton.edu.

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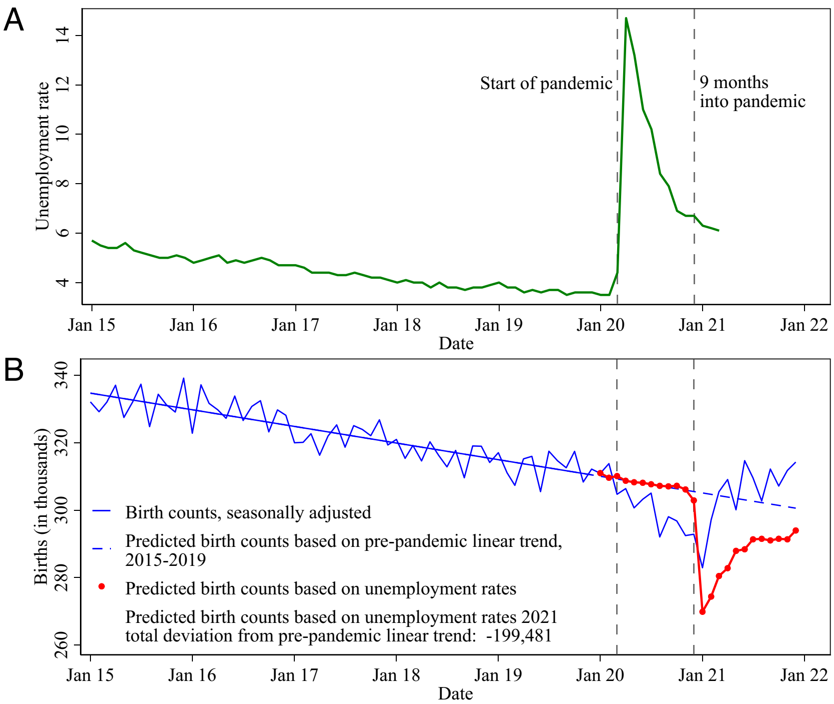

Fig. 1. Changes in the US unemployment rate and predicted changes in births. Subtitles: (*A*) Seasonally adjusted unemployment rate. (*B*) Seasonally adjusted birth counts (actual and predicted). Legend (for *B*): 1. Birth counts, seasonally adjusted – solid blue. 2. Predicted birth counts based on prepandemic linear trend, 2015 to 2019 – dashed blue. 3. Predicted birth counts based on unemployment rates – red dot. *Notes:* (*A*) plots changes in the US unemployment rate from March 2015 to March 2021. (*B*) plots three series: the seasonally adjusted US birth counts from January 2015 to December 2021; a linear trend fit on prepandemic seasonally adjusted birth counts from 2015 to 2019 (solid line) and projected to 2020 to 2021 (dashed line); and the predicted US fertility rate based on changes in unemployment rates based on (9). See *Materials and Methods* for more details about seasonal adjustments and our *SI Appendix*, *Methods Appendix* for more details.

This paper uses microdata covering the universe of childbirths in the United States for 2015 to 2021 and from the state of California through February 2023 to examine fertility changes for different demographic groups in the period leading up to the pandemic and up to 2 y (in the case of California) after the pandemic began. Although California is only one state, it comprises approximately an eighth of the US population and we show that where they can be compared, trends in California match those of the overall United States closely. Our main outcomes are seasonally adjusted birth counts and birth rates, and the absolute and percent deviations of these outcomes from their prepandemic trends. Trends are estimated separately for each subgroup considered.

Our paper provides two reasons why US birth rates deviated from Fig. 1*B*'s projection. First, actual births declined before the unemployment rate could have affected birth rates due in large part to the sharp reduction in births in early 2020 to foreign-born women. We find that 60% of the 2020 decline in US fertility rates was driven by reductions in births to foreign-born mothers although births to this group only comprised 22% of all US births in 2019. US births to foreign-born mothers fell by 45,000 more than expected in 2020 and by 39,000 more than expected in 2021, for a total of 85,000 missing births—a statistically significant 5.2% decrease for 2020 to 2021 relative to a linear projection of the prepandemic trend. These declines in childbearing among foreign-born women can be contrasted with a substantial increase in childbearing among US-born women.

A second reason for the deviation of actual birth rates from predicted birth rates is that births to US-born women surged much more than predicted by the historical relationship between US fertility rates and changes in unemployment rates. The number of births to US-born mothers fell by 31,000 in 2020 relative to a prepandemic linear trend. This decline represents only a 1% fall in births in this group and is not statistically different from the prepandemic linear group–specific trend. In contrast to the declining fertility rates observed after previous recessions, births then increased by 71,000 among US-born mothers in 2021, for a net gain of 40,000 births in 2020 to 2021.

The TFR for US-born mothers was a statistically significant 5.1% higher than a prepandemic linear trend by the end of the 2021. This increase is in sharp contrast to the large decline that models based on previous recessions would have predicted (see the discussion of Fig. 1*B* above). This 2021 "baby bump" among US-born women represents the first substantial reversal in US fertility rates since the 2007 Great Recession and is large enough to reverse 2 y of post-2007 fertility decline. The baby bump was most pronounced for first births and among women under age 25, suggesting that the pandemic led many women to start families sooner. The baby bump was also pronounced among women 30 to 34 and among those aged 25 to 49 with a college degree or more.

While it is difficult to say what the long-term effect of these changes will be, data through February 2023 in California are potentially informative. Although the levels are lower, trends in the TFR for California track those in the rest of the United States through 2021, and the increase in births to US-born women continued in California through February 2023. Using the sustained increase in California to project US fertility rates through February 2023 suggests that there may have been an additional increase of 130,000 births to US-born mothers between January 2022 and February 2023 relative to the prepandemic trend. Births to foreign-born mothers had returned to trend levels by the end of 2022.

1. Results: The COVID-19 Baby Bump

Fig. 2 *A* and *B* plot seasonally adjusted TFRs and birth counts for all US-born and foreign-born mothers from 2015 to 2021 as well as TFRs for both groups giving birth in California through February 2023 (2022 data for the entire United States are not yet available).[§] The straight blue line presents the prepandemic linear trend for all US births, and the dashed line shows its projection through December 2021. For US-born mothers, the patterns in the TFR (left vertical axis) and birth counts (right vertical axis)

[§]*SI Appendix*, Fig. A1 shows patterns for all U.S. (not stratified by mothers' nativity). All US births began to decline around March 2020 and continued to further deviate from trend through January 2021. The pattern for the TFR is very similar. In addition, the TFR for California which is available through February 2023 shows a similar time-series pattern.

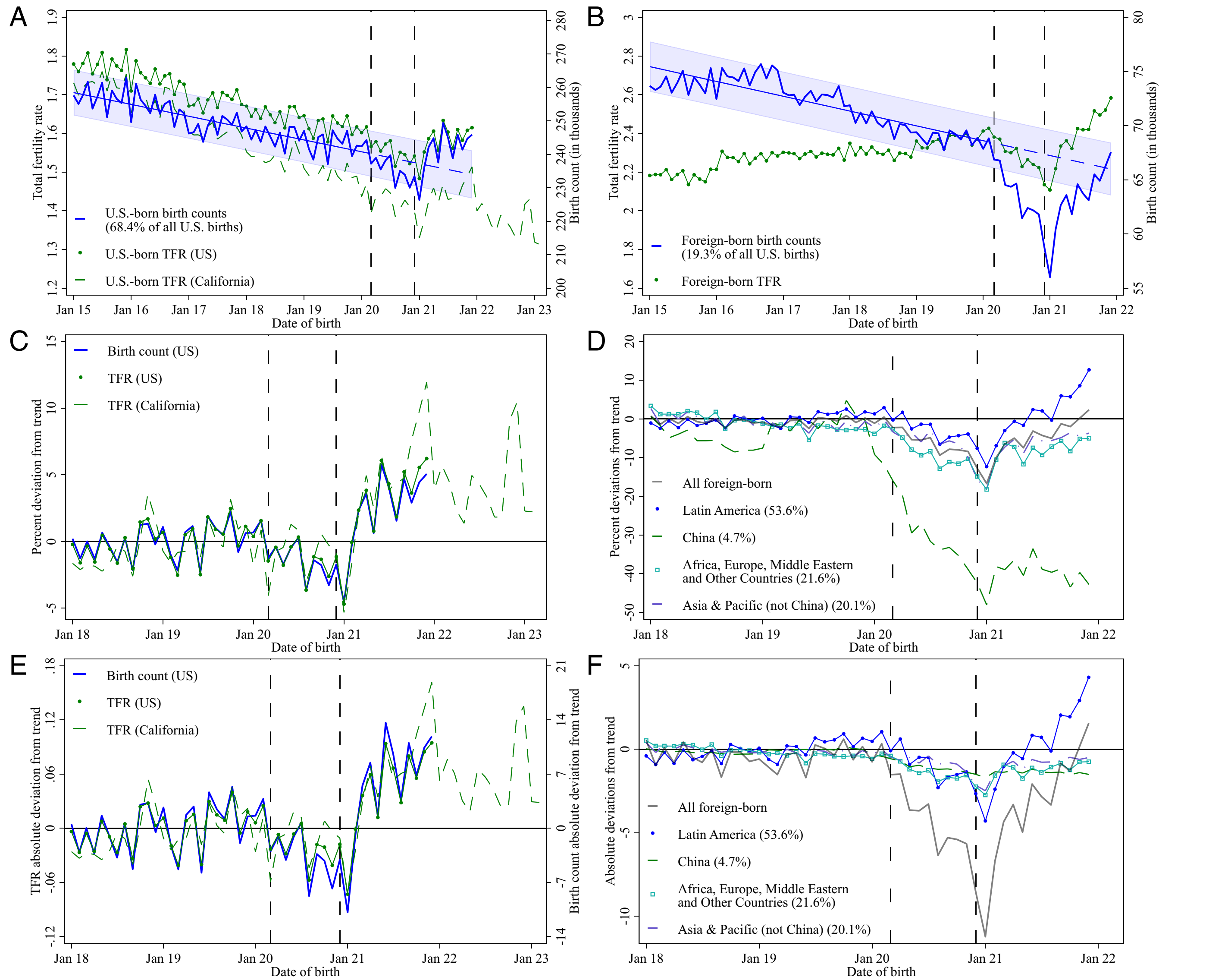

Fig. 2. Seasonally adjusted births and deviations from prepandemic trends, by mothers' nativity. Subtitles: (*A*) Births to US-born women. (*B*) Births to foreign-born women. (*C*) Percent deviations among US-born women. (*D*) Percent deviations among foreign-born women, by mothers' region of birth. (*E*) Absolute deviations among US-born women. (*F*) Absolute deviations among foreign-born women, by mothers' region of birth. Legend: (*A*) Births to US-born women. 1. US-born TFR (US) – green dot. 2. US-born birth counts (78% of all US births) – solid blue. 3. US-born TFR (California) – dashed green. (*B*) Births to foreign-born women. 1. Foreign-born TFR – green dot. 2. Foreign-born birth counts (22% of all US births) – solid blue. 3. Foreign-born TFR (California) – dashed green. (*C*) Percent deviations among US-born women. 1. Birth count (US) – solid blue. 2. TFR (US) –green dot. 3. TFR (California) – dashed green. (*D*) Percent deviations among foreign-born women, by mothers' region of birth. 1. All foreign born – solid gray. 2. Latin America (53%) – green dot. 3. China (5.1%) – dashed blue. 4. Africa, Europe, Middle Eastern, and Other Countries (22%) – teal square. 5. Asia & Pacific (not China) (20%) – long dashed purple. (*E*) Absolute deviations among US-born women. 1. Birth count (US) – solid blue. 2. TFR (US) – green dot. 3. TFR (California) – dashed green. (*F*) Absolute deviations among foreign-born women, by mothers' region of birth. 1. All foreign born – solid gray. 2. Latin America (53%) – green dot. 3. China (5.1%) – dashed blue. 4. Africa, Europe, Middle Eastern and Other Countries (22%) – teal square. 5. Asia & Pacific (not China) (20%) – long dashed purple. *Notes*: Calculations use all births occurring in the United States and stratify by whether the mother was born in or outside the United States. The legends in *A* and *B* indicate in parentheses the percent of all births in the United States in 2019 that occurred to US-born women (*A*) or foreign-born women (*B*). The legends in *D* and *F* indicate in parentheses the percent of all births in the United States to foreign-born women in 2019 occurring to women in the indicated region of birth grouping. See *Materials and Methods* for more details.

track one another closely. The TFR for US-born mothers in California has been falling more quickly and was at a lower level in January 2021 than in the United States overall.

Contrary to the well-known statistical relationship between unemployment and fertility rates described above, neither the TFR nor total births among US-born women show the strong decline predicted by the spike in unemployment seen in Fig. 1. Despite the substantial increase in unemployment, Fig. 2*A* shows that births to US-born women remained mostly within a 95% CI around the prepandemic linear trend throughout the first 9 mo of 2020, falling outside that interval only briefly in August 2020 and again in November 2020 and January 2021.

After January 2021, the TFR and births to US-born women increased. By mid-2021, the measures exceeded the level implied by their prepandemic trend. By the end of 2021, both the TFR and birth counts exceeded their prepandemic trend by around 5% (Fig. 2*C*). This pattern suggests that conceptions increased sharply as early as May 2020 and that this increase in conceptions persisted until at least March 2021.

The 2021 increase in births among US-born mothers above prepandemic trends exceeded the 2020 decline. While births to US-born women in 2020 were 31,104 below the prepandemic trend, they exceeded the trend in 2021 by more than twice this amount—70,865 births—resulting in a net increase

Table 1. US birth counts, birth rates, and deviations from prepandemic trends, 2019 to 2021

	2019	2020			2021			2020–2021
	All births or TFR	All births or TFR	Total dev.	% dev.	All births or TFR	Total dev.	% dev.	Net births relative to trend
A. Births in the United States to women ages 15–49								
Number	3,754,688	3,617,034	−76,304	−2.03	3,666,993	32,777	1.00	−43,528
Total fertility rate (TFR)	1.74	1.68		−1.86	1.70		1.38	
B. Births in United States to women ages 15–49, by nativity of mother								
Number, US-born mothers	2,919,763	2,839,025	−31,104	−1.06	2,898,521	70,865	2.58	39,760
TFR, US-born mothers	1.62	1.56		−0.95	1.58		3.00	
Number, foreign-born mothers	826,991	770,561	−45,338	−5.41	760,240	−39,257	−4.67	−84,595
Number, nativity not specified	7,934	7,448	138	2.16	8,232	1,169	18.88	1,307
C. Number of births in United States to foreign-born women, by mothers' region of birth								
Asia & Pacific (not China)	166,181	157,383	−9,314	−5.43	153,412	−11,213	−6.65	−20,527
China	42,569	31,033	−11,674	−25.87	25,496	−16,917	−39.68	−28,592
Latin America	439,270	415,680	−9,327	−2.09	416,913	4,154	1.43	−5,173
Africa, Europe, middle eastern and other countries	178,971	166,465	−15,022	−8.10	164,419	−15,281	−8.37	−30,303

Notes: Columns labeled "All births or TFR" present the number of births in the U.S. or the TFR for the indicated calendar year. "Total deviation" is computed by summing over the difference between the seasonally adjusted, monthly births or fertility rates and the pre-pandemic trend for the indicated year. "% deviation" is calculated by dividing the total deviation by the average level of the trend in the same year. "Net births relative to trend" is calculated by adding the total deviations in 2020 and 2021 together. "Number" indicates the total count of births in a calendar year. See *Materials and Methods* for more details. * dev. stands for "deviation."
Sources: Authors' calculations using natality data for all births in the United States for January 2015 to December 2021 from the National Center for Health Statistics (NCHS).

of around 40,000 births over the entire 2020 to 2021 period (Table 1*B*).

SI Appendix, Fig. A2 shows that using a linear prepandemic trend that is estimated from 2015 through the end of 2019 is a conservative choice when measuring the pandemic baby bump. Estimating nonlinear trends over a longer period going back further in time or including births up to November 2020 (9 mo after the latest prepandemic conceptions) yields a smaller shortfall in births to US-born women in 2020 and a larger baby bump in 2021. Alternative trend choices are further discussed below.

As shown in Fig. 2 *C* and *E*, the deviations from trend tend to be similar in California and the United States though the California deviations are higher at the end of 2021. California's TFR remained higher by an average of 4.15% from January 2022 through the end of February 2023. If patterns among US-born mothers in the United States remain as elevated as in California—as they did before, during, and after the pandemic—then the national baby bump among US-born mothers will be seen to have extended through February 2023. A continued positive deviation of 4.15% in 2022 and through February 2023 would imply around 134,000 additional births among US-born mothers over that time period relative to a linear prepandemic trend.[¶] The total estimated net increase among US-born mothers since the beginning of the pandemic through the first quarter of 2023 would then amount to an excess of up to 174,000 births relative to prepandemic trends (134,000 projected additional births from January 2022 to February 2023 plus the 40,000 births for 2020 to 2021 from Table 1).

In contrast to births among US-born mothers, Fig. 2*B* shows that both the TFR and births to foreign-born women fell sharply beginning in the early months of 2020. Births to foreign-born women continued to fall until early 2021, after which they recovered, bringing births among foreign-born women back to the prepandemic trend by the end of 2021. The TFR for foreign-born women also reverted to close to its prepandemic trend.[#] Data for California suggest that fertility for foreign-born women may have begun to rise above trend in 2022, although not by enough to offset declines in 2020 and 2021.

Table 1*B* shows that births to foreign-born women fell by more than 45,000 in 2020. Consequently, around 60% (45,000/76,000) of the reduction in overall US births during the first 9 mo of the pandemic in 2020 was due to a decline in births to foreign-born women even though they accounted for only 22% of total births in 2019. In 2021, births to foreign-born women continued to remain 4.7% lower, amounting to 39,000 fewer births than predicted by the prepandemic linear trend.

Fig. 2 *D* and *F* break these patterns down by country of origin for foreign-born mothers. Although births to women born in China typically make up less than 5% of births in the United States, births to this group fell precipitously after January 2020, falling by proportionally more than among other groups of foreign-born mothers. This steep decline exceeded 40% by January 2021, and unlike births to other foreign-born mothers, births to women born in China remained consistently low through December 2021.

Although the percent decline in births was largest among mothers born in China, the largest absolute change in births to foreign-born women is due to reductions in childbearing among women born in Mexico and Latin America (Table 1*C*). These women accounted for 54% of all births to foreign-born mothers in 2019, and for 12% of total US births. These births began to fall early in the pandemic and then started to rise again in January 2021, exceeding the prepandemic trend by mid-year.

[¶]Note that the estimated 1/2022 to 2/2023 deviation of around 134,000 births is substantially larger than the estimated 2021 deviation of around 71,000. This is because the 12 mo of 2021 included two months with negative birth deviations while the later period consists of 14 mo which all experienced positive deviations.

[#]The TFR for foreign-born women is rising while the birth counts are falling which suggests that the number of births to foreign-born women is falling more slowly than changes in the population counts of foreign-born women would suggest.

Table 2 and *SI Appendix*, Figs. A3–A7 break down the baby bump for US-born women by demographic group to uncover clues about the mechanisms driving these patterns. Prepandemic linear trends are estimated for each of the subgroups separately, and deviations from linear trends are calculated relative to each group's prepandemic trend (see details in the *Material and Methods* section below). *SI Appendix*, Figs. A3–A7 plot birth rates by month and their percent deviations from trend by age group, birth parity, race/ethnicity group, marital status, and educational attainment. The panels showing deviations from trend also plot the data for California. One can see that in most cases, the patterns for 2021 continued through 2022 in California, suggesting that they may also have continued for the United States as a whole.

Childbearing responses to the pandemic among US-born women varied sharply by age group. Table 2*B* shows that the two youngest age groups did not experience a baby bust at all in 2020: Births in these groups exceeded the prepandemic trend by 9,000, or 4%, in 2020. In 2021, births to 15 to 24-y olds exceeded the trend prediction by 28,000. For 25 to 29- and 30 to 34-y olds, births fell insignificantly in 2020 relative to the prepandemic trend. In 2021, women aged 25 to 29 saw a decrease of 1.7%, whereas those aged 30 to 34 saw an increase of 6% relative to trend. Aggregating over both 2020 and 2021, women aged 25 to 34 had around 5,000 more births than would have been expected based on linear prepandemic trends.

Births to women aged 35 and older show a modest decline relative to prepandemic trends in 2020. These dips, however, quickly reversed, and older women's childbearing showed large jumps in 2021—for women 40 and older, the birth rate peaked at 13% above trend by mid-2021. Table 2*B* summarizes these changes in 2020 and in the first postpandemic year, showing that net decreases in childbearing for 25 to 29- and 35 to 39-y olds were offset by gains for other groups, resulting in a net 40,000 births relative to the prepandemic trend by the end of 2021. The California data suggest that the age groups that gained births continued to do so in 2022.

Table 2*C* shows that childbearing responses to the pandemic vary by parity. The COVID-19 baby bump was largely driven by first and, to some extent, second births rather than by higher order births. Although second and higher-order births among US-born women declined in 2020, first births rose slightly relative to the prepandemic trend. In 2021, first births rose by 5.3% and second births by 3.0%, whereas higher order births fell by 1.4%. *SI Appendix*, Fig. A4 shows a spike in births in February 2021, suggesting that large increases in the number of these conceptions had already begun by May 2020. In contrast, births of parity three and higher declined through December 2020 before returning to their prepandemic trend by mid-2021. The California data suggest that second-order births may also have returned to trend by the end of 2022, though first births remained elevated.

Table 2*D* explores differences in childbearing responses to the pandemic by race/ethnicity for US born women. The results show that the COVID-19 baby bust in February 2021 was largest among non-Hispanic Black and Hispanic/Latina women (*SI Appendix*, Fig. SA5), and that the baby bump over the rest of 2021 occurred primarily among non-Hispanic White and Hispanic/Latina women as well as Asian/Pacific Islander women. In 2021, non-Hispanic White, Non-Hispanic Asian/Pacific Islanders, and Hispanic/Latina women gave birth to 3.9%, 5.1%, and 3.5% more children than expected relative to the prepandemic trend, and these groups' birth rates remained elevated at the end of 2021. In contrast, births among Non-Hispanic Black women declined by −3.3% more than the prepandemic trend through 2021 and remained below the prepandemic trend through 2021. The California data suggest that births to non-Hispanic White women, Hispanic/Latina women, and Asian/Pacific Islander women remained elevated in 2022.

Table 2*E* breaks down childbearing responses to the pandemic by marital status. California no longer includes marital status on the birth certificate, so these calculations are missing for approximately one-eighth of the population, and we have no data for 2022. Over our sample period, approximately 40% of US births were to unmarried mothers. Married women show both a larger (and earlier) baby bust in 2020 as well as a larger baby bump in 2021.[‖] In contrast, unmarried women show little evidence of a baby bust (except in January 2021) and also less of a baby bump. One important caveat to these results is that marriage rates also changed in response to the pandemic. One study estimates that marriage rates fell by 12% in 2020 relative to what would have been expected (21). Many of these marriages appear to have been postponed until they could be safely held. If marriages were postponed but childbearing was not, this could cause a dip in marital births and an increase in non-marital births, which could offset a downturn in nonmarital fertility rates among women who were not postponing weddings.

In the last section, Table 2*F* reveals striking differences by mother's educational attainment. Because college education was itself affected by the COVID-19 pandemic, the sample is restricted to women aged 25 to 49. *SI Appendix*, Fig. A7 shows that women with 4 or more y of college showed little evidence of a baby bust in 2020 relative to their prepandemic trend, but their birth rates surged in 2021, exceeding the trend by 6.9%. California data suggest that these rates continued to be elevated in 2022. In contrast, women aged 25 and over with less than 4 y of college education saw declines in birth rates relative to trend in 2020 but returned to their prepandemic trend by the middle of 2021. Women with less than a college education did not experience a baby bump.

2. Discussion

This paper starts from the fact that in 2020 US fertility rates declined by much less than would have been predicted by standard statistical models given the large changes in unemployment and uncertainty created by the pandemic. This paper's first contribution is to show that the declines in childbearing in 2020 reflect disproportionally large declines in births among foreign-born mothers. A second contribution is to show that there was a large and unexpected increase in childbearing in 2021 among US-born women, which we break down by population subgroups. Data for California suggest that the increases in US births to US-born women are likely to have continued into February 2023. A third contribution is that we show that the timing of the 2020 baby bust was different for foreign-born and US-born mothers. For the former, births began to decline in January 2020, while the declines for US-born women, in addition to being small in percentage terms, did not become apparent until many months after the pandemic began.

The COVID-19 recession is the first in recent history that was not followed by a baby bust. In a resounding rejection of this well-documented statistical relationship, the 2020 COVID-19 recession was followed by a surge in births, which marked the first substantial reversal in declining fertility rates since the Great Recession. The US experience does not appear to be unusual. A review of 22 countries' fertility rates after the COVID-19 pandemic finds that Finland and South Korea show evidence of increased

‖We also examined marital and nonmarital births by age and found that within 5-y age groups, trends were similar for married and unmarried women except for 25 to 29-y olds. In this age group, births to married women fall during 2020 and then rise above trend. However, unmarried women in the 25 to 29-y-old age group saw declines in births in 2020 which then flattened out and had not returned to trend by December 2021.

Table 2. US birth counts, birth rates, and deviations from prepandemic trends among US-born women, 2019 to 2021, by subgroup

	2019	2020			2021			2020–2021
	All births or TFR	All births or TFR	Total dev.	% dev.	All births or TFR	Total dev.	% dev.	Net births relative to trend
A. Number of births in United States to US-born women ages 15–49								
Number	2,919,763	2,839,025	−31,104	−1.06	2,898,521	70,865	2.58	39,760
Total fertility rate (TFR)	1.60	1.56		−0.95	1.58		3.00	
B. Number of births in United States to US-born women, by age group								
Age 15–19	150,807	139,456	3,682	2.79	128,298	5,082	4.50	8,764
Age 20–24	602,605	572,030	5,124	0.93	558,700	22,541	4.34	27,666
Age 25–29	871,810	835,379	−29,370	−3.35	840,517	−14,588	−1.66	−43,958
Age 30–34	818,576	817,066	937	0.14	864,276	48,048	5.95	48,986
Age 35–39	397,945	395,514	−12,515	−2.96	421,357	4,348	1.12	−8,167
Age 40–44	73,552	75,195	1,028	1.55	80,712	5,065	7.02	6,093
Age 45–49	4,468	4,385	9	1.55	4,661	368	10.21	377
C. Number of births in United States to US-born women, by parity								
First birth	1,128,390	1,114,401	12,862	1.18	1,133,890	55,664	5.26	68,526
Second birth	933,970	900,826	−13,718	−1.47	926,074	25,932	2.96	12,214
Third or higher	850,677	818,531	−30,757	−3.57	832,138	−12,243	−1.40	−43,000
Not specified	6,726	6,267	509	13.61	6,420	1,512	35.42	2,022
D. Number of births in United States to US-born women, by race/ethnicity								
White Non-Hispanic women	1,785,360	1,721,009	−20,449	−1.15	1,765,038	65,357	3.92	44,908
Hispanic/Latina women	495,350	494,367	−311	−0.04	513,161	16,566	3.47	16,255
Black Non-Hispanic women	456,768	443,650	−7,686	−1.67	432,160	−15,130	−3.32	−22,816
Asian/Pacific Islander women	52,517	52,471	−476	−0.83	56,515	2,646	5.10	2,170
Other or not specified women	129,768	127,528	−2,181	−1.65	131,647	1,426	1.19	−756
E. Number of births in United States to US-born women, by marital status								
Married women	1,508,948	1,459,346	−25,972	−1.71	1,520,111	58,288	4.07	32,316
Unmarried women	1,121,216	1,098,742	−2,272	−0.19	1,089,939	2,897	0.34	625
Not specified	289,599	280,937	−2,861	−0.99	288,471	9,680	3.61	6,819
F. Number of births in United States to US-born women ages 25 to 49, by education								
Number, ages 25 to 49	2,166,351	2,127,539	−39,911	−1.80	2,211,523	43,242	2.05	3,331
Less than 4 y of college	1,217,391	1,185,819	−34,400	−2.77	1,196,528	−23,077	−1.84	−57,477
Four or more years of college	924,956	918,175	−5,267	−0.53	987,695	63,435	6.94	58,168
Not specified	24,004	23,545	−242	−0.86	27,300	2,886	12.64	2,644

Notes: "Other or not specified women" for race/ethnicity groups the following women together: women identifying as American Indian/Alaskan Native, women identifying as more than one race, and women who do not indicate their race or ethnic group. Some states are missing information at points in time. Country of birth and education is missing for Connecticut in 2015 and in New Jersey for Q3 2014 to Q4 2015. We project education and country of birth outcomes for states with missing outcomes as described in *Materials and Methods*. Marital status is missing for California for 2017 to 2021, so California is in the "not specified" category in all years. * dev. stands for "deviation." See also Table 1 notes and *Materials and Methods* for more information.
Sources: See Table 1 notes.

fertility rates, 14 countries show no significant change, and six countries (primarily in the Mediterranean and East Asia) exhibit reduced fertility rates (22). Using the data for California, which have trends that track the overall US data closely, we project that US births to US-born women remained elevated through February 2023. Importantly, the increases in fertility among US-born women not only made up for declines in the initial stages of the pandemic but resulted in a net increase of 40,000 births for the 2020 to 2021 period, and possibly for an additional 134,000 births from January 2022 to February 2023. If and when fertility rates return to their long-term trend, there is likely to be a larger pandemic-era birth cohort going forward.

One reason for the reversal of the standard relationship between unemployment and fertility is that the COVID-19 recession was unlike previous downturns. In an unprecedented response to job losses affecting 22 million workers, the federal government spent $650 billion in federal pandemic unemployment benefits between March 2020 and September 2021 (23). These programs might have mitigated the fertility reductions that are usually observed in response to job losses (24). The U.S. Census Bureau reports that, as a result of these programs, poverty fell in 2020 in every race and age group (25). Moreover, the increase in unemployment was short-lived relative to previous recessions. By December 2020, unemployment had fallen from a high of 14.7% to a still elevated 6.7%. Hall and Kudlyak note that the "unprecedented burst of temporary layoffs early in the pandemic [was] followed by their rapid reversal from April to November 2020... [however] We show that, after we account for the unusual surge in temporary layoffs, the unemployment pattern in the current recovery is actually similar to the past" (26). In addition to the unusual number of temporary layoffs, other changes included the fact that more affluent families saw increases in the value of their assets as both stock markets and home prices soared (27). And employment opportunities for women dried up as the "shecession" affected the service industries employing women more than traditionally male employments like manufacturing (28).

The standard economic model of fertility emphasizes both the income effects of recessions and the impacts of changes in the opportunity cost of childbearing (29). In the case of COVID-19, both reduced employment and greater work from home as well as pandemic aid may have increased childbearing for certain groups. For example, the reduction in in-person employment may have reduced the opportunity cost of having a child while additional income from pandemic aid loosened budget constraints.

Working backward from the timing of births implies that increases in conceptions among US-born women started about the time that the first economic stimulus checks arrived in Americans' bank accounts. More generally, many women saw little income loss and even income gains due to pandemic support programs, which *ceteris paribus* would tend to raise fertility rates.

Research into changes in fertility rates after the pandemic suggests a number of additional reasons for changes in childbearing, including changes in pregnancy desires, the use of contraception, intimacy patterns, relationship status, and maternal stress. Survey data show that many US women planned to delay or avoid childbearing due to the pandemic and that these planned delays were especially pronounced among lower wage women and racial minority women, who experienced greater economic hardship and more COVID-19 cases (30, 31). On the other hand, the college-educated women we examine are older (over 25) and may have had less scope to delay childbearing in the face of continuing pandemic-related uncertainty. Moreover, the effect of pandemic lockdowns themselves may have encouraged childbearing, similar to research that finds that severe storm warnings induced spikes in births 9 mo later (32, 33).

Researchers have used GoogleTrends data to understand changes in pregnancy desires with mixed results. One study finds little evidence of changes in Google searches related to fertility (34), but another predicts, based on Google keyword searches relating to conception and pregnancy, that Black women and women with less than a college education were more likely to experience declines in childbearing—a prediction this paper substantiates (1). There may also have been biological factors associated with reduced fertility conditional on people's desires. For example, some evidence shows that maternal stress reduces the likelihood of childbirth 9 mo later by reducing the release of pregnancy supporting hormones in the early months of gestation (35).

Offsetting declines in desired childbearing and biological effects of stress is the reduction in access to reproductive health-care services and abortion. In some cases, reproductive health services completely shut down (36), which may have increased unintended pregnancies at younger ages by reducing access to contraception (37) as well as reducing fertility rates at older ages by affecting access to assisted reproductive technologies (ART) (38). *SI Appendix*, Fig. SA8 shows a reduction in the share of births to mothers using ART and in the number of multiple births (which are associated with the use of ART).

Breakdowns for US-born women by demographic group provide clues about which mechanisms may have been operating. The baby bump was most pronounced for first births and women under age 25, which suggests that the pandemic led some women to start their families earlier. Above age 25, the baby bump was pronounced for women aged 30 to 34 and women with a college education. In contrast, we find larger declines among Black women, who were hard hit by both the recession and pandemic.

Understanding why the baby bump was concentrated in some groups of US-born mothers is complicated as the explanation is likely to be multifaceted. The pandemic led to a historic rise in remote work, particularly for more educated workers, and 40% of days worked were still at home by spring 2021 (39). This may be one reason that the baby bump was stronger among college-educated women since working from home could reduce the opportunity costs of having a child. Consistent with this idea, there were much larger gains in fertility among childless women (i.e., mothers with first births) who, in addition to increased flexibility, did not have to manage the loss of day care and schooling opportunities for older children.

These observations highlight the potentially significant role that the organization of labor markets and childcare markets may be playing in driving the long-term US fertility decline. For example, one study suggests that institutions such as stable public sector employment and maternity leave are important determinants of fertility (7). Another focuses on the burden of childcare for working mothers, showing that it is a major determinant of the "motherhood penalty" in women's wages, which in turn may also discourage childbearing (40). To the extent that work-from-home trends begun during COVID-19 lockdowns help mitigate these barriers to motherhood, childbearing may continue to be elevated for groups who can take advantage of them.

Black women are the only race/ethnic group who showed a pandemic decline in fertility *without* a subsequent recovery. Black people suffered the largest economic losses (41) as well as a disproportionate burden of COVID morbidity and mortality (42, 43). By the end of 2022 in California, fertility rates for this group still had not rebounded. The trauma of the pandemic may continue to depress fertility rates for the worst affected groups. In short, different experiences with the pandemic may have led to very different fertility responses across groups, which are still playing out in 2023.

Turning to the timing of the downturn in births, one possible explanation for declining birth rates in early 2020 is that the COVID-19 recession was anticipated. Research shows that conceptions are typically a "leading indicator" of recessions (44). However, unlike other recessions in recent memory, the COVID-19 recession did not emerge from deteriorating economic circumstances (which could have been felt by individuals planning their families) but from an unexpected pandemic and ensuing lockdowns to contain its spread. In June 2019, the US unemployment rate was very low at 3.6% and it remained at 3.5% until February 2020. The 2019 GDP growth rate of 2.3% was the same as in 2015 and higher than in 2016 or 2017 though it was lower than in 2018 when it was 2.9%. To look for signs of fears about the economy, we used GoogleTrends to search for discussions about recession in the summer and fall of 2019 (results shown in *SI Appendix*, Fig. SA9). There was little discussion of impending recession except for a 1-wk spike in mid-August. In short, there is little evidence that the economy was sliding into recession prior to the pandemic or that the COVID-19 recession, brought on by rapid lockdowns, was expected.

For the shortfall in births beginning in early 2020 to reflect falling conceptions, behavioral changes would have had to begin by June 2019—well before COVID-19 had been identified and before there was any evidence or even talk of future recession. Moreover, these changes in conceptions in 2019 would have had to occur among foreign-born women, but not among US-born women, to match the distinct patterns in these populations. All things considered, changes in conceptions starting in mid-2019 are unlikely to explain the patterns.

Turning to the results for foreign-born women, one explanation for the sharp reduction in births to foreign-born mothers in early 2020 relates to the Trump Administration's restrictions on travel from foreign countries to contain the spread of COVID-19. Restrictions on individuals traveling from China were enacted in January 2020 and then restrictions were extended to individuals traveling from Mexico, Canada, and most European countries in March 2020. Births to Chinese-born women began to decline in January 2020, and births to Mexican and Latin American women began to decline in March 2020—changes which correspond closely to the implementation of these travel restrictions.

The Trump administration also issued a controversial January 2020 ban on pregnant women entering the country on tourist visas.[**] This ban was explicitly aimed at preventing "birth tourism," a term referring to foreign nationals who enter the United States on tourist visas, give birth, and then return to their home countries, presumably so that their children can gain US citizenship. Although it is extremely difficult to quantify, this phenomenon has received increasing attention in recent years, with much of that attention focused on Chinese nationals. Estimates of the number of pregnant Chinese-born women entering the United States to give birth before returning home range from 10,000 to 50,000 per y (45, 46). There have also been recent immigration crackdowns on agencies and organizations facilitating such travel (47).

One piece of evidence consistent with the idea that reductions in US births to foreign nationals drove at least some of the sharp decline in births starting in January 2020 is that the number of US births that were self-paid (rather than paid by insurance) fell sharply starting in January 2020 (*SI Appendix*, Fig. SA10). Anecdotal reports suggest that many women entering the country to give birth pay out of pocket.[††]

The COVID-19 recession and lockdowns may also have reduced the number of migrants coming to the United States to seek or hold jobs. Cherlin and coauthors argue that the substantial drop in fertility seen among Mexican-born women during the Great Recession can be explained by the recession's effect on the inflow of new Mexican migrants, since these new migrants historically have had higher fertility than Mexican-born women who have been in the United States for some time. He notes that, "the reasons for this sudden drop in net migration include the decline in employment opportunities during the Great Recession, along with heightened border enforcement and the difficulty and danger of border crossings…The consequences for fertility are straightforward" (p. 222) (48).

While most foreign-born mothers are US residents, the declines in births to foreign-born mothers began in January 2020, coinciding with this policy change and with more general pandemic travel restrictions, and suggesting that such policy changes may have been important on the margin. The decline in births to foreign-born mothers may have also reflected some foreign-born pregnant women who are usually US residents returning to their country of origin during lockdowns to be with family.

It is also important to note that with the important exception of Black US-born women, the 2020 reductions in childbearing are concentrated among the foreign-born per se, rather than in a particular race or ethnic group. *SI Appendix*, Fig. A11 shows that if we break Hispanic/Latina women and Asian/Pacific Islander women into the US-born and the foreign-born, US-born mothers in both groups look quite similar to other US-born women, whereas births to foreign-born Asian/Pacific Islander and Hispanic/Latina women fall starting in January 2020 and March 2020, respectively.

Births to foreign-born mothers recovered but did not exceed prepandemic trends in 2021. The V-shaped pattern in births to foreign-born women shown in Fig. 2*B* may reflect two countervailing trends. If foreign-born mothers who are US residents experienced the same surge in childbearing as US-born mothers in 2021 (as *SI Appendix*, Fig. A11 suggests), then this could have offset declines in childbearing among foreign-born women who were also foreign nationals. US birth certificates do not record citizenship making it impossible to investigate this hypothesis statistically in our data.[‡‡]

These estimates highlight the important role that foreign-born women play in bolstering US fertility rates. Without these births, the US TFR would be 0.12 births lower and closer to European countries such as Norway or Germany. Moreover, the fact that the fall in births to foreign-born women occurred contemporaneously with disruptions to international travel and the recession suggests that the phenomenon of foreign nationals giving birth in the United States may be an important one that is worthy of further study.

Our results should be interpreted with some limitations in mind. One important limitation of a deviations-from-trends analysis is that the size of the deviation depends on how the trend is measured. There is no theoretical reason, for example, that trends must be linear over time or that prepandemic trends should continue indefinitely. In addition to considering the shape of the trend, one might also choose alternative periods over which to estimate prepandemic trends.

To evaluate the sensitivity of our results to alternative choices, *SI Appendix*, Fig. A2 shows prepandemic trends estimated over different time windows. Whereas trends in birth rates appear linear in the short run between 2015 and 2019, a quadratic fits the data better when extending the period to 2011. However, our conclusion that foreign-born women drove the 2020 baby bust and that US-born women drove the 2021 baby bump is robust to multiple alternative specifications. For example, a comparison of the alternative trend lines in *SI Appendix*, Fig. A2 *E* and *F* shows that trends calculated over a longer period suggest a larger baby bump among US-born mothers in 2021 compared to our baseline trend specification, while still indicating a large negative trend deviation for foreign-born mothers in 2020.

3. Materials and Methods

This analysis draws on natality data and population estimates to create seasonally adjusted estimates of childbearing between 2015 and 2021 for the United States and between 2015 and February 2023 for California. The following sections discuss data and methods. See *SI Appendix*, Section C for additional information on data access and replication.

[**]See https://help.cbp.gov/s/article/Article1838 (accessed April 1, 2023) for more information about the policy change.

[††]Some foreign nationals apparently receive advice about how to claim Medicaid eligibility suggesting that the decline in the number of self-paid births may understate the fall in the number of foreign nationals giving birth in the United States (37).

[‡‡]Birth certificates contain information on place of residence, but 99.73% of certificates report a US residence suggesting that births to foreign nationals are not well captured.

3.1. Natality Data. Natality data are from the National Center for Health Statistics for 2011 to 2021 and the California Department of Health for January 2015 to February 2023 (49, 50). Although California mothers are slightly older and more educated than US mothers on average, the state is home to one-eighth of the US population and allows us to provide a rich description of multiple subgroups through February 2023. In contrast, national microdata are currently only available through December 2021.[§§] Natality data contain detailed information about every birth in the US and California, respectively, including the month and year of the birth and birth order (e.g., first birth, second birth). The data also include the nativity of the mother, mother's race and ethnicity, age, and education. The subsample of US-born mothers includes those born in the 50 US states, the District of Columbia, and US territories. Although this analysis focuses on births that occurred in 2020 through 2021 (or February 2023 for California), births in 2015 to 2019 and alternatively 2011 to 2019 were also examined to estimate the prepandemic natality trends and assess deviations from them.

3.2. Construction of Fertility Rates. The analysis focuses on birth counts, TFRs, and birth rates to allow comparisons to other estimates in the literature and to aid in interpretation. The TFR, which projects the number of children a woman would have over her lifetime if she experienced the age-specific birth rates in a particular period, is calculated for month *m* as follows:

$$TFR_m = 5 \times \sum_a \frac{12 \times births_{a,m}}{population_{a,m}},$$

where *births* captures the number of births to women in age group *a* in month *m*, and *population* is the number of women in age group *a* in month *m*. Age is grouped in 5-y age intervals for women aged 15 to 49. Rates are multiplied by 12 to translate monthly birth rates into an annual equivalent to facilitate comparisons with more typically reported annual TFRs. Multiplying by five relates to the fact that birth rates are measured for 5-y groups, and hence women are expected to experience an age-group specific birth rate for 5 y.

In addition, birth rates by month *m* are computed for specific demographic groups *g* as follows:

$$B_m^g = \frac{12{,}000 \times births_m^g}{population_m^g},$$

where $births_m^g$ is the number of births to women in group *g* in month *m*, and *population* is for the same group in the same month. It is standard to report birth rates per 1,000 in the population, and multiplying by 12,000 translates monthly birth rates into an annual equivalent which facilitates comparisons with annual birth rates.

Groups *g* are defined as 5-y age groups[¶¶], race groups[##] (White Non-Hispanic, Black Non-Hispanic, Hispanic/Latina, Asian/Pacific Islander Non-Hispanic), marital status, education groups (high school or less, some college, college attainment), and birth parity (first birth, second births, or higher order births). One complication relates to the rise of multirace reporting, because the incidence of people reporting that they are multirace has risen dramatically over the last decade. For transparency, our main results by race classify only individuals who report a single race group. *SI Appendix*, Fig. SA12 reports supplemental figures for women reporting multiple races or without a race/ethnicity specified.

Information on mothers' education and their country of birth is missing from birth certificates for Connecticut in 2015 and for New Jersey in the third and fourth quarter of 2015. This missing information induced discontinuous changes in birth counts and fertility rates, which affected the estimation of prepandemic trends. To correct this problem, the missing information is extrapolated assuming that these characteristics followed the trend observed in 2016 to 2019—an assumption that was verified in states without missing data. In particular, the share of births in each subcategory is first calculated at the state-year level. Then the predicted shares are calculated for each reported group in each subcategory by estimating a regression for each group-subcategory and state with the share as the dependent variable and the date as a linear predictor, using nonmissing information across all years prior to 2020. Birth counts in missing categories and years are then replaced for the states of interest by calculating the total monthly birth counts and multiplying that number by the predicted shares for each month in the missing year.

3.3. Population Estimates. Fertility rates are calculated to aid in interpretation of the results and to facilitate comparisons with other population estimates. Calculations of fertility rates require population estimates, which are difficult to estimate during periods like the pandemic, when individuals may change their country of residence. For instance, the exact number of foreign-born women in the United States in any month in 2020 is unknowable, because migration flows experienced changes due to the pandemic. In addition, well-documented problems with the 2020 Census complicate the direct calculation of populations in 2020 and 2021 (51). Consequently, indirect methods were used to compute populations by group, which helps avoid some issues with measurement error. Moreover, all results are also presented using birth counts, so that the results are not driven by the construction of the population estimates.

Overall population counts (and by age group, nativity, marital status, race and ethnicity group, and education group) were calculated by mother's individual birth-year cohort based on the mean population in the 5-y American Community Surveys (ACS) for 2015 to 2019 (52). To avoid problems with the 2020 Census and 2021 ACS enumeration, the cohort population was assumed to remain the same in 2020 and 2021 (for California through February 2023). This number will overstate the population denominators in these years slightly due to deaths and emigration, but these outcomes are rare for women of childbearing age. Denominators may be less reliable for foreign-born women. Annual population counts are assigned to December of the corresponding calendar year and smoothed across months using cubic interpolations to avoid inducing discontinuities or kinks in population denominators. This procedure results in population estimates by month.

For US-born mothers, cohort counts are summed up to correspond to the groups *g* defined previously. (For race and parity birth rates, women 15 to 49 are used to construct the population denominators. For comparability with the natality data, our denominators for race/ethnicity groups only count individuals in single-race categories.) Education birth rates are based on a narrower sample of women aged 25 to 49, because they are more likely than younger women to have completed their education. Younger women may have had their education disrupted by the pandemic. To account for the fact that education increases with age, education shares in 2015 to 2019 are regressed on age-specific linear trends to predict each cohort's educational distribution in 2020 and 2021. Population estimates by subgroup are plotted in *SI Appendix*, Fig. SA13.

3.4. Seasonal Adjustment, Prepandemic Trends and Deviations from Trends. Childbearing is highly seasonal, and seasonality differs across population subgroups (53). To adjust for seasonality, monthly birth counts or rates from 2015 to 2019—overall and for each specific subgroup—are regressed on calendar month fixed effects. The regression is estimated using the prepandemic period. Residuals are then computed for the entire period, either for January 2015 to December 2021 in the United States or January 2015 to February 2023 in California. These residuals are then added to the mean of the outcome for 2015 to 2019, so that the level (either the count or rate) is easily interpretable. We refer to these constructs as "seasonality adjusted" birth or fertility rates, and this is what is used in the analysis.

[§§]We have also searched state vital statistics offices in search of additional state data to inform this study. At the time of our writing, other large states tended to release aggregate data on birth rates only through 2020 or 2021. For example, Florida has data through 2021, Illinois only posts birth counts through 2020, Pennsylvania has data available through 2020, New York has data through 2020, Texas has data through 2020, and Wisconsin only has data available through 2020. To the best of our knowledge, California is unique in making its microdata available for as recently as February 2023.

[¶¶]Due to small sample sizes, we group 40 to 44- and 45 to 49-y-old women into a 40+ category for the age-group analysis.

[##]In the Vital Statistics Natality data, the six race classifications are American Indian or Alaska Native; Asian; Black or African American; more than one race; Native Hawaiian or Other Pacific Islander; White; Unknown or Not Stated. In the ACS, individuals can choose White, Black or African American, American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander, or Other Race, and can check more than one box. In our primary analysis of natality and ACS data, individuals reporting multiple races are omitted from the estimates by race.

Trends in seasonally adjusted births or birth rates are computed separately for each group, *g*, by regressing these outcomes on a linear trend in months using data for the prepandemic period, January 2015 to December 2019, which is plotted as a solid line in the figures (Kearney and Levine (19) seasonally adjust monthly birth data using month fixed effects and estimate pre-pandemic trends using all U.S. births from October 2016 to September 2020 (16). The use of all 2020 data in the pretrend estimation means their prepandemic trend will be more sharply downward sloped due to changes occurring in early 2020 in response to the pandemic as we show in *SI Appendix*, Fig. A2.). The figures present the projection of this trend as a dashed line in January 2020 to December 2021 for the United States overall and through February 2023 for California. In addition, 95% CI for the linear prediction are displayed as a shaded region on the figures. Total deviations from prepandemic trends are computed by taking the difference in monthly births or fertility rates from the trend at a particular point in time or by summing over all months in a period. Percent deviations are computed by dividing the sum of total deviations by the average trend level in the same period.

3.5. Using Unemployment Rates to Predict Changes in Fertility Rates. We use Currie and Schwandt's 2014 methodology to calculate how the TFR for the United States would have evolved if conceptions had responded similarly to the changes in the national unemployment rate as they did in the previous four recessions (9). We use their estimates of the association between live births (lagged by 9 mo) and changes in the unemployment rate over the previous 12 mo. Note that Fig. 1*B* plots these predictions in calendar time even though the association is estimated using lagged birth rates. See the *SI Appendix*, *Methods Appendix* for more information on this methodology.

Data, Materials, and Software Availability. Readers wishing to replicate our analysis can access individual-level national vital statistics natality data at https://www.cdc.gov/nchs/data_access/VitalStatsOnline.htm (54). In addition, users wishing to obtain restricted data containing geographical information can request it at https://www.cdc.gov/nchs/nvss/nvss-restricted-data.htm (55). The individual-level California vital statistics natality data is available with an approved application only. Data access to the California vital statistics can be requested following the process outlined here: https://www.cdph.ca.gov/Programs/CHSI/Pages/Data-Applications.aspx (56). Replication programs can be downloaded from OpenICPSR at https://doi.org/10.3886/E192846 (57).

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