Ashoka University
Economics Discussion Paper 115

# The Effect of COVID-19 on Fertility in India: Evidence from the National Family Health Survey

## July 2024

Gby Atee, Ashoka University
Aparajita Dasgupta, Ashoka University
Sneha Lamba, University of Gottingen

https://ashoka.edu.in/economics-discussionpapers

Plot No. 2, Rajiv Gandhi Education City,
National Capital Region,
P.O.Rai, Sonepat, Haryana 131029

# The Effect of COVID-19 on Fertility in India: Evidence from the National Family Health Survey

Gby Atee[1] Aparajita Dasgupta[2,*] Sneha Lamba[2]

July 9, 2024

**Abstract**

How fertility responds to the changes in the disease environment is an important question for understanding population dynamics. We investigate this question in the context of the COVID-19 pandemic in India. We leverage the intensity of the nation-wide mobility restrictions in difference-in-differences and event study frameworks to estimate the impact of the pandemic on fertility in the country. To do this, we harmonise district-wise data on lockdown intensity with birth histories from the latest round of the National Family Health Survey 2019-2021 (NFHS-5). We find a 0.2 percentage point increase in the probability of births in the post-COVID period compared to the pre-COVID period — the effect starts at nine months after the first lockdown in India and tapers off ten months later. Strikingly, the rise in fertility is most prominent in states with higher fertility rates at the baseline and in districts which are likely to have high reverse migration during COVID. We also find that the increase in fertility occurred for the higher order births. In contrast, we find a decline in the probability of first order births in districts with most restrictions on mobility. We explore potential mechanisms and find a significant decrease in the use of modern contraceptives in the post-COVID period, which aligns with our main finding. Our results have important implications for understanding fertility behaviour and human capital investments in the face of shocks.

*Keywords:* Fertility, Shock, Healthcare, COVID-19, India

*JEL Classification:* I12, I15, J11, J13

[1]Department of Economics, Ashoka University. E-mail: gby.atee@alumni.ashoka.edu.in

[2]Department of Economics, Ashoka University. E-mail: aparajita.dasgupta@ashoka.edu.in

[3]CeMIS and Department of Economics, University of Göttingen. E-mail: sneha.lamba@uni-goettingen.de

*Corresponding Author

# 1 Introduction

How changes in the disease environments affect human fertility behaviour has been an important subject of economic enquiry, in the framework of the quantity-quality trade-off (Becker and Lewis, 1973). We address this question in the context of the novel coronavirus (COVID-19) pandemic in India. COVID-19 not only changed the risk of contracting the disease and mortality for most humans, but led to public health crises and associated economic downturn. The pandemic had —continues to have — far-reaching societal and economic consequences. Economic theory and responses documented in the empirical literature for pandemics that preceded COVID-19 suggest that these implications might extend to reproductive behavior (Chin and Wilson, 2018; Gori et al., 2020; Kalemli-Ozcan and Turan, 2011; Marteleto et al., 2020; Wang et al., 2022; Young, 2005). This is true for COVID-19 too: researchers studying the impact of the COVID-19 pandemic for the United States found that the COVID-19 pandemic led to an initial baby bust and then baby boom in fertility rates in the country (Bailey et al., 2022; Kearney and Levine, 2023). The fact that this reversal was the first time since 2007 that fertility did not decline in the U.S. demonstrates how wide-reaching the impacts of the pandemic were for the country. How did the COVID-19 pandemic and the strict lockdowns —which unleashed a huge reverse migration crisis for the most vulnerable— affect fertility rates in India? Total fertility rates in India have been declining for the past 50 years, and have reduced from more than 5 births per woman in 1970 to 2.05 births per woman in 2020. In this paper we examine whether COVID-19 accelerated or stalled this decline and investigate the underlying mechanisms.

To answer these questions we use the national-wide lockdowns (or shutdowns) instituted by the Indian Government (GOI), and study whether the pandemic systematically affected fertility behavior and outcomes in the country. We use the restrictions announced on May 3, 2020, under which districts were classified into different zones based on the intensity of their COVID burden: red (most restricted), orange (less restricted than red but more than green), and green (least restricted). This led to a spatial variation in the extent to which Indians were exposed to mobility restrictions. We combine this district level information with data from the fifth round of the Indian National Family Health Survey which was carried out in 2019-2021 (hereafter, NFHS-5) to address our research hypotheses. The NFHS-5 covered time periods both before and after the pandemic, which enables us to study the effect of COVID-19 on fertility.

Our preferred specifications find a notable (but small) rise in the likelihood of birth: the probability of birth increases by 0.2 percentage points in the post-COVID period. Strikingly, this surge in fertility is particularly evident among mothers living in states characterized by higher baseline fertility levels and districts likely to experience high reverse migration. We also find that the increase occurred among second and higher order births. For higher order births, households located in the least restricted (green) zones experienced an increase in fertility irrespective of the sex of their firstborn child. We delve into potential mechanisms and identify a noteworthy decline in the usage of modern contraception, particularly short acting reversible contraceptives and sterilization following the pandemic, which aligns with our primary results. These findings have implications for our understanding of how unforeseen shocks in the disease environment and disruptions in health service delivery may affect reproductive behavior and consequently fertility in India.

We contribute to at least three distinct strands of the literature. Firstly, we add to the broad literature which studies the effect of unanticipated mortality shocks and changes in disease risk on fertility behavior in the global South (Nandi et al., 2018; Nobles et al., 2015; Weitzman and Behrman, 2016). Secondly, our work contributes to the literature studying the effect of epidemics on fertility (Chin and Wilson, 2018; Gori et al., 2020; Kalemli-Ozcan and Turan, 2011; Young, 2005). Lastly, this paper can be situated within the literature which examines the effect of the COVID-19 pandemic on non-COVID outcomes (Bailey et al., 2022; Cozzani et al., 2023; Gori et al., 2020; Kearney and Levine, 2023; Pomar et al., 2022; Singh et al., 2024).

The rest of the paper is structured as follows. In Section 2, we situate this work in the current body of literature. We lay out our hypotheses in Section 3, and describe the data and key variables in Section 4. We discuss our empirical strategy in Section 5, followed by the presentation of results in Section 6. Lastly, Section 7 wraps up the discussion.

## 2 Existing Literature

Research investigating the effect of unanticipated mortality shocks such as natural disasters generally finds that these shocks increase fertility, but that there is considerable heterogeneity in how shocks affect different socio-economic and demographic groups. Nandi et al. (2018) examines the effect of the 2001 Gujarat earthquakes on reproductive outcomes, using a difference-in-differences set-up with data five years before and after the event. And find that the earthquake increased birth rates by 1.2 percentage points (equivalent to a 9.5% rise from baseline) in earthquake affected districts compared to neighboring districts not affected by the disaster. The earthquake also decreased the incidence of male births by 2.2 percentage points (equivalent to 4.1% fall from baseline) and reduced birth spacing among tribal, uneducated and Muslim women in the state. Similarly, authors studying the 2004 Indian Ocean tsunami (Nobles et al., 2015) found that, overall, exposure to the Tsunami led to sustained increases in fertility. These increases were driven by two behavioural routes. One, mothers who lost children to the tsunami were more likely to give birth after the disaster. Two, women who had not started their childbearing careers were more likely to start families in the aftermath of the disaster in areas with greater tsunami-related mortality. In research from other countries, Weitzman and Behrman (2016) showed that the 2010 earthquake in Haiti had a favorable impact on current pregnancies, current unwanted pregnancies, and had an adverse effect on current usage of injectables. This impact was especially notable among women with lower levels of education and those residing in areas severely impacted by the earthquake.

Earlier works that examined the effect of epidemics that preceded COVID-19 have largely found a positive fertility response to epidemics. For example, the fertility response to the HIV epidemic has been widely studied in the context of Sub-Saharan Africa (SSA) (Kalemli-Ozcan and Turan, 2011; Young, 2005). In the context of the HIV epidemic, there was an increase in the disease and mortality risk among adults which was transmitted through sexual activity and an increase in disease and mortality risk among children born to HIV positive individuals. A large body of work documents that the HIV-AIDS epidemic triggered an increase in fertility, which amounted to fertility reversal and a subsequent slowdown in demographic transition for countries of SSA. Further, this fertility reversal was found to be greater in countries that experienced severe HIV epidemics (Chin and Wilson, 2018; Gori et al., 2020).

Within this literature, there are a few papers that study the impact of the COVID-19 pandemic on fertility behavior. These papers show varying results based on the population and stage of pandemic under consideration. Further, much of this work has emerged from countries in the global North. In the context of the United States (U.S.) for example, Bailey et al. (2022); Kearney and Levine (2023) uncover a post-COVID baby bust among U.S. born mothers leading to fewer births in 2020 followed by a baby boom leading to more births in 2021. Similarly, comparing birth rates in 2018 and 2019 with post-COVID birth rates for 24 European countries, Pomar et al. (2022) find that there was a decline in birth-rates nine months after the first wave of the pandemic in all 24 countries. On the contrary, in Spain, Cozzani et al. (2023) find that there was an improvement in fertility in November 2020 followed by a period of fertility decline. In the context of the Republic of Moldova, Emery and Koops (2022) find that the pandemic reduced the use of intrauterine devices and increased the use of male condoms, but overall, there was no change in contraceptive use. They find that the pandemic led to fewer conceptions right after it started but that medium-term fertility intentions remained unchanged. At the start of the pandemic, between March and April 2020, Gori et al. (2020) carried out of survey of 18-34 year old residents of France, Germany, Italy, Spain, and United Kingdom who were planning to have children in 2020. They found that close to 70 percent or more of their sample for each country reported that they were planning to postpone childbearing due to COVID-19 or were abandoning their plans to have children due to COVID-19. Italy and Spain, which are countries with low fertility rates, had the largest proportion of young people (36.5 percent in Italy and 29.2 percent in Spain) reporting that they had abandoned their plans of child-bearing. There have been therefore contrasting effects of the pandemic on fertility trends in various settings. To the best of our knowledge no paper has studied this question for India.

Natural disasters —such as the tsunami and the earthquake studied in the literature— cause devastating but one time increase in mortality and sudden economic losses. In contrast, the COVID-19 pandemic caused an increase in disease and mortality risk over a longer period as well as uncertainty and insecurity regarding future disease environment and economic conditions. Further, it was associated with mobility restrictions and shut-downs imposed upon the populations all over the world. For instance, in the context of India, Kumar et al. (2024) find that children born during the COVID-19 pandemic were more likely to have low birth weight alluding to the health channel. Additionally, the uncertainty around employment has been documented in Haryana, India by Anukriti et al. (2024) where it is noted that COVID-19 pandemic lowered female vocational students' labor market aspirations (wages), particularly in rural areas, which potentially is due to decreased willingness to migrate for work. Therefore, the COVID-19 context is different in several important ways from natural disasters. We argue that the COVID-19 context is also different from earlier epidemics (such as the HIV-AIDS) which have been studied in the literature. Further, the Indian context is different from the context studied in the literature. We accordingly outline (in Section 3) the possible mechanisms through which COVID-19 may have affected fertility for Indian citizens.

## 3 Hypotheses

In this section, we outline some potential channels through which we can expect to see the pandemic affecting fertility rates. To do this, we draw from both economic and demographic models. First, the standard household model of demand for children or Becker and Lewis's Quantity-Quality model of children suggests that increases in disease and mortality risks in one's disease environment may affect the demand for children via reductions in household incomes and via changes in shadow prices of quantity and quality of children (Becker, 1992; Becker and Lewis, 1973). Following this model and standard "Malthusian" economic reasoning, first, we should expect to see a decline in fertility rates that corresponds to a recession, higher unemployment rates, and declines in household incomes. The job losses, and household income losses as a result of the pandemic could have caused fertility rates to drop in India. The scholarship on whether fertility is procyclical or countercyclical is large and growing but usually finds that fertility is procyclical, i.e., that fertility falls with unemployment (Currie and Schwandt, 2014; Matysiak et al., 2021; Schaller, 2016). Changes in disease and mortality environments increase the shadow prices of child quality and quantity through changes in expectations of future survival of children. An increase in the price of children may cause a decline in fertility. Therefore, Beckerian economic theory is ambiguous about the direction in which we should expect fertility to change in response to the COVID-19 pandemic.

Second, the proximate determinants (PD) of fertility model offers some guidance on the possible ways the pandemic may have affected total fertility rates (TFR) (Bongaarts, 2015). The PD model uses a multiplicative equation where TFR for a population at each point of time is a function of the (i) the proportion of women in a sexual union or proportion of women who are exposed to sexual activity, (ii) proportion of women using contraception, (iii) incidence of abortion, (iv) postpartum infecundability, which is a period of infertility experienced after giving birth, and (v) the total fecundity rates, which is the hypothetical TFR that would be experienced by a population in the absence of any contraception, abortion, and postpartum infecundability. Among these proximate determinants, we can conceptualize the pandemic to have affected access to contraceptives and access to abortion services, and therefore the determinants (ii) and (iii) in the PD model. It is unlikely that it affected postpartum infecundability, and total fecundity rates. Further, it is unlikely that the pandemic had a large effect on proportion of women who are married, or are in a sexual union, although there is some emerging evidence that the pandemic reduced the number of marriages and divorces, the overall effect being unclear (Ghaznavi et al., 2022).

Further, another important channel could be how the pandemic may have affected the frequency of sexual activity(Masoudi et al., 2022; Yuksel and Ozgor, 2020). Overall, the effect of pandemic on TFR using the PD model is also ambiguous, although we can test some channels through which the pandemic affected determinants in the PD model. We particularly test whether the pandemic changed contraceptive usage or the proportion of women using contraception as one of the channels through which the pandemic changed childbearing rates.

The COVID-19 pandemic placed a heavy burden on health systems across the world including the Indian health system, disrupting critical non-COVID health services (Jain and Dupas, 2022; Kapoor et al., 2023). For example, Debnath et al. (2023) find that the pandemic and lockdown-induced mobility restrictions in India led to a decline in the coverage for routine immunization in India. These disruptions extended to barriers in access to contraceptives and reproductive health services (Aly et al., 2022; Diamond-Smith et al., 2021; Karp et al., 2024; Muhoza et al., 2021). The PD model predicts that if these barriers reduced the proportion of women using contraceptives and/or reduced the proportion of women accessing abortions ceteris paribus then TFR would increase. But the evidence for whether these barriers led to reductions in contraceptive use is not definitive. In a scoping review on the impact of COVID-19 on contraceptive access and abortion care services in low and middle income countries, Polis et al. (2022) find that contraceptive service provision did face declines due to COVID-19, but severe disruptions were not as common as predicted. Further, even within provision of and access to contraceptives and abortion services, the effects of COVID-19 varied substantially by the country context, population and health service under consideration. While it is true that barriers in access to contraceptives and abortion services can cause unintended pregnancies leading to increases in TFR, disruptions in reproductive health services may also increase the likelihood of pregnancy related complications going untreated leading to miscarriages and reducing the number of live births.

Further, disruptions in services provided by fertility clinics may cause fewer pregnancies among those who are struggling to conceive. The PD model also suggests that elevated risks associated with unprotected sex in situations of disrupted supply of contraceptives, especially among those who rely on short acting reversible contraceptives (SARCs) such as condoms and pills may cause individuals to reduce frequency of sexual intercourse reducing fertility rates. Stay-at-home orders led some commentators on media to quip that this would mean that individuals spend more time with their partners leading to higher birth rates. But these speculations have not been tested statistically (Kearney and Levine, 2023). In India, stay-at-home orders also meant that not only children but also other household members for those living in joint families stayed home. This may have in turn reduced privacy for couples living in joint families. Therefore, the effect of COVID-19 on the proximate determinants of fertility and consequently on fertility is unclear, and is an empirical question. While we cannot directly test whether the pandemic led to any disruptions in supply of contraceptives and other reproductive health services, we test whether there were any changes in contraceptive usage in the post-pandemic period and differential usage by intensity of lockdowns.

Third, demographers have identified three mechanisms through which elevated disease and mortality risks during a pandemic may affect fertility rates. These are the physiological effect, the replacement effect, and the hoarding effect (Angeles, 2010; Nandi et al., 2018; Roodman, 2020). Replacement effect can come to play by which after a disaster, it is likely that fertility rates will surge as parents aim to compensate for children or family members lost in the calamity by bringing forth new offspring (Ben-Porath, 1976). The physiological effect operates out of necessity, triggered by the "abrupt cessation of breastfeeding, leading to the resumption of menses and ovulation, consequently extending the window for potential conception" (Palloni and Rafalimanana, 1999). The hoarding effect or precautionary demand occurs when families choose to have more children than their optimal number as a precaution against potential future high mortality within the family. It serves as a proactive measure, stemming from the unpredictability of mortality events, prompting families to "insure" themselves against high mortality scenarios by increasing birth rates. Mortality rate increased significantly during the pandemic, so these effect anticipates increased fertility, especially if child mortality increased. We cannot test these mechanisms directly but study whether the pandemic led to changes in fertility rates of women at different birth orders.

Fourth, in India, the government mandated lockdowns triggered a massive migrant crisis. Daily wage earners lost their livelihoods and were forced to travel from urban areas to their homes in rural areas in what can be termed as one of the largest instances of reverse migration to ever occur in human history. Scholars estimate that there are upwards of 450 million internal migrants in India. But these estimates are based on the last Census of India carried out in 2011. Even if a fraction of these estimated internal migrants migrated to their village homes, then more than a hundred million of Indians were forced to move to their rural homes temporarily (Dandekar and Ghai, 2020). It is hard to predict whether and how this reverse migration may have affected fertility rates in rural areas.

Research on the relationship between seasonal migration and fertility is sparse —compared to that studying long-term migration and fertility— and focuses on how migration causes "disruption" in the normal functioning of marital relationships. It suggests that spousal separation decreases exposure to conception and therefore reduces fertility in the short-term. But higher frequency of sexual activity on return may increase fertility rates (Agadjanian et al., 2011). Therefore, reverse migration among male migrants whose female partners are left behind in rural areas might increase fertility rates if couples delayed their fertility to periods when they cohabit their village residence and increases the proportion of women engaging in sexual activity (Bongaarts, 2015). For instance, in Thailand in 1960, Goldstein (1973) finds that the fertility rates of migrants who have been at their destination for five years are noticeably lower. On the other hand, the reverse migration was triggered by loss of livelihoods in cities as well as uncertainty regarding future incomes, which may depress fertility desires.

Overall, the channels we outlined above provide us with some mechanisms through which the pandemic may have affected fertility rates in India, but do not provide a clear prediction in the direction of change. We address this question empirically in this paper.

# 4 Data and Measures

## 4.1 Data

To examine the impact of COVID-19 (and the associated lockdown induced mobility restrictions) on fertility, we use data from National Family Health Survey (NFHS-5), a national household survey, conducted between 2019 and 2021. NFHS-5 collected data on 636,699 households and 724,115 women between the ages of 15-49 years. NFHS-5 data was collected in two phases: Phase 1 from June 2019 to January 2020 and Phase II from January 2020 to April 2021. Phase 1 covered 17 States and 5 Union Territories (UTs) and Phase II covered 11 States and 5 UTs. Due to the imposition of COVID-19 related lockdowns in April 2020, the NFHS-5 data collection for Phase 2 States and UTs was interrupted and completed in two parts. For these States and UTs, part one interviews occurred between January 2020 and March 2020 and part two interviews which occurred between December 2020 to April 2021 IIPS (2022).

## 4.2 Outcome measures

For the birth outcomes, we pool data from retrospective birth histories of all women aged between 15-49 years to construct a dataset of all births that have taken place in the four year period between 2018 and 2021. The observations are defined at the mother-month-year level. A mother enters the panel in 2018 if she is at least 13 years in the year 2018 and exits the panel the year after the survey is completed. This dataset includes over 23.5 million mother-month-year observations on almost 42,000 unique mothers. *Birth* takes the value one, if a mother $m$ in month $t$ and year $y$ had given birth to a child, zero otherwise. Given that we have only one year of observation for the post shock period and because the survey ends by April 2021, we have comparatively fewer birth records for the post-COVID period. To increase the sample size, we impute the expected month and year of child birth for women who were currently pregnant using the information on duration of pregnancy and using 9-months as a standard range. Therefore, currently pregnant women have imputed births in addition to the history of actual births.

We also study the effect of COVID-19 on the contraceptive use: whether the mother is using any method of modern contraceptives. For mothers who report using any contraceptives, we create the outcome variables of (a) whether the mother is using any short term reversible contraceptives (*SARCs*) like condoms, pills, patch, ring, or injectables, (b) whether the mother is using any long term reversible contraceptives (*LARCs*) like IUDs or implants, and (c) whether the women or her partner has undergone the permanent method of sterilization (*Sterilized*). To do this, we use the retrospective contraceptive calendar in the NFHS-5. The contraceptive calendar is a month-by-month history of key events in the respondents' reproductive career such as births, pregnancies, terminations, and contraceptive use. The contraceptive calendar covers the entire year of the survey as well as the period five years prior to the survey (DHS, 2018). We create a mother-month-year panel (similar to the one described above for births) to be able to measure contraceptive use during the pandemic for women in the NFHS-5.

### 4.3 Measurement of COVID-19 lockdowns

We measure COVID-19 related lockdown induced mobility restrictions using the Government of India's (GoI) district-wise zone classification, under which districts in India were classified into Red Zones, Orange Zones and Green Zones. Red Zones had the strictest mobility restrictions, followed by Orange and Green Zones (Ravindran and Shah, 2023). The Ministry of Health and Family Welfare published a circular on 4th April, 2020 designating districts into red zones, orange zones or green zones based on the cumulative cases reported, doubling rate, incidence of cases, extent of testing and surveillance and feedback. We use the zonal classification notification issued on 30th April, 2020, which came into effect from 3rd May, 2020. Although updated on a weekly basis, we make use of this one-time classification of COVID intensity to explore the differential impact of the pandemic on fertility across these zones. This classification follows Ravindran and Shah (2023), who exploit the same spatial variation in mobility restrictions to estimate whether the lockdown induced mobility restrictions in India affected complaints of domestic violence from women.

## 5 Empirical Strategy

Our main analysis examines the impact of COVID-19 and associated mobility restrictions on the probability of birth (or, fertility). We estimate the following equation:

$$\begin{aligned} Y_{mbdty} &= \beta_0 + \beta_1 \text{Post}_{ty} + \beta_2 (\text{Post} \times \text{OrangeZone})_{dty} + \beta_3 (\text{Post} \times \text{RedZone})_{dty} \\ &+ \eta \text{X}_m + \gamma Year_d + \tau_y + \mu_s t + \delta_d + \lambda_b + \epsilon_{mbdty} \end{aligned} \quad (1)$$

where, $Y_{mbdty}$ is the outcome variable, as of any given month $t$ and year $y$, for mother $m$ residing in district $d$, and at parity $b$. As mentioned above, for our primary outcome variable *Birth*, $Y_{mbdty}$ takes the value one for mothers who gave birth to a child in a particular month and year, and 0 for mothers who did not. $Post_t$ takes the value one for the period after April 2020, and zero otherwise. Red$Zone_d$ takes the value one, if the district was classified as a Red Zone as on May 3, 2020 and zero otherwise. We similarly define Zone dummies for Orange and Green Zones respectively.

The main coefficients of interest, are $\beta_1$, $\beta_2$, and $\beta_3$. $\beta_1$ estimates the probability of having a child after COVID-19 shock, relative to pre-shock period in green zones. $\beta_2$ estimates the differential change in the probability of having a child in an Orange Zone after COVID-19 shock, relative to Green Zone. Similarly, $\beta_3$ estimates the differential probability of having a child in a Red Zone after COVID-19 shock, relative to Green Zone.

We include district-specific linear time trends ($\gamma Year_d$), district fixed effects ($\delta_d$), year fixed effects ($\tau_y$), state-specific month fixed effects ($\mu_s t$) and parity fixed effects ($\lambda_b$). District-specific linear time trends account for differing fertility trends across districts. District fixed effects allow us to control for time-invariant local characteristics, such as the state of the local economy, which could be associated with the likelihood of child birth. Year fixed effects help account for broader macroeconomic influences that might affect fertility decisions in a given year. Parity fixed effects recognize that the probability of giving birth differs at various parity levels, with higher parities typically having lower probabilities of birth.

Further, the estimation includes $X_m$, a vector of socioeconomic and demographic characteristics comprising mother's age, a dummy for whether the mother completed primary education, dummies for mother's religion and caste, a dummy for whether the house is located in an urban area, number of household members, and dummies for household wealth index quintiles, and composition of adults in the household. Standard errors are clustered at the district level. These controls help us isolate and assess the specific impact of the variable of interest while holding other relevant factors constant.

We also carry out estimations that include state-specific month fixed effects, to account for seasonal variations in fertility that varies by states. Further, we include mother fixed effects in certain specification. This approach allows us to directly compare the fertility choices of individual mothers before and after COVID-19. By focusing on changes within the same individual, we can isolate the effect of the shock on their fertility decisions, while controlling for all other factors that remain constant for that mother over time. This is particularly useful for understanding how the pandemic impacted individual mothers' decisions regarding childbirth.

In our model, the variable *Post* is defined as the period after the first wave hit India, and includes the period immediately after the pandemic. This means that all the births that occurred in the first eight-nine months after the first wave of the pandemic may have been conceived before pandemic. Our main model does not enable us to estimate the effect of the pandemic for the period nine months after the first wave. This is because the main coefficient of interest $\beta_1$ is omitted when we introduce a nine month lag. In this case, *Post* takes the value one after January 2021, which is collinear with year fixed effects. To ensure that our results are not driven by births conceived before the pandemic we additionally examine the effect of COVID-19 in an event study framework using the year 2018 as the base time period.

# 6 Results

## 6.1 Descriptive Statistics

We present the summary statistics for the key variables in this paper across all three zones, and by red, orange and green zones during the pre-COVID period. Comparing the results in columns 1 and 3 of table 1, we see that the proportion of households who are rich, i.e. households in the top two wealth quintiles, are higher in orange and red zones, compared to the green zones on an average. Further, the proportion of households that are classified as living in urban areas is higher in the most restricted red zones. We also find that women have more children on an average and have lower contraceptive usage rates (particularly SARC) in green zones compared to red zones.

## 6.2 Effect on Probability of Birth

Table 2 presents the results from regression models that estimate the the effect of COVID-19 and associated lockdown induced mobility restrictions on the probability of birth. Column 1 presents the results with the controls that account for various socioeconomic and demographic characteristics, district fixed effects, district linear time trends, year fixed effects, and parity fixed effects. Column 2 adds state-specific month fixed effects to the specification in Column 1 to account for seasonal variation in fertility. We add mother fixed effects in Column 3 and both state-specific month and mother fixed effects in Column 4.

Regardless of the specification used, we find a spike in fertility by 0.2-0.3 percentage points post COVID-19 in the Green Zone (reference category). The results are highly significant at the 1% level. The results are also robust to the inclusion of mother fixed effects, state-specific month fixed effects, and both. In Column 4, which is the specification with most controls, we find that the coefficient on the interaction of *Red Zone* (which had the most mobility restriction) and *Post* is negative and significant. This indicates that, relative to the Green Zone, the Red Zone saw a decline in the probability of childbirth by 0.3 percentage points in columns (2) and (4). However, there is no overall significant decline in the likelihood of childbirth in the Red Zone as indicated by the p-values from the joint test reported in the bottom of the table. Since we do not find significant change at the mobility restriction margin, we do not dwell deep into this henceforth.

We show results from our event study in Figure 1 for all zones combined. $t$ is the month when COVID hit which is March 2020, $t + i$ is $i$ months after the shock and likewise $t - i$ is $i$ months before the shock. As discussed in the methods section, the *Post* period in Table 2 includes the period just after the lockdowns were announced in April 2020. We use the event study to tease out how the probability of births may have changed in the months after the first wave of the pandemic in India. We find that the coefficients for each month starting from January 2021 (t+10 in the figure) are positive and significant (these are relative to 2018). The period starting from February 2021 (t+11 in the figure) excludes any births that may have been conceived prior to the first wave of COVID-19. Further, the coefficients start to decline at eight months into the pandemic and taper off eleven months into the pandemic. We also find the coefficients for all the months in the period prior to the pandemic and nine months into the pandemic contain zero in their confidence interval and are therefore insignificant. This confirms that the fertility boom we observe are indeed children conceived after pandemic, therefore, the fertility boom can be attributed to COVID. The results for each zone is presented in the appendix in table 3 and we observe a similar trend when we carry out event studies for each zones with the most consistent results for the Green Zone as expected from the results in Table 2.

To rule out the pre-treatment trends in our main results, we conduct a placebo test, where we use NFHS 4 data and set March 2015 as the fake shock year in the same specification. The data is restricted to the years 2013-2016 and the main results are replicated in table 5. The coefficient on *Post* is now negative and significant. Hence, we conclude that the increase in likelihood of birth is not simply picking up the pre-trends and could indeed be attributed to the impact of pandemic.

### 6.3 Heterogeneous Effects

To study how the pandemic may have affected fertility among the various policy-relevant subgroups of interest, we estimate equation 1 for the following sub-samples: (i) women who reside in households that are located in states with high fertility (TFR>2.1) vs low fertility (TFR<=2.1) based on NFHS-4 data, (ii) women who reside in households located in districts with high in-migration vs low in-migration districts[1], (iii) women who reside in households located in districts with high out-migration vs those who reside in low out-migration districts[2], and (v) women's parity at the time of the survey. These results shed light on some of the mechanisms through which the pandemic may have affected the overall fertility. We only show the results for specifications that include state-specific month and/or mother fixed effects.

Panel A in Table 3 presents results for the households that reside in high TFR states (Columns 1 and 2), high in-migration districts (Columns 3 and 4), and reside in high out-migration districts (Columns 5 and 6). Panel B in Table 3 presents results for the households that reside in low TFR states (Columns 1 and 2), reside in low in-migration districts (Columns 3 and 4), and reside in low out-migration districts (Columns 5 and 6). The results reveal that the increase in fertility is driven by individuals living in states with high TFR as reported in Columns 1 and 2 in Panel A. Further, districts that have low in-migration and high out-migration in the past (are likely to be the ones that will experience significant COVID induced reverse migration) experience a 0.2 percentage point increase in the likelihood of child birth. The effect is insignificant in districts with high in- migration and low out-migration.

Panel A in Table 4 presents results for mothers at varying parities at the time of the survey. We present results for the sub-group of mothers at parity one (Columns 1 and 2) and the sub-group of mothers at parity two and above (Columns 3 and 4). Estimating equation (1) for the subgroup of women at parity one enables us to estimate the effect of the pandemic on the likelihood of a women giving birth to her first child, or starting her reproductive career. Similarly, estimating equation (1) for the subgroup of women, at parity two and above, at the time of the survey enables us to estimate the effect of pandemic on the likelihood of a woman giving birth to higher order children, or continuing her reproductive career.

The coefficient for *Post* is significant and thus we can say that the pandemic increased the probability of birth in the Green Zones by 0.2 percentage points among women at parity

[1]2011 Census data is used to construct the proportion of migrants living in a district relative to the population of the district. A district is categorized as high in-migration if the ratio is greater than the national average.

[2]NSS 66 and 2011 Population Census is used to construct the proportion of out-migrant households in a district relative to the population of the district. We exclude migration for marriage to compute this. A district is categorized as having high out-migration if the ratio is greater than the national average.

two and above. However, among first time mothers, we do not observe any difference, implying that COVID only induced women who had already begun their reproductive career to increase fertility.

Panel B in Table 4 further breaks down the sample at higher parity births into sub-samples of those who have a firstborn daughter (Columns 1 and 2) and those who have a firstborn son (Columns 3 and 4). We find that women at higher parities of two and above residing in Green Zones had a 0.2 percentage point higher probability of birth in the post COVID period, irrespective of whether they had a firstborn female child or a male child.

### 6.4 Effect on Contraceptive Use

In this section, we explore one of the mechanisms through which COVID-19 may have caused the increase in overall fertility in Green Zones ( as discussed above). We are able to examine if the lockdowns affected the use of modern contraceptives, which can help us understand if access to contraceptives are an underlying mechanism causing the small spike in fertility. We present the event study plots for measure of contraception usage for all zones in figure 2. The results shown in the top left panel captures if the individual uses any modern methods of contraceptives. Similarly, results shown in the top right panel show results for the use of SARCs. The bottom left and right panels show results for LARCs and sterilization respectively. The contraceptive use relative to 2018 went down by 0.6 percentage points significantly from the period $t + 10$, which is January 2020 onwards. This decline in modern contraceptive use seems to be driven by the reduction in the use of SARCs and the permanent method of contraception sterilization where we observe a similar trend. We don't observe a corresponding decline in the use of LARCs in the post pandemic period. Unfortunately, our measures of contraceptive usage do not enable us to comment on the reasons behind this decline: disruptions in supply or reductions in the demand of contraceptives.

## 7 Discussion and Conclusion

In this paper we examine how COVID-19, which we conceptualize as a shock, affects fertility behaviour in the Indian households. We leverage the variations in the timing of the nation-wide lockdown, under which districts were classified into zones and study whether the probability of birth changed systematically by these restrictions. Using a difference-in-differences framework, we find a significant 0.2-0.3 percentage point increase in the probability of births in the least mobility restricted Green Zones.

Strikingly, this increase in fertility comes from mothers who already had at least one child giving birth and is not a response from first time mothers. Further, we find that the rise in fertility is prominent in states with higher fertility in the baseline and also in districts which are likely to see high COVID induced reverse migration (high out migration and low in migration districts in the baseline). Next, we check if there are any pre-trends using an event study framework. Our event study results indicate the absence of pre-existing trends in rising fertility, providing assurance and confidence in the validity of our main results. We explore potential mechanisms and examine contraception related behavior Interestingly, we find a significant decrease in SARC and sterilization, post pandemic, which aligns with our main finding.

This spike in fertility may have occurred due to multiple reasons that we discussed above. First, according to the PD model a spike in fertility may be expected if the pandemic led to reduced access to contraceptives and abortion services, or/and an increase in the proportion of women in a sexual union (cohabiting with their partners) due to the large reverse migration that occurred in India. Next, a spike in fertility may occur due to "replacement effect" which comes into play when parents compensate for mortality (or expectation of mortality) among their children with further childbearing.

Notably, the increase in fertility observed comes from mothers giving birth to second and higher order children as reported in panel B and C of table 4. This is somewhat different from the evidence from the 2004 Indian Ocean Tsunami, where first time mothers increased fertility (Nobles et al., 2015). In our context, this could be because first time mothers could be postponing pregnancy possibly out of fear of complications in availing medical services. Our results on the decline in child immunization as a result of COVID are similar to the literature (Chakrabarti et al., 2023; Debnath et al., 2023; Summan et al., 2023).

Thus, overall, we find that the immediate effects of the pandemic seems to increase fertility. However, our analysis suggests that the effect of first wave of COVID-19 tapers off 10 months after the lockdowns. Our results have important implications for understanding fertility behaviour and human capital investments in the face of shocks. It would be important for future research to study the long-term effects of the pandemic on fertility and health outcomes.

# References

Agadjanian, V., Yabiku, S. T., and Cau, B. (2011). Men's migration and women's fertility in rural mozambique. *Demography*, 48(3):1029–1048.

Aly, J., Choi, L., and Christy, A. Y. (2022). The impact of coronavirus on reproduction: contraceptive access, pregnancy rates, pregnancy delay, and the role of vaccination. *F&s Reviews*, 3(3):190–200.

Angeles, L. (2010). Demographic transitions: analyzing the effects of mortality on fertility. *Journal of Population Economics*, 23:99–120.

Anukriti, S., Herrera-Almanza, C., and Ochmann, S. (2024). The influence of covid-19 on young women's labor market aspirations and expectations in india. In *AEA Papers and Proceedings*, volume 114, pages 243–247. American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203.

Bailey, M. J., Currie, J., and Schwandt, H. (2022). The covid-19 baby bump: the unexpected increase in us fertility rates in response to the pandemic. Technical report, National Bureau of economic research.

Becker, G. S. (1992). Fertility and the economy. *Journal of Population Economics*, 5(3):185–201.

Becker, G. S. and Lewis, H. G. (1973). On the interaction between the quantity and quality of children. *Journal of political Economy*, 81(2, Part 2):S279–S288.

Ben-Porath, Y. (1976). Fertility response to child mortality: micro data from israel. *Journal of Political Economy*, 84(4, Part 2):S163–S178.

Bongaarts, J. (2015). Modeling the fertility impact of the proximate determinants: Time for a tune-up. *Demographic Research*, 33:535–560.

Chakrabarti, A., Bair, E. F., and Thirumurthy, H. (2023). Routine child immunizations in india during the covid-19 pandemic. *SSM-population health*, 22:101383.

Chin, Y.-M. and Wilson, N. (2018). Disease risk and fertility: evidence from the hiv/aids pandemic. *Journal of Population Economics*, 31:429–451.

Cozzani, M., Fallesen, P., Passaretta, G., Härkönen, J., and Bernardi, F. (2023). The consequences of the covid-19 pandemic for fertility and birth outcomes: evidence from spanish birth registers. *Population and Development Review*.

Currie, J. and Schwandt, H. (2014). Short-and long-term effects of unemployment on fertility. *Proceedings of the National Academy of Sciences*, 111(41):14734–14739.

Dandekar, A. and Ghai, R. (2020). Migration and reverse migration in the age of covid-19. *Economic and Political Weekly*, 55(19):28–31.

Debnath, S., Paul, S. B., and Sareen, K. (2023). Effect of covid-19 pandemic on routine childhood immunization.

DHS (2018). *DHS Contraceptive Calendar Tutorial*. United States Agency for International Development (USAID).

Diamond-Smith, N., Logan, R., Marshall, C., Corbetta-Rastelli, C., Gutierrez, S., Adler, A., and Kerns, J. (2021). Covid-19's impact on contraception experiences: Exacerbation of structural inequities in women's health. *Contraception*, 104(6):600–605.

Emery, T. and Koops, J. C. (2022). The impact of covid-19 on fertility behaviour and intentions in a middle income country. *PLoS One*, 17(1):e0261509.

Ghaznavi, C., Kawashima, T., Tanoue, Y., Yoneoka, D., Makiyama, K., Sakamoto, H., Ueda, P., Eguchi, A., and Nomura, S. (2022). Changes in marriage, divorce and births during the covid-19 pandemic in japan. *BMJ global health*, 7(5):e007866.

Goldstein, S. (1973). Interrelations between migration and fertility in thailand. *Demography*, 10(2):225–241.

Gori, L., Lupi, E., Manfredi, P., and Sodini, M. (2020). A contribution to the theory of economic development and the demographic transition: fertility reversal under the hiv epidemic. *Journal of Demographic Economics*, 86(2):125–155.

IIPS (2022). India dhs, 2019-21 - final report.

Jain, R. and Dupas, P. (2022). The effects of india's covid-19 lockdown on critical non-covid health care and outcomes: Evidence from dialysis patients. *Social Science & Medicine*, 296:114762.

Kalemli-Ozcan, S. and Turan, B. (2011). Hiv and fertility revisited. *Journal of Development Economics*, 96(1):61–65.

Kapoor, M., Nidhi Kaur, K., Saeed, S., Shannawaz, M., and Chandra, A. (2023). Impact of covid-19 on healthcare system in india: A systematic review. *Journal of Public Health Research*, 12(3):22799036231186349.

Karp, C., Williams, K., Wood, S. N., OlaOlorun, F. M., Akilimali, P., Guiella, G., Gichangi, P., Mosso, R., Makumbi, F., Anglewicz, P. A., et al. (2024). Family planning service disruptions in the first two years of the covid-19 pandemic: Evidence from health facilities in seven low-and middle-income countries. *PLOS Global Public Health*, 4(1):e0002435.

Kearney, M. S. and Levine, P. B. (2023). The us covid-19 baby bust and rebound. *Journal of Population Economics*, pages 1–24.

Kumar, S., Hill, C., and Halliday, T. J. (2024). Effects of covid-19 pandemic on low birth weight in a nationwide study in india. *Communications Medicine*, 4(1):118.

Marteleto, L. J., Guedes, G., Coutinho, R. Z., and Weitzman, A. (2020). Live births and fertility amid the zika epidemic in brazil. *Demography*, 57(3):843–872.

Masoudi, M., Maasoumi, R., and Bragazzi, N. L. (2022). Effects of the covid-19 pandemic on sexual functioning and activity: a systematic review and meta-analysis. *BMC Public Health*, 22(1):189.

Matysiak, A., Sobotka, T., and Vignoli, D. (2021). The great recession and fertility in europe: A sub-national analysis. *European Journal of Population*, 37(1):29–64.

Muhoza, P., Koffi, A. K., Anglewicz, P., Gichangi, P., Guiella, G., OlaOlorun, F., Omoluabi, E., Sodani, P., Thiongo, M., Akilimali, P., et al. (2021). Modern contraceptive availability and stockouts: a multi-country analysis of trends in supply and consumption. *Health policy and planning*, 36(3):273–287.

Nandi, A., Mazumdar, S., and Behrman, J. R. (2018). The effect of natural disaster on fertility, birth spacing, and child sex ratio: evidence from a major earthquake in india. *Journal of Population Economics*, 31:267–293.

Nobles, J., Frankenberg, E., and Thomas, D. (2015). The effects of mortality on fertility: population dynamics after a natural disaster. *Demography*, 52(1):15–38.

Palloni, A. and Rafalimanana, H. (1999). The effects of infant mortality on fertility revisited: New evidence from latin america. *Demography*, 36:41–58.

Polis, C. B., Biddlecom, A., Singh, S., Ushie, B. A., Rosman, L., and Saad, A. (2022). Impacts of covid-19 on contraceptive and abortion services in low-and middle-income countries: a scoping review. *Sexual and Reproductive Health Matters*, 30(1):2098557.

Pomar, L., Favre, G., De Labrusse, C., Contier, A., Boulvain, M., and Baud, D. (2022). Impact of the first wave of the covid-19 pandemic on birth rates in europe: a time series analysis in 24 countries. *Human Reproduction*, 37(12):2921–2931.

Ravindran, S. and Shah, M. (2023). Unintended consequences of lockdowns, covid-19 and the shadow pandemic in india. *Nature human behaviour*, 7(3):323–331.

Roodman, D. (2020). The impact of life-saving interventions on fertility. *arXiv preprint arXiv:2007.11388*.

Schaller, J. (2016). Booms, busts, and fertility: Testing the becker model using gender-specific labor demand. *Journal of Human Resources*, 51(1):1–29.

Singh, A., Romero, M., and Muralidharan, K. (2024). Covid-19 learning loss and recovery: Panel data evidence from india. *Journal of Human Resources*.

Summan, A., Nandi, A., Shet, A., and Laxminarayan, R. (2023). The effect of the covid-19 pandemic on routine childhood immunization coverage and timeliness in india: retrospective analysis of the national family health survey of 2019–2021 data. *The Lancet Regional Health-Southeast Asia*, 8.

Wang, Y., Gozgor, G., and Lau, C. K. M. (2022). Effects of pandemics uncertainty on fertility. *Frontiers in Public Health*, 10:854771.

Weitzman, A. and Behrman, J. A. (2016). Disaster, disruption to family life, and intimate partner violence: The case of the 2010 earthquake in haiti. *Sociological science*, 3:167–189.

Young, A. (2005). The gift of the dying: The tragedy of aids and the welfare of future african generations. *The Quarterly Journal of Economics*, 120(2):423–466.

Yuksel, B. and Ozgor, F. (2020). Effect of the covid-19 pandemic on female sexual behavior. *International Journal of Gynecology & Obstetrics*, 150(1):98–102.

# 8 Tables

**Table 1:** Summary of key variables

| | (1) Green Zone | (2) Orange Zone | (3) Red Zone |
|---|---|---|---|
| | **Mother level outcomes** | | |
| N children | 2.085 | 1.833 | 1.754 |
| | (0.016) | (0.012) | (0.019) |
| Currently pregnant | 0.294 | 0.296 | 0.279 |
| | (0.004) | (0.004) | (0.007) |
| Parity | 1.772 | 1.723 | 1.721 |
| | (0.010) | (0.008) | (0.013) |
| Mother: Age | 26.305 | 25.780 | 25.524 |
| | (0.050) | (0.043) | (0.071) |
| Mother: Primary Edu | 0.790 | 0.796 | 0.823 |
| | (0.004) | (0.004) | (0.006) |
| Hindu | 0.548 | 0.743 | 0.788 |
| | (0.005) | (0.004) | (0.006) |
| SC/ST | 0.574 | 0.353 | 0.324 |
| | (0.005) | (0.004) | (0.007) |
| Urban | 0.543 | 0.687 | 0.895 |
| | (0.015) | (0.016) | (0.029) |
| N HH members | 5.809 | 6.209 | 6.258 |
| | (0.024) | (0.023) | (0.042) |
| rich | 0.213 | 0.326 | 0.415 |
| | (0.004) | (0.004) | (0.008) |
| *N* | 11487 | 13177 | 4305 |
| | **Fertility Calendar** | | |
| Probability of Birth | 0.030 | 0.031 | 0.031 |
| | (0.000) | (0.000) | (0.000) |
| *N* | 865990 | 943797 | 344251 |
| | **Contraceptive Calendar** | | |
| Use modern contraception | 0.107 | 0.122 | 0.144 |
| | (0.000) | (0.000) | (0.001) |
| SARC | 0.069 | 0.081 | 0.099 |
| | (0.000) | (0.000) | (0.001) |
| LARC | 0.015 | 0.014 | 0.013 |
| | (0.000) | (0.000) | (0.000) |
| Sterilization | 0.027 | 0.032 | 0.036 |
| | (0.000) | (0.000) | (0.000) |
| *N* | 865990 | 943797 | 344251 |

*Note: Orange, Red and Green Zone* takes the value one, if the district was classified Orange, Red or Green zone as on May 3, 2020 respectively, zero otherwise. *Birth*, takes the value one, if mother in a month and year had given birth to a child, zero otherwise. *N children* indicates the number of children a women has at the time of survey. *Parity* indicates the number of pregnancy a mother is likely to have at each point. *Currently pregnant* takes the value one if the women is currently pregnant at the time of survey, zero otherwise. *Mother's Age* indicates the mother's age at the time of survey. *Mother: Primary Edu* takes the value one if the mother has completed primary education at the time of survey, zero otherwise. *Hindu* takes the value one if the women follows Hindu religion, zero otherwise. *SC/ST* takes the value one if the women belongs to SC/ST social group, zero otherwise. *Urban* takes the value one if the women resides in urban region at the time of survey, zero otherwise. *N HH members* indicates the number of members in the household at the time of survey. *Rich* takes the value one if the household is on the top two wealth quintiles at the time of the survey, zero otherwise. *Contraception* takes the value one if the women uses any modern method of contraception and zero otherwise. *SARC* takes the value one if the women or her partner uses condoms, pills, patch, ring, or injectables, zero if any other mode. *LARC* take the value one if the women reports using IUDs or implants, zero if any other mode. *Sterilization* takes the value one if the women or her partner is sterilized, zero if any other mode. The sample is restricted to the pre COVID period.

**Table 2:** Impact of COVID-19 on Birth

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Post | 0.003*** | 0.002** | 0.003*** | 0.002** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Orange Zone X Post | -0.001 | -0.002 | -0.000 | -0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Red Zone X Post | -0.002* | -0.003** | -0.002 | -0.003** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Observations | 2535217 | 2535217 | 2535217 | 2535217 |
| Mean of Dep. Variable | 0.030 | 0.030 | 0.030 | 0.030 |
| SD | 0.170 | 0.170 | 0.170 | 0.170 |
| Month FE | No | Yes | No | Yes |
| Mother FE | No | No | Yes | Yes |
| Joint significance (Red Zone) | 0.565 | 0.192 | 0.567 | 0.182 |

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Notes: The dependent variable, *Birth*, takes the value one, if mother in a month and year had given birth to a child, zero otherwise. *Post* takes the value one for all period after April 2020, and zero otherwise. *Orange, Red and Green Zone* takes the value one, if the district was classified Orange, Red or Green zone as on May 3, 2020 respectively and zero otherwise. All the estimates control for mother's age, a dummy for whether the mother completed primary education, dummies for mother's religion and caste, a dummy for whether the house is located in an urban area, number of household members, dummies for household wealth index quintiles, and composition of adults in the household and additionally includes district specific linear time trends, district fixed effects, year fixed effects and parity fixed effects. Columns 2 and 4 additionally includes state-specific month fixed effects and columns 3 and 4 further include mother fixed effects. The range of years is restricted to 2018-2021. Standard errors are clustered at the district level.

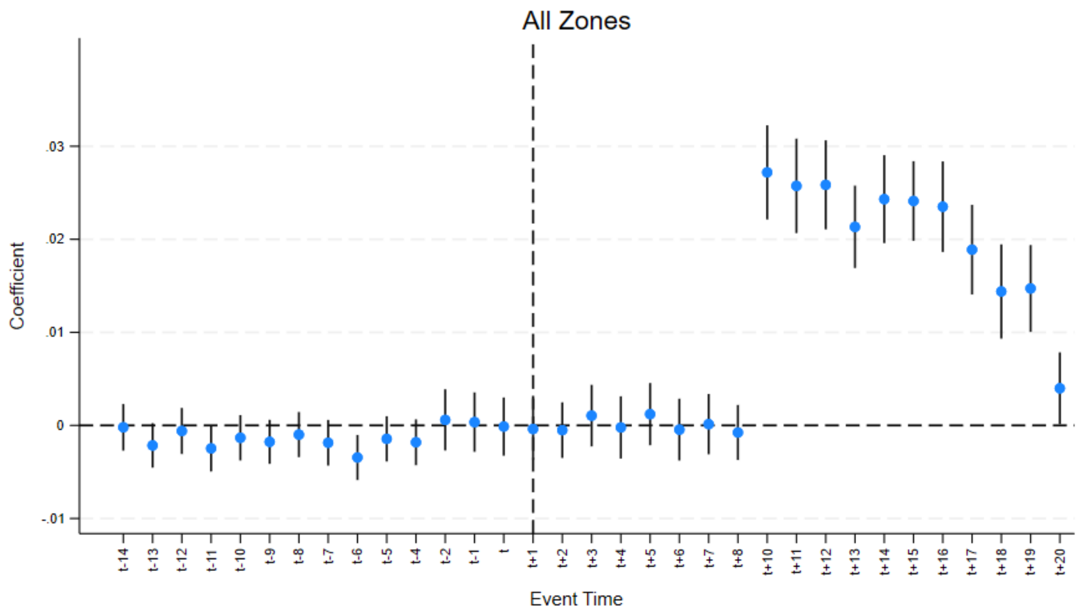


**Figure 1:** Event study on the probability of birth

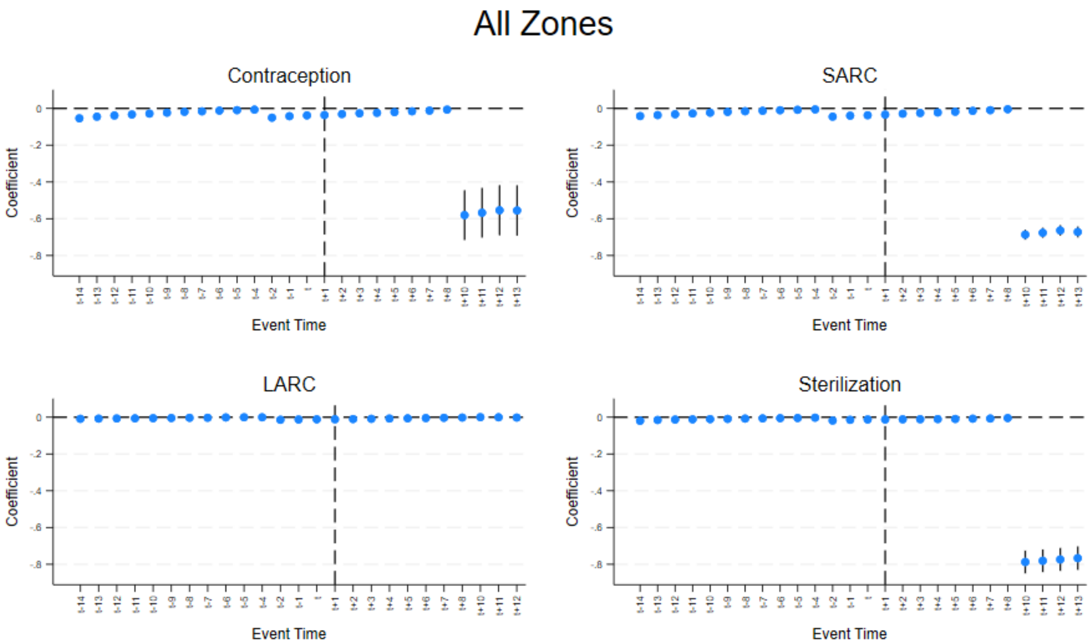


**Figure 2:** Event study on probability of contraception use

**Table 3:** Heterogeneity I: Impact of COVID-19 on Birth

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | | **Panel A: High** | | | |
| | TFR>= 2.1 | | High In Migration | | High Out Migration | |
| Post | 0.002** | 0.002* | 0.001 | 0.000 | 0.002* | 0.002* |
| | (0.001) | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) |
| Orange Zone X Post | -0.002 | -0.001 | -0.002 | -0.001 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| Red Zone X Post | -0.004*** | -0.004** | -0.001 | -0.000 | -0.005** | -0.005*** |
| | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| Observations | 2058052 | 2058052 | 742993 | 742993 | 1158931 | 1158931 |
| Mean of Dep. Variable | 0.029 | 0.029 | 0.030 | 0.030 | 0.030 | 0.030 |
| SD | 0.168 | 0.168 | 0.170 | 0.170 | 0.171 | 0.171 |
| Joint significance (Red Zone) | 0.118 | 0.152 | 0.970 | 0.985 | 0.102 | 0.067 |
| | | | **Panel B: Low** | | | |
| | TFR< 2.1 | | Low In Migration | | Low Out Migration | |
| Post | -0.002 | -0.003 | 0.002* | 0.002* | 0.002 | 0.002 |
| | (0.004) | (0.004) | (0.001) | (0.001) | (0.001) | (0.001) |
| Orange Zone X Post | 0.004 | 0.004 | -0.001 | -0.001 | -0.002 | -0.003 |
| | (0.005) | (0.004) | (0.001) | (0.001) | (0.002) | (0.002) |
| Red Zone X Post | 0.003 | 0.003 | -0.004** | -0.004** | -0.002 | -0.002 |
| | (0.005) | (0.004) | (0.002) | (0.002) | (0.002) | (0.002) |
| Observations | 473291 | 473291 | 1729624 | 1729624 | 1242389 | 1242389 |
| Mean of Dep. Variable | 0.033 | 0.033 | 0.030 | 0.030 | 0.030 | 0.030 |
| SD | 0.178 | 0.178 | 0.171 | 0.171 | 0.171 | 0.171 |
| Month FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Mother FE | No | Yes | No | Yes | No | Yes |
| Joint significance (Red Zone) | 0.876 | 0.936 | 0.144 | 0.114 | 0.786 | 0.779 |

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: The dependent variable, *Birth*, takes the value one, if mother in a month and year had given birth to a child, zero otherwise. *Post* takes the value one for all period after April 2020, and zero otherwise. *Orange, Red and Green Zone* takes the value one, if the district was classified Orange, Red or Green zone as on May 3, 2020 respectively and zero otherwise. All the estimates control for mother's age, a dummy for whether the mother completed primary education, dummies for mother's religion and caste, a dummy for whether the house is located in an urban area, number of household members, dummies for household wealth index quintiles, and composition of adults in the household and additionally includes district specific linear time trends, district fixed effects, year fixed effects and parity fixed effects. Odd columns include state-specific month fixed effects and even columns additionally includes mother fixed effects. *TRF>=2.1* takes the value one if the individual is from a states where the fertility rate of the state reported in NFHS 4 is grater than 2.1 and zero if *TRF<2.1*. *High In Migration* takes the value one if the individual lives in a district where the proportion on in migrants in a district based on 2011 Census is greater than the national average and zero if *Low In Migration* otherwise. *High Out Migration* takes the value one if the individual lives in a district where the proportion of households with out migrants in a district based on 2009-2010 NSS data is greater than the national average and zero if *Low Out Migration* otherwise. The range of years is restricted to 2018-2021. Standard errors are clustered at the district level.

**Table 4:** Heterogeneity II: Impact of COVID-19 on Birth

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **Panel A: Parity** | | | |
| | Parity = 1 | | Parity >=2 | |
| Post | 0.002 | 0.001 | 0.002** | 0.002** |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| Orange Zone X Post | -0.002 | -0.001 | -0.001 | -0.001 |
| | (0.002) | (0.002) | (0.001) | (0.001) |
| Red Zone X Post | -0.007** | -0.006** | -0.001 | -0.001 |
| | (0.003) | (0.003) | (0.001) | (0.001) |
| Observations | 1091262 | 1087991 | 1443955 | 1441577 |
| Mean of Dep. Variable | 0.055 | 0.053 | 0.011 | 0.011 |
| SD | 0.229 | 0.224 | 0.102 | 0.103 |
| Joint significance (Red Zone) | 0.052 | 0.060 | 0.373 | 0.398 |
| | **Panel B: Sex of firstborn for Parity >=2** | | | |
| | Firstborn Female HH | | Firstborn Male HH | |
| Post | 0.002** | 0.002* | 0.002* | 0.002** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Orange Zone X Post | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Red Zone X Post | -0.004*** | -0.004*** | 0.002 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Observations | 703409 | 702348 | 740546 | 739229 |
| Mean of Dep. Variable | 0.012 | 0.012 | 0.009 | 0.009 |
| SD | 0.109 | 0.110 | 0.095 | 0.095 |
| Month FE | Yes | Yes | Yes | Yes |
| Mother FE | No | Yes | No | Yes |
| Joint significance (Red Zone) | 0.152 | 0.095 | 0.003 | 0.003 |

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Notes: The dependent variable, *Birth*, takes the value one, if mother in a month and year had given birth to a child, zero otherwise. *Post* takes the value one for all period after April 2020, and zero otherwise. *Orange, Red and Green Zone* takes the value one, if the district was classified Orange, Red or Green zone as on May 3, 2020 respectively and zero otherwise. All the estimates control for mother's age, a dummy for whether the mother completed primary education, dummies for mother's religion and caste, a dummy for whether the house is located in an urban area, number of household members, dummies for household wealth index quintiles, and composition of adults in the household and additionally includes district specific linear time trends, district fixed effects, year fixed effects and parity fixed effects. Odd columns include state-specific month fixed effects and even columns additionally includes mother fixed effects. *Parity=1* restrict focus to the period when a women who has not yet or given birth to their first child and *Parity>=2* otherwise. *Firstborn Female HH* takes the value one if the sex of the first child is female, and *Firstborn Male HH* if male. The range of years is restricted to 2018-2021. Standard errors are clustered at the district level.

# 9 Appendix

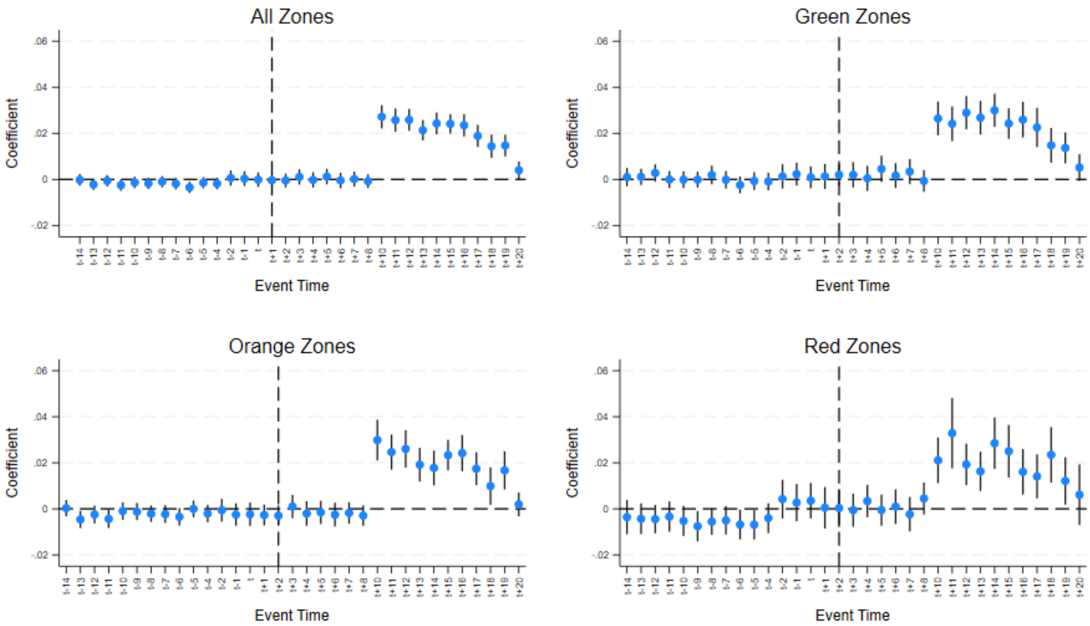


**Figure 3:** Event study on the probability of birth (by zones)

**Table 5:** Placebo test: Impact of COVID-19 on Birth

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Post | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Orange Zone X Post | 0.001 | 0.000 | 0.001 | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Red Zone X Post | 0.002** | 0.001 | 0.002** | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Observations | 5278150 | 5278150 | 5278150 | 5278150 |
| Mean of Dep. Variable | 0.026 | 0.026 | 0.026 | 0.026 |
| SD | 0.159 | 0.159 | 0.159 | 0.159 |
| Month FE | No | Yes | No | Yes |
| Mother FE | No | No | Yes | Yes |
| Joint significance (Red Zone) | 0.024 | 0.437 | 0.020 | 0.409 |

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Notes: The dependent variable, *Birth*, takes the value one, if mother in a month and year had given birth to a child, zero otherwise. *Post* takes the value one for all period after April 2015 to December 2016, and zero otherwise. *Orange, Red and Green Zone* takes the value one, if the district was classified Orange, Red or Green zone as on May 3, 2020 respectively and zero otherwise. All the estimates control for mother's age, a dummy for whether the mother completed primary education, dummies for mother's religion and caste, a dummy for whether the house is located in an urban area, number of household members, dummies for household wealth index quintiles, and composition of adults in the household and additionally includes district specific linear time trends, district fixed effects, year fixed effects, state-month fixed effects and parity fixed effects. Panel A excludes interview mother fixed effect while Panel B includes mother fixed effects. Births history is restricted to the years between 2011-2016. Standard errors are clustered at the district level.