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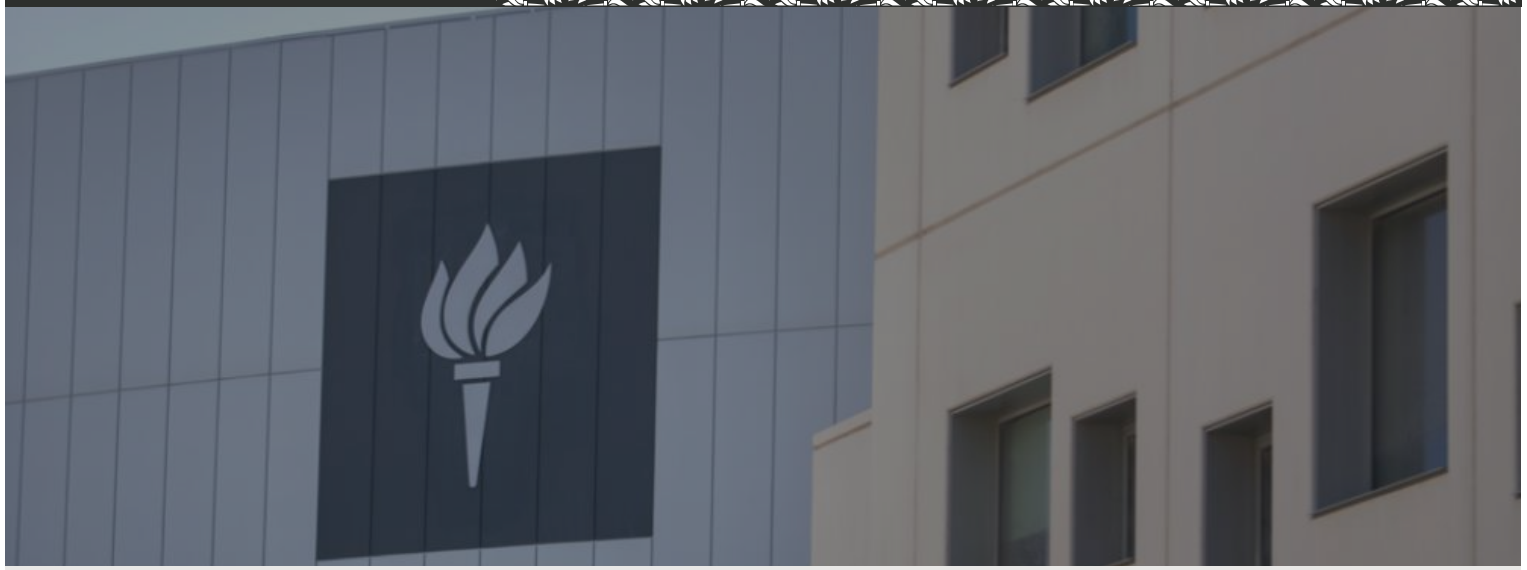

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Abstract

Extensive demographic scholarship shows that the population-level implications of mortality crises such as the COVID-19 pandemic extend beyond mortality dynamics to affect fertility and family-formation strategies. Using novel municipality-level data from Chile covering all births that occurred between January 2017 and December 2021, this study explores trends in fertility and implications of the COVID-19 pandemic for "quantum" and "quality" of births in the Chilean context. Building both a monthly and a yearly panel of 346 municipalities and leveraging fixed-effects regression analyses, we focus on births and Crude Birth Rates (CBRs) to measure quantum, while quality is assessed through the share of births that are low-weight (LBW) and preterm (PTB). Our findings provide evidence of a significant drop in fertility in the wake of COVID – of the magnitude of a reduction of 1.3 live births per 1,000 individuals – which reaches a minimum around February 2021, followed by an incipient rebound in late 2021. Moreover, estimates on child health at birth suggest that the COVID period was associated with an increase in LBW and, foremost, PTB, by 1 and 2.2 percentage points, respectively. Findings from this study shed light on the role of policy interventions in the health arena and the linkages between short- and long-run effects in relation to the various COVID-19 waves.

Keywords: COVID-19; fertility; infant health; baby bust; Chile.

Introduction

The COVID-19 pandemic has pervaded our lives for over two years. Science has done an extraordinary job during this time frame in devising solutions and expanding scholarships on the manifold implications of this global crisis for individuals' lives and societal wellbeing. The pandemic has affected every single aspect of people's lives, from social distancing and strict lockdowns, to economic uncertainty and job insecurity, union instability and spikes in intimate partner violence, short- and long-term consequences for health and wellbeing, and a spike in mortality which left behind an unimaginable number of bereaved family and non-family members (Agüero 2020; Andrasfay and Goldman 2021; Bullinger, Carr, and Packham 2021; Manning and Payne 2021; Verdery et al. 2020; etc.).

Given these significant disruptions to daily lives, it is reasonable to expect the pandemic to have affected couples' fertility ideals and childbearing strategies, thus ultimately shaping actual fertility. History teaches us that spikes in mortality owing to events such as famines, wars, droughts, and epidemics tend to be followed by changes in fertility, mostly resulting in fewer births in the short term (Palloni 1988), with some exceptions in low-resourced contexts, for instance following natural disasters such as the 2004 tsunami (Nobles, Frankenberg, and Thomas 2015), which led to sustained fertility increases. Not only, given the significant number of contextual stressors that the pandemic brought about, there is reason to expect crises and unexpected shocks to produce changes in the "quality" of births as measured by infant health at birth. This has been proven correct, for instance, following the global financial crisis in Portugal (Kana et al. 2017), exposure to extreme temperature shocks in Vietnam (Le and Nguyen 2021), and in-utero exposure to an earthquake in Chile (Torche 2011). When it comes to COVID-19, however, the magnitude and direction of these changes remains unclear for two reasons. The first has to do with the global

nature of the phenomenon and the widely different socioeconomic and sociodemographic conditions (e.g., higher mortality and morbidity due to higher incidence of the disease at older ages) of the current global scenario relative to some major big crises of the past, such as the Spanish flu, the Ebola epidemic in sub-Saharan Africa, and the Zika epidemic in Brazil and other parts of Latin America (Aassve et al. 2021; Wilde, Chen, and Lohmann 2020).[1] The second relates instead to the ongoing nature of the pandemic, which makes it challenging to have reliable and real-time data on many outcomes of interest, including actual births (rather than, for instance, fertility ideals collected through sample surveys), especially at the individual level.

Despite these differences, early on in the pandemic a group of scholars engaged in elaborate theorizing related to how human fertility would have reacted to COVID-19, concluding that birth trends would have varied according to socioeconomic conditions of societies (Aassve et al. 2020). The authors outlined two different scenarios on post-pandemic fertility trajectories and hypothesized that the social measures aimed at reducing COVID-19 may have had different effects on fertility depending on societies' development, stage of demographic transition, population density, age distribution, and access to assisted reproductive technology (ART). According to the first scenario (*high-income countries*), fertility would decline in the wake of COVID-19 due to significant reductions in work-life balance, higher economic losses and uncertainty, and less access to ART due to mobility restrictions and lockdowns. In line with evidence from the Great Recession, Aassve et al. (2020) claimed that a pervasive feeling of uncertainty would make couples postpone any long-term investments, primarily children, yet the study remains silent on the

[1] Still, studies on the relationship between previous crises and fertility outcomes suggest the following: for the Great Recession, a strong negative impact on fertility (Goldstein et al. 2013; Sobotka, Skirbekk, and Philipov 2011); for the Spanish flu, a fertility reduction followed by a subsequent rebound, partly due to fetal loss (Boberg-Fazlic et al. 2021); and for the Zika epidemic, strong negative effects on pregnancies and births (Marteleto et al. 2020; Rangel, Nobles, and Hamoudi 2020).

"quality" of births element. According to the second scenario (*low- and middle-income countries*), the short-term effects of economic uncertainty and reduced access to contraception and family planning programs would result in an increase in pregnancies – some of them unwanted – yet fertility would increase less in more developed and urbanized areas. While in July 2020 these were mostly hypotheses informed by past trends and scholarly contributions from historical demography, two years into the pandemic we have now access to more and better sources of data that may in fact provide an answer to the above puzzle in several societies.

This is precisely the contribution we intend to provide with this paper, focusing on Chile as a case study. Chile is a high-income country located in Latin America which was very severely impacted by the COVID-19 pandemic. Initial cases had been imported from Southeast Asia and Europe, and expanded into a large number of untraceable infections, placing the country within phase 4 of the pandemic as defined by the World Health Organization, with over 1,000 confirmed cases by the end of March 2020 – a situation which led to the imposition of a first nationwide lockdown as of late March/early April 2020. Some media outlets reported that, considering its population, by June 2020 (first peak) Chile had one of the worst outbreaks in the world and by July 2020 10,000 people had died, placing Chile as the country with the sixth largest number of cases in the world.[2] Overall, with over 4.5 million cases and more than 60,000 deaths as of October 2022, [3] the impact of the pandemic has been really severe in the South American country, making it a very suitable context to study its implications on fertility dynamics and infant health outcomes.

We thus provide two contributions to the relevant literature. First, to the best of our knowledge, this is the first study to examine the association between COVID-19 and actual fertility

[2] https://www.bloomberg.com/news/articles/2020-06-16/once-a-covid-role-model-chile-now-among-the-world-s-worst-hit.
[3] https://www.gob.cl/pasoapaso/cifrasoficiales/.

outcomes – births and Crude Birth Rates (CBRs) – in the Chilean context using data from January 2017 to December 2021. To do so, we leverage high-quality data at the municipality level covering 346 municipalities and providing monthly information on actual births and yearly information on birth-related characteristics, such as information on infant health. As such, we build two panels of municipalities and employ fixed-effects regression techniques attempting to minimize concerns related to seasonality alongside the confounding role of pre-pandemic fertility trends. Second, we complement the growing literature on COVID-19-induced "baby booms" or "baby busts" with a novel analysis of the implications of the COVID-19 period for a set of infant health outcomes computed as the share of low-weight (LBW) and preterm (PTB) births. As such, our study is unique in providing a first complementary overview of the dramatic implications of COVID-19 for both quantity and quality of births in a Latin American country that has been very hardly hit by COVID – and surrounded by massive protests and social unrest that preceded the outbreak of the COVID-19 pandemic by a few months – yet it has been largely neglected in the literature on the topic. In so doing, we caution the reader that all analyses in this paper are carried out at the municipality level as individual-level data are not available. In other words, we cannot make any distinction between individuals who contracted COVID vs. those who did not and, as such, all our findings describe trends in fertility indicators and measures of infant health in the broader context of the COVID-19 pandemic (not "due" to the COVID-19 pandemic).

Background

COVID-19 and existing fertility research

Due to the ongoing nature of the pandemic and the complexity of collecting high-quality data on actual births, research on the fertility implications of COVID-19 has proceeded at a slower pace

than research on health and mortality. Three are the main areas that have contributed to this growing body of evidence: scholarship on fertility intentions, scholarship forecasting fertility by means of big data such as Google searches, and scholarship on actual birth trends – the latter coming out since early 2021 due to the well-known gap between conceptions and deliveries. To the best of our knowledge, very limited research has focused on the quality aspect of births – with the notable exception of Torche and Nobles (2022) in the US – a contribution we ourselves provide with the current study.

Starting from the first stream, Luppi, Arpino, and Rosina (2020) offered a descriptive overview of changes in fertility plans during the COVID-19 pandemic in a sample of youth across five European countries, namely Italy, Germany, France, Spain and the UK, and found that fertility plans had been negatively revised in all countries. However, while in Germany and France fertility plans changed moderately, with many people simply postponing their decision to have a child, in Italy the proportion of "abandoners" was much higher than in the other countries. Differently, in the context of Moldova, Emery and Koops (2022) found that medium-term fertility intentions were not affected by the pandemic, yet restricted access to contraception requiring medical consultation and a decrease in short-term fertility intentions did disrupt short-term family planning. Focusing on the United States, Naya, Saxbe, and Dunton (2021) found that among a sample of 440 women trying to conceive, approximately one in three women reported changing their fertility preferences because of the COVID-19 pandemic. Of those that reported changing their fertility preferences, 23.9% reported trying to conceive earlier, while 61.6% reported trying to conceive later. These results are in line with Lindberg et al. (2020), who also found that among 2,009 women, 34% reported wanting to delay childbearing or having fewer children as a result of the pandemic, with a disproportionate concentration among Hispanics and non-Hispanic Blacks. Lastly, while

evidence from low-income contexts is scarce, a recent study from Kenya suggests that the COVID-19 pandemic did not lead to widespread changes in fertility intentions (neither in terms of quantum nor timing), though the most vulnerable women accelerated their childbearing intentions (Zimmerman et al. 2022). For instance, women who reported chronic food insecurity had 4.78 times the odds of accelerating their desired timing to next birth compared to those who reported no food insecurity. As of now, we are not aware of studies focusing on the relationship between COVID-19 and fertility intentions in Latin America.

Moving to the second stream, given the lack of timely data, some scholars resorted to big data to track fertility dynamics in the US in a timely manner. In one of the first studies on the topic, Wilde et al. (2020) used data on Google searches during the COVID-19 pandemic to predict changes in aggregate fertility rates in the United States. They found that between November 2020 and February 2021 monthly US births dropped by roughly 15%, a much larger decline than that of the Great Recession of 2008 and one that is rather comparable to those of the Spanish flu and the Great Depression. Consistently with higher caseloads of COVID-19 among low-income and minority neighborhoods, they also found significant differences for different groups of women, with African American women predicted to suffer from largest declines in fertility due to the pandemic. Taking the analysis to the cross-national level, Berger et al. (2021) explored trends in searches for specific keywords exploiting the variability over time and between countries in lockdown dates. In doing so, they found statistically significant impacts of lockdown timing on changes in searches for terms such as wedding and those related to condom use, emergency contraception, pregnancy tests, and abortion, but little evidence of changes in searches related to fertility. Impacts for union formation and dissolution tended to only be statistically significant at the start of the lockdown, with a return to average levels few months after the lockdown.

Lastly, recent studies focusing on actual births tend to find evidence in favor of "baby busts," followed by weak rebounds. For instance, Cohen (2021) estimated a 3.8% drop in births for 2020 compared to 2019, with an accelerating rate of decline at the end of 2020 (his data do not allow to examine subsequent rebounds). Similarly, across a set of 17 countries Sobotka et al. (2021) found that the number of births fell on average by 5.1% in November 2020, 6.5% in December 2020 and 8.9% in January 2021 when compared with the same months of the previous year. Spain sustained the sharpest drop in the number of births among the analyzed countries, with births plummeting by 20% in December 2020 and January 2021. In a similar spirit, Aassve et al. (2021) studied trends in CBRs in 22 high-income countries, finding significant declines in seven out of the 22 countries considered, with particularly strong declines in Italy (-9.1%), Spain (-8.4%), and Portugal (-6.6%), alongside evidence of rebound in mid 2021 in countries such as Spain, France, Switzerland, and the Netherlands. Again, evidence from Latin America is scarce, yet a recent study by Lima, Soares, and Monteiro da Silva (2022) using vital-statistics data from the six largest cities in Brazil found strong declines in the number of births in some of the cities analyzed, and most reductions occurring among women around the age of 30. Nonetheless, they also documented that in the cities of Rio de Janeiro and Belo Horizonte, the decreasing trend in birth counts appeared to have slowed down, or even reversed, thus highlighting widespread geographical heterogeneity.

Fertility and COVID-19 in the Chilean context

According to the National Institute of Statistics (*Instituto Nacional de Estadísticas*, INE), the Total Fertility Rate (TFR) in Chile was 1.4 in 2019, far below generational replacement. After the baby boom (1950s), the TFR in Chile had been falling consistently. The rate of decline was fastest between 1960s and 1990s, as a series of social, economic, and healthcare reforms contributed to

boosting women's participation in education, as well as reducing child mortality. Fertility fell below replacement level in the early 2000s. Research from Stefanelli et al. (2016) suggests that the TFR experienced a sustained decline in Chile, falling from 5.49 to 1.86 between 1960 and 2011, and this reduction has been linked to an increase in female labor force participation, but also to generalized trends in the country's social and economic development.

This decline in fertility rates is not a unique characteristic of Chile. According to the Department of Economic and Social Affairs of the United Nations (UN-DESA), the global total fertility rate is expected to continue falling, and has decreased in the whole region during the last 50 years (United Nations 2020). Chile fits well within the general trends described for Latin American countries, yet it stands out for being one of the few countries in the region with fertility rates below replacement level, with more children born outside of marriage – currently over 70% of all Chilean children are born to unmarried mothers – and the proportion of childless women is the second lowest among OECD countries (OECD 2015).

In terms of trends in infant health, research from Chile has shown that the gestational age and birth weight of live births have significantly changed over the past decades (Abufhele, Pesando, and Castro 2022; Lopez and Bréart 2012; Torche and Abufhele 2021). Despite the rapid economic growth that the country experienced over the last decades, the share of children born with less than 2,500 grams – the definition of low weight at birth – and the share of children born before 37 weeks of gestation – the definition of preterm birth – have increased over time, echoing recent worrisome evidence from the US (Rauscher and Rangel 2020). In 1990, the proportion of LBW was 5.7%, while this rose to 6.3% in 2015. For PTB, the increase was even more marked: from 5.5% in 1990 to 8.1% in 2015. Again, these patterns are not unique to Chile and they are partly a reflection of increased maternal age (Chawanpaiboon et al. 2019; Zeitlin et al. 2013),

multiple pregnancies (Araya et al. 2017), and associated comorbidities (da Silveira et al. 2008). All of these features – alongside the below-replacement fertility and some of the "unique" family dynamics within Latin America mentioned above – make Chile a very appealing context to study the fertility and infant health implications of the COVID-19 pandemic.

In the global context of the COVID-19 pandemic, in March of 2020 Chile declared the beginning of a series of measures aimed at containing the spread of the virus and strengthening the response of health systems to its threat. The government's actions began with restrictions on massive events and sworn declarations requested on arrival from those coming from abroad. A week later, schools were closed, and classes started to transition remotely. Remote work was also encouraged in every possible case, among other suggestions and regulations. However, with the rapid spread of the virus, measures were tightened rapidly. On March 22, a curfew was established throughout the national territory, from 10:00 pm to 5:00 am every day. During this time, people were asked to stay at home. The objective of these measures was to reduce social contacts and to reinforce mandatory quarantine for those who tested positive. Different measures were taken from the government to alleviate the potential job difficulties that families were experiencing and among those were economic packages and early withdrawals of pension funds.

Note that the COVID-19 outbreak in Chile followed an intense period of social unrest which started on October 19th 2019, in which massive political protests motivated by social demands disrupted the social and economic daily life. In social terms, despite a lack of organized leadership, this social movement featured high attendance rates and strong national support; given the civil unrest and social protests, the government declared a state of emergency characterized by restricted mobility, a curfew, and the deployment of armed soldiers and policemen to control street disturbances (Somma et al. 2021). In economic terms, the "estallido social" represented an

important domestic economic shock and had large impacts on all segments of society. It disrupted transportation in significant parts of the country and affected several businesses, particularly the retail sector and construction. In terms of health, Gajardo et al. (2021) showed that during the first ten weeks of protests, trauma hospitalizations increased and emergency consultations declined, on average, for trauma, respiratory causes, and respiratory hospitalizations; yet these results were not statistically significant. As such, despite the major disruptions brought about by the protests, it is hard to think that pregnant women stopped receiving care in the health system or when giving birth, yet the social and economic uncertainty may have contributed to a slight postponement of fertility.

Chile is divided into 16 regions and 346 municipalities (*comunas*) – see Appendix Figure A1 for a map of Chile with a regional breakdown. The population distribution in these regions is unequal, as approximately half of the people living in the country (41%, according to the 2017 census) are concentrated in the Metropolitan area, where the country's capital Santiago de Chile is located. At the very end of March, the government imposed a total lockdown for seven of the municipalities in the Eastern sector of the Metropolitan region, alongside special containment measures for some cities in the South of the country. With the virus's rapid spread, the Health Ministry and a Social Table composed of various experts and actors proposed the program "Step by Step" (*Paso a Paso*), a containment model that established four phases or steps that regulated commercial activities and mobility. For the areas in phase 1, mobility was minimal, so people had to stay in their homes. Two individual permits were granted weekly to go out for two hours, either to go shopping or to solve emergencies. For phase 2 areas, free circulation was allowed between Monday and Friday, but departures were restricted on weekends. Phases 3 and 4 implied free

movement but presented different restrictions in terms of capacity for public and private establishments.

Although some initial research suggested that the implemented public health interventions were initially effective in curbing the spread of the pandemic (Canals et al. 2020), later research questioned their effectiveness for all population strata. A study showed that small-area lockdowns produced a sizable reduction in human mobility but a smaller effect on viral transmission and that these effects had a smaller impact than the early closures of schools and universities (Cuadrado et al. 2020). Another piece of research showed that the effectiveness of the dynamic lockdowns depended on the interdependence between municipalities (Li, Undurraga, and Zubizarreta 2022). Lastly, Bennett (2021) showed evidence that small-area lockdown measures had a differential effect on higher- and lower-income populations, as the possibility to stay at home was not the same for everyone.

Data and Methods

This study relies on unique data on fertility and child health outcomes at the municipality level (N=346) monitored and collected by the Chilean Ministry of Health (*Ministerio de Salud, Minsal*) and updated regularly through a virtual platform which is publicly available.[4] While the data are publicly available, no consistent effort has been undertaken (yet) to produce related spreadsheets to be downloaded for public and accessible use. For this paper, we therefore recreated all the time series at the municipality level – both monthly and yearly – on the variables of interest by web scraping the information collected and displayed on the aforementioned platform.[5] Note that, given

[4] The platform can be accessed at this link from the Department of Statistics and Health Information: https://deis.minsal.cl/#tableros.
[5] Subject to approval from the Ministry of Health, we are committed to making this dataset publicly available.

data availability, we collected two series of data which in turn shaped the two types of analyses that we conducted. Municipalities are our units of observation. The first series of data contains monthly births from January 2017 to December 2021 for each municipality.[6] Through these data, we created a panel of births where each municipality is observed in each month-year combination (346 municipalities*12 months*5 years), for a total of 20,760 observations. While this dataset is very rich in terms of fertility information, there are no additional variables provided by Minsal that we could account for in our analyses, primarily due to the lack of monthly-level information on characteristics such as infant health, age of the mother, etc. Therefore, we complemented the dataset in two ways: first, we obtained information on population size for each municipality from the National Institute of Statistics to estimate monthly Crude Birth Rates. We matched information on monthly live births with mid-year population estimates. Monthly CBRs per 1,000 population per year were computed as follows: (monthly live births/mid-year population)*1,000*12. Note that we did have access to population estimates by municipality by year, yet not by month (a very hard-to-obtain statistic), which prevented us from estimating "exact" monthly CBRs, defined as live births within the month in a specific municipality divided by mid-period population as a proxy for person-years within that same month. In other words, each municipality within a year was assigned the same person-years denominator irrespective of month, in a spirit similar to Aassve et al. (2021). Nonetheless, obtaining CBRs – rather than raw births, which are not comparable – is particularly valuable when it comes to making comparisons by year, as the population "at risk" of producing births – i.e., the exposure – is likely to significantly change across municipalities over

[6] Live birth counts for 2020 and 2021 for some municipalities are provisional and are likely to be marginally updated – as it is currently the case in many countries.

time.[7] The average monthly CBR for Chile as a whole ranged from 11.45 live births per 1,000 individuals in 2017 to 9.26 in 2021. Second, we obtained information on the total number of days per month spent under lockdown, obtained from a public repository managed by the Ministry of Science, Technology, Knowledge and Innovation (*Ministerio de Ciencia, Tecnología, Conocimiento e Innovación*), as a way to measure the strictness of the measures imposed in each municipality and an indirect proxy for the incidence of COVID.[8] The average monthly number of days spent in lockdown for Chile as a whole ranged between 4.6 in 2020 to 12.4 in 2021. We also built a "pandemic" dummy taking the value of 1 from the end of January 2021 onwards, in order to reflect the time point in which most COVID conceptions reached full term (9-10 months after the first lockdown was imposed).

The second series of data contains yearly municipality-level information on number of births between 2017 and 2021, alongside sex of the newborn (i.e., number of boys and girls born in each municipality), mother's average age, weeks of gestation in categories (less than 24 weeks, 24-27 weeks, 28-31 weeks, 32-36 weeks, 37-41 weeks, and more than 42 weeks), and birth weight in categories (less than 1,500 grams, 1,500-2,499 grams, 2,500-2,999 grams, 3,000-3,999 grams, and more than 4,000 grams). Through these data, we created a panel of variables where each municipality is observed in each year (346 municipalities*5 years), for a total of 1,730 observations. As these are municipality-level variables, we created additional variables based on the above categories, namely the *share* of births that are female, the *share* of births that are low weight (i.e., less than 2,500 grams) and the *share* of births that are preterm (i.e., 36 weeks or less)

[7] We acknowledge that age-standardized fertility rates and/or monthly Total Fertility Rates (TFR) would be more correct measures to fully control for differences in the population age structure, yet data on births by age of the mother were not available, thus preventing us from computing age-specific fertility rates.
[8] https://github.com/MinCiencia/Datos-COVID19.

– the latter two representing the outcomes of interest in the yearly panel analyses.[9] As above, we merged the total number of days per municipality spent in lockdown at the yearly level, ranging between 55.8 days in 2020 to 148.8 days in 2021, and we created a pandemic dummy taking the value of 1 for the year 2021 and 0 otherwise. As data at the monthly level are not available, coding the whole of 2021 as "pandemic" was the only possible strategy in this scenario to capture the generalized implications of the pandemic context for children's health outcomes. While this is an approximation and we acknowledge that the etiology of LBW and PTB originates in utero far before delivery and is affected by external events and stressors throughout pregnancy (Gluckman et al. 2008; Torche 2011; Torche and Echevarría 2011; Torche and Kleinhaus 2012) – thus also affecting part of 2020 – this is the best approximation we can opt for given the available yearly data for this part of the study.[10]

As both datasets focus primarily on births, a few words of caution are worth expressing regarding the quality of birth data. Chile is characterized for the high quality of administrative data, and during the Covid-19 pandemic this was no exception. Moreover, in terms of birth records, during 2020 and 2021, 99.5% and 99.4% of births occurred in hospitals, respectively. Moreover, 99,9% of the births during those years received some form of professional attention during birth.[11] This means that almost all the births in Chile were registered at the correct time and according to the usual registration protocols.

With both datasets we ran panel-data fixed-effects (FE) regressions with municipalities as the main units of analysis. As such, our results reflect within-municipality comparisons over time,

[9] Note that, while it is the case that children who are born preterm tend to weigh less at birth, the two outcomes are not overlapping, as there are plenty of babies who reach full term yet are born LBW. The correlation between these two municipality-level shares is around 0.6, suggesting that the outcomes do capture some different elements. This is also confirmed by ample previous research, including in Chile, such as Abufhele, Pesando, and Castro (2022).
[10] Results replacing a dummy for 2020 instead of 2021 deliver similar results.
[11] https://informesdeis.minsal.cl/

a feature of our study which should minimize the role of compositional factors related to, for instance, different age structures *across* municipalities (e.g., very rural and remote ones versus urban ones).[12] We ran two types of models per outcome. Using monthly data, we first ran models predicting monthly CBRs as a function of the month-year combination and controlling for monthly number of days spent in lockdown and plot the resulting estimated coefficients, including interactions by region. Second, we replaced the whole series of month-year dummies with one single pandemic dummy to better assess the association between the pandemic itself and the CBR. In these latter models, we still controlled for the number of days spent in lockdown and for month fixed effects to account for seasonality. Accounting for these time variables is one partial strategy to control for the evolution of the age structure, yet to further ensure that our findings are not driven by pre-pandemic trends in the outcomes of interest, we tested the results by constructing an alternative range of outcomes. As a counterpart for the monthly CBR, we constructed the "adjusted CBR" as the ratio of the CBR in a specific month in a specific year (say, January 2021) and the average between the January CBRs in 2017, 2018, and 2019 (i.e., the pre-pandemic years), as in Aassve et al. (2021). We did the same for the child health outcomes constructing the ratios at the yearly (rather than monthly) levels, thus obtaining "adjusted LBW" and "adjusted PTB" (i.e., denominators are yearly averages between share of births LBW and PTB in 2017, 2018, 2019, respectively). For the sake of intuition and easy interpretation, we report analyses on the unadjusted outcomes in the main body of the paper, while analyses on "adjusted" outcomes – which deliver essentially analogous results – are provided in the Appendix.

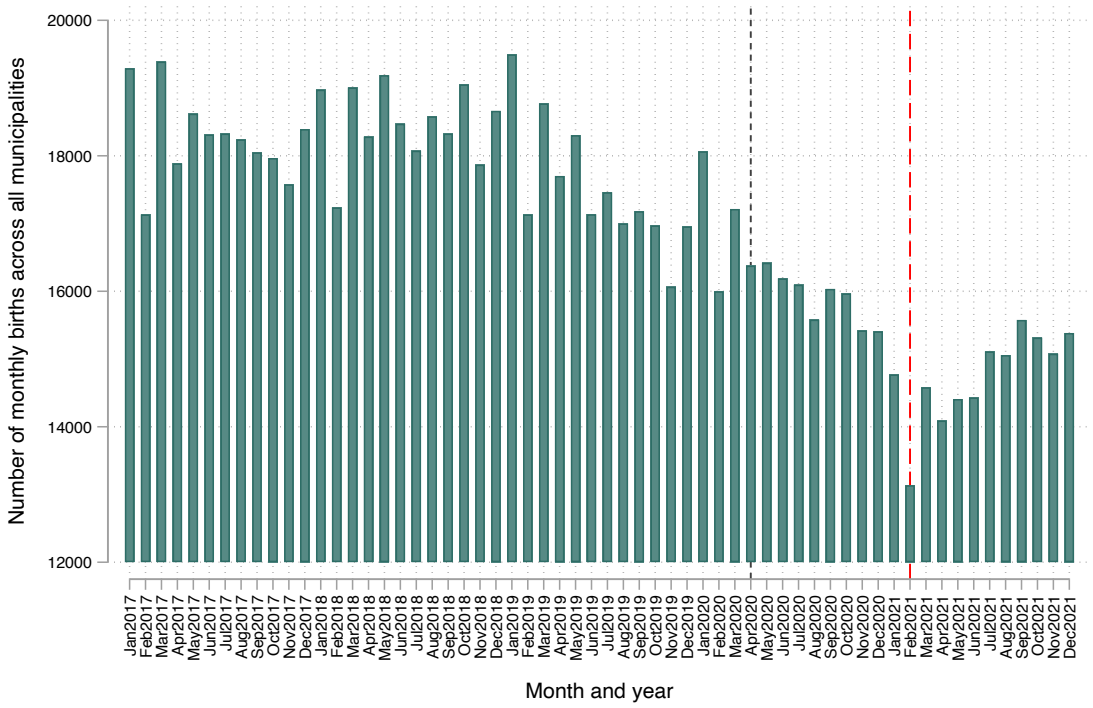
Results

[12] Note that our results are analogous when estimating Generalized Estimating Equation (GEE) models.

Evidence on quantum of fertility from monthly data

Combining monthly-level data across all 346 municipalities, Figure 1 plots the raw number of live births for each month from January 2017 to December 2021. The Figure provides evidence of seasonal patterns yet a rather stable number of births up until mid-2019, approximately. A clear inflection point (minimum) emerges from this Figure, which corresponds to babies delivered in February 2021 (long dashed line), i.e., conceptions that date back to April-May 2020 (thin dashed line) – a preliminary finding which provides raw descriptive evidence that the pandemic may have led to a baby bust in Chile, in line with findings from other high-income societies, especially countries in Southern Europe such as Italy, Spain, and Portugal (Aassve et al. 2021). For the sake of comparison, 17,134 babies were born in Chile in February 2017, against 13,137 babies in February 2021, corresponding to a 23.3% decline. Although 2022 data would be needed to reach more solid conclusions, the Figure also points towards an incipient rebound in total number of births following February 2021, in line with findings from France and Switzerland in Aassve et al. (2021). Nonetheless, it is common knowledge that comparing raw number of births may be misleading as no reference population is accounted for. Hence, in what follows we estimate models relying on the monthly CBR as main outcome of interest.

FIGURE 1 Raw number of births by month across all municipalities in Chile between January 2017 and December 2021



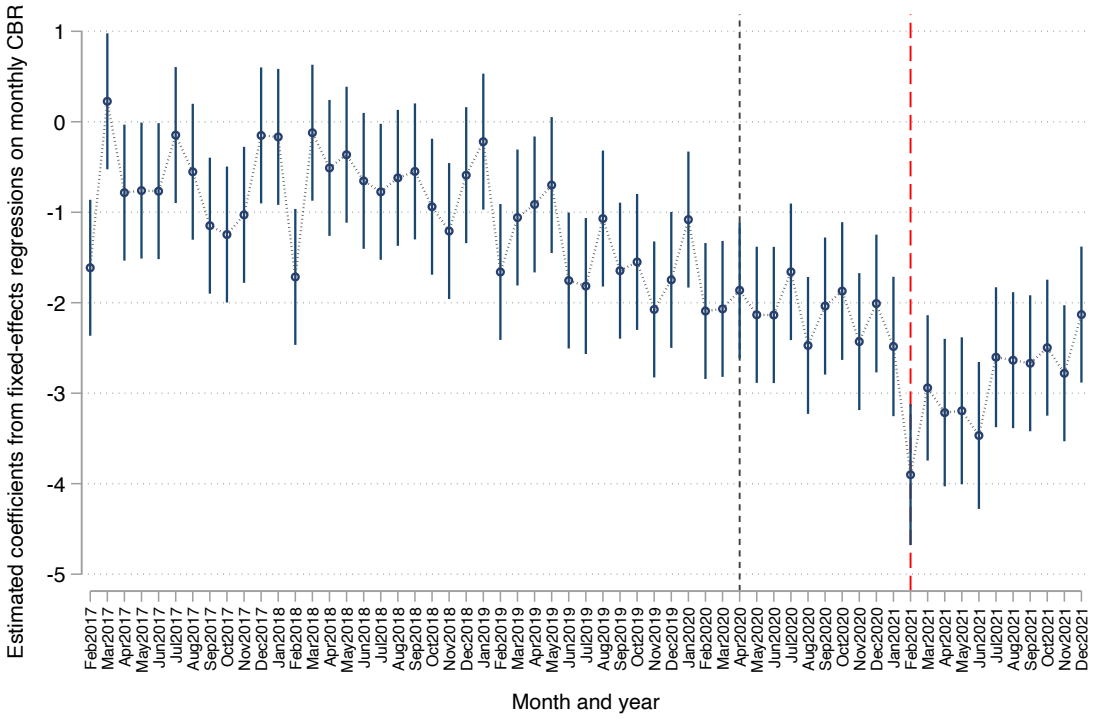
Notes: Monthly data from Minsal – Chilean Ministry of Health, by municipality. The black thin dashed line corresponds to the official launch of the nationwide lockdown (April 2020), while the red long dashed line corresponds to the approximate time in which COVID conceptions reach full term (January-February 2021).

To provide some descriptive evidence on CBRs, in January 2021 (conceptions of April 2020) we find a 12.5% decline in CBRs relative to the same month in 2020 (9.65 versus 11.03). In February 2021 (conceptions of May 2020), the decline is even higher, around 17.8% (8.24 versus 10.02). Comparing CBRs one year apart is a sensible strategy as it provides estimates that are robust to seasonality (Aassve et al. 2021). Indeed, the measured decline in births may also be due to secular trends of CBR decline, which are in turn affected by changes in the age structure. Although Figure 1 is quite clear in providing evidence of seasonality (e.g., births in February are lower in every year, while births in November and December tend to be higher), there is no marked decline in births in 2017 and 2018, suggesting that secular declines in CBRs may be less of an

issue in this context. Nonetheless, in the estimates that follow we control for seasonality and ensure that findings are not driven by pre-pandemic declining trends in the outcomes of interest by computing adjusted dependent variables.

Figure 2 provides estimated coefficients from fixed-effects regressions of monthly CBRs on time dummies (i.e., month-year combinations), controlling for monthly number of days spent in lockdown. Despite the difference in outcome – CBRs instead of births – and the different modeling strategy – within-municipality analyses through FE – the evidence obtained is very much consistent with trends observed in Figure 1. Estimated coefficients provide evidence of seasonality yet relative stability from January 2017 to about June 2019, followed by a gradual decline which reaches a minimum in February 2021 and is followed by a mild rebound afterwards. In terms of magnitudes, the graph suggests that relative to January 2017 (the reference category), the CBR in February 2021 was lower by about 3.9 live births per 1,000 individuals. Evidence from Figure 2 thus confirms preliminary descriptive findings suggesting that Chile underwent a relatively "rapid" baby bust in the wake of the first wave of the COVID-19 pandemic.

FIGURE 2 Estimated coefficients from fixed-effects regressions on monthly CBR, coefficients for month-year reported



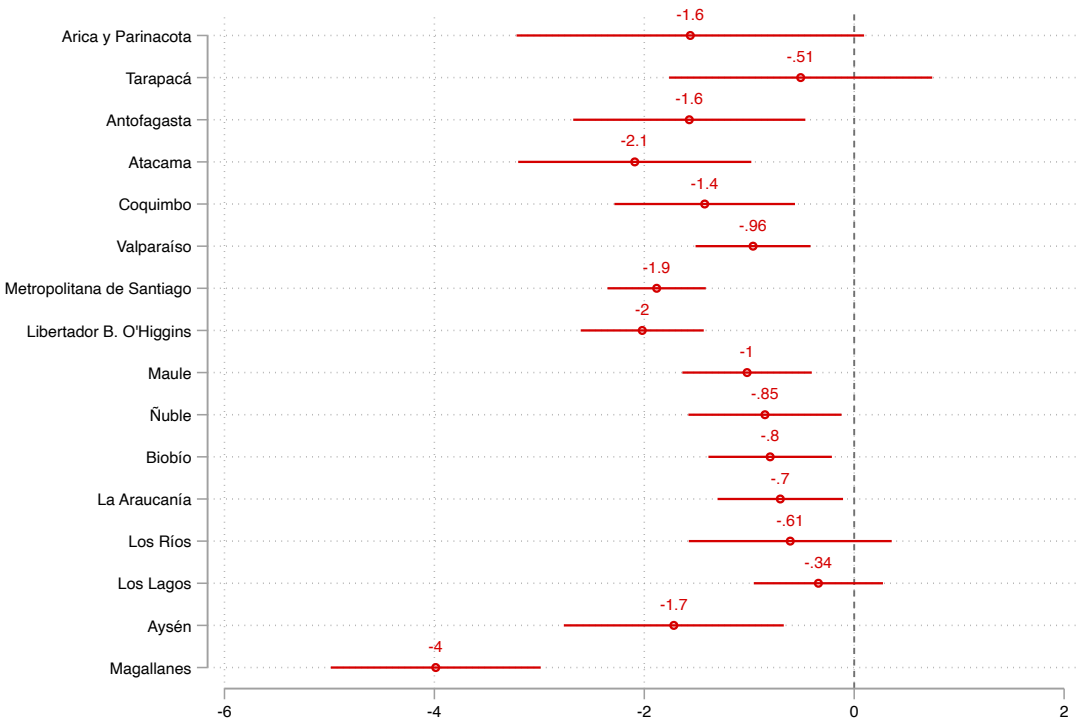
Notes: Monthly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. The black thin dashed line corresponds to the official launch of the nationwide lockdown (April 2020), while the red long dashed line corresponds to the approximate time in which COVID conceptions reach full term (January-February 2021). The omitted reference category is January 2017. 95% confidence intervals reported.

To better characterize the association between the COVID pandemic itself and CBRs, in the next set of estimates we replaced the whole set of month-year dummies with a simple "pandemic" dummy that equals 1 from February 2021 onwards, still controlling for month fixed effects and number of days per month spent in lockdown. Coefficient estimates, provided in Appendix Table A1 (panel a, column 3), suggest that the COVID-19 pandemic was associated with a decline in the monthly CBR by 1.31 live births per 1,000 individuals, a quite sizeable reduction given the mean monthly CBR over the pre-2021 period of 10.94 live births per 1,000 (a 12% decline, approximately). The same model also reveals a strong negative association between number of days spent in lockdown and monthly CBRs, whereby every additional day spent in

lockdown is associated with a lower CBR by 0.03 live births per 1,000 individuals. Using this same specification, Figure 3 provides estimates obtained by interacting the pandemic dummy with a regional identifier – all the 16 Chilean regions – in order to assess whether the association is driven by specific regions or is relatively evenly spread across the country. Findings are overwhelmingly consistent across regions: the estimated association is negative in all 16 regions and statistically significant at the 5% level in 12 of them, including the ones featuring the highest number of births, namely Region Metropolitana (which includes the capital city), followed by Valparaíso, Biobío, and Maule. Estimates from the Region Metropolitana suggest that the pandemic was associated with a decline in the monthly CBR by 1.9 live births per 1,000 individuals which, out of a mean CBR of 11.69 live births per 1,000 over the pre-2021 period, corresponds to a 16.2% decline, approximately. The Figure also shows that the most negative association with fertility is observed in Magallanes, yet we caution the reader that this finding may be a by-product of the fact that births in such region are among the lowest in Chile and some municipalities reported zero births over several months during the time period considered.[13]

[13] Further research is needed on this front.

FIGURE 3 Estimated coefficients from fixed-effects regressions on monthly CBR by region (pandemic dummy interacted with regional identifier)



Notes: Monthly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. Regions are sorted geographically from the far North (Arica y Parinacota) to the far South (Magallanes). 95% confidence intervals reported.

As anticipated above, to further rule out the possibility that results be driven by pre-pandemic declines in CBRs, we reran estimates adjusting the CBR by the average of the CBR in the same month in the pre-pandemic years (2017, 2018, 2019), and used this "adjusted CBR" or "CBR ratio" as outcome. Figure A2 provides corresponding estimates to Figure 2 and shows essentially analogous results with declines in the CBR ratio in early 2021 followed by a mild yet gradual rebound. Similarly, Figure A3 provides corresponding regional estimates to Figure 3, also highlighting statistically significant negative associations at the 5% level in 12 of the 16 regions, accompanied by, on average, wider variability in the estimates, especially in the regions of Arica Y Parinacota, Tarapacá, and Aysén. Lastly, estimates from Appendix Table A1 (panel b, column

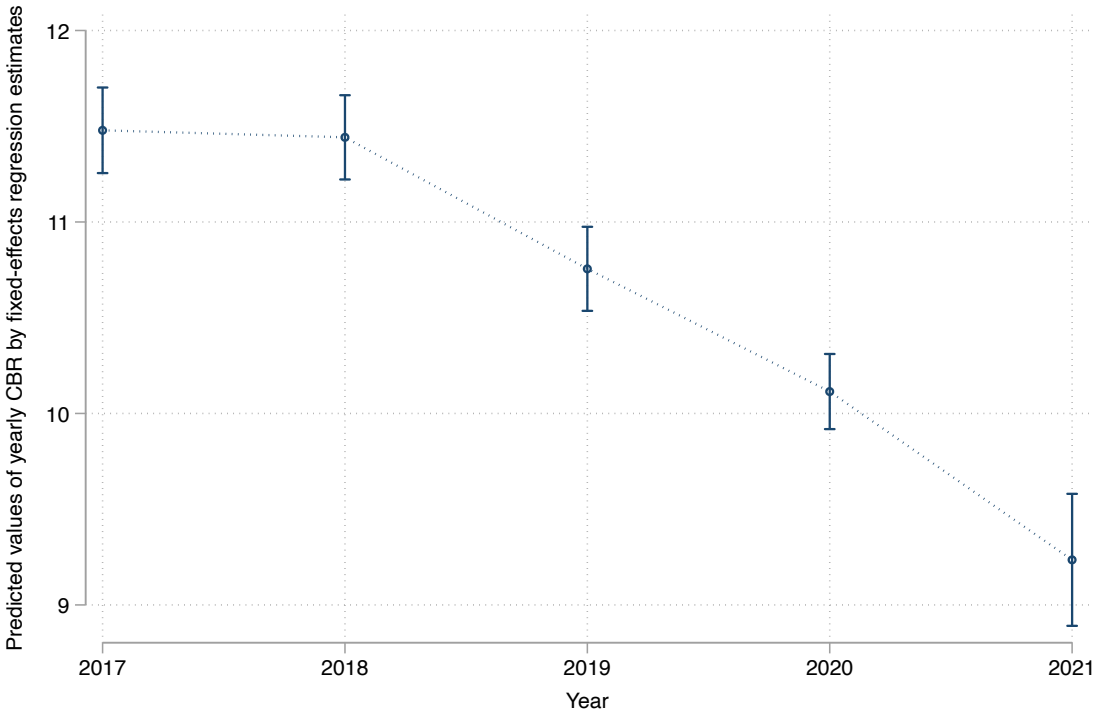
3) suggest that the COVID-19 pandemic was associated with a statistically significant decline in the monthly CBR ratio by 0.08 units.

Evidence on quantum and quality of fertility from yearly data

Although the above section provides more detailed information on births as it collects monthly data, we transition to the yearly analyses on children's health at birth by first reporting corresponding estimates of the associations between time variables and yearly CBRs through FE regression analyses, controlling for age of the mother and yearly number of days spent in lockdown. Predicted values of yearly CBRs are reported in Figure 4, which confirms rather stable CBRs in 2017 and 2018, yet declining estimates from 2019 onwards, reaching a minimum of 9.23 in 2021. Corresponding estimates on the adjusted yearly CBR are provided in Appendix Figure A4 and deliver analogous results, except for even a mild increase in the CBR ratio between 2017 and 2018, suggesting once again no real decline in pre-pandemic fertility. Similarly, estimates in Appendix Table A2 replicate the evidence provided in Table A1 focusing on yearly CBRs and a pandemic dummy that takes the value of 1 for the year 2021 (our "pandemic-fertility" effect).[14] Such estimates suggest that the COVID-19 pandemic was associated with a decline in the yearly CBR by 0.88 live births per 1,000 individuals (panel a, column 2) and a decline in the yearly CBR ratio by 0.05 units (panel b, column 2).

[14] The term effect is used here and throughout the paper in a purely associational manner.

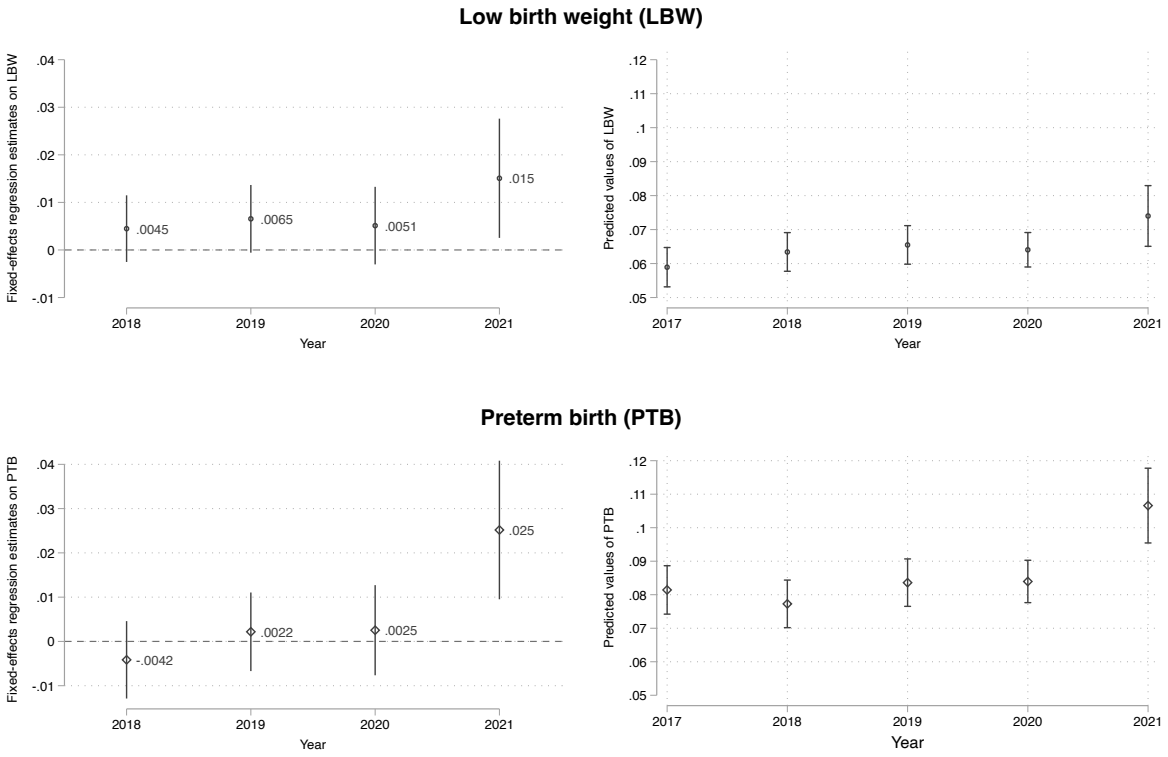
FIGURE 4 Predicted values of yearly CBRs by fixed-effects regression estimates



Notes: Yearly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. 95% confidence intervals reported.

We next move to explore the relationship between COVID-19 and infant health, leveraging some characteristics related to the births themselves, such as birth weight and gestational age which were not available in the monthly data. To do so, we focus on two outcomes defined above, namely the share of births that are low-weight (LBW) and the share of births that are preterm (PTB). We present two panels per outcome in Figure 5, with LBW (top) and PTB (bottom): the first panel (left) provides estimated coefficients of year dummies (2017 as reference category) from fixed-effects regressions controlling for the age of the mother, the share of female newborns, and the number of days spent in lockdown. Note that the 2021 coefficient constitutes here our focus of interest (our "pandemic-health" contextual effect). The second panel (right) provides predicted values of the outcomes from the same specifications.

FIGURE 5 Estimated coefficients from fixed-effects regressions (left panel) and predicted values from fixed effects regressions (right panel) on LBW (top) and PTB (bottom)



Notes: Yearly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. For the left panels, 2017 is the reference category. 95% confidence intervals reported.

Starting from LBW, the left panel shows that, relative to 2017, the only statistically significant coefficient is the 2021 one, suggesting that the share of low-weight births increased by 0.015 units (an increase of about 23% given a pre-pandemic mean of 0.064). None of the other coefficients are statistically significant, suggesting that there may be something unique to 2021 (conceptions of 2020) in terms of infant health. Nonetheless, predicted values on the right show that most confidence intervals are overlapping, revealing that the predicted value in 2021 was higher yet not statistically higher than predicted values from previous years. The 2021 "jump" is instead far more marked for the PTB outcome. Again, relative to 2017, none of the pre-2021

coefficients are statistically different from zero, while the 2021 dummy is positive and strongly statistically significant, revealing an increase in PTB by 0.025 units (an increase of about 29.8% given a pre-pandemic mean of 0.084). Differently from LBW, the right graph shows predicted values that are significantly higher than those obtained in each previous year, which are relatively constant. Analogous estimates adjusting the two health outcomes of interest by their mean in the three pre-pandemic years (2017, 2018, and 2019) are essentially unaltered (Appendix Figure A5) yet even more suggestive of the idea that 2021 was indeed a different year in terms of both estimated coefficients and predicted values for *both* LBW and PTB. While we have no causal setup here to claim that such poorer health outcomes are due to the COVID-19 pandemic itself – nor we have individual-level data on COVID-positive vs. COVID-negative women – our evidence suggests that the overall economic, sociodemographic, and societal instability that surrounded the COVID period (alongside prior protests and social unrest) may constitute one plausible explanation.

Related models replacing the year dummies with a unique pandemic dummy (Appendix Table A3) allow to better quantify the association between the COVID-19 period and child health. Following the same structure of the above tables, for LBW panel a (column 2) suggests that the COVID-19 pandemic period was associated with a higher share of LBW by 0.01 units, while panel b (column 2) shows that the same was associated with a higher adjusted LBW by 0.23 units. Similarly, for PTB panel a (column 2) suggests that the COVID-19 period was associated with a higher share of PTB by 0.023 units, while panel b (column 2) shows that the pandemic period was associated with a higher adjusted PTB by 0.16 units. All in all, despite the lack of detailed monthly data on child health, our results combined provide support to the idea that COVID-19 period was associated not only to a lower quantum of fertility, but also to poorer infant-health outcomes. The

extent to which these negative associations will last into the future is unclear as of yet, especially for the child-health outcomes, yet better data at a more granular and spatiotemporal level of analysis will cast additional light on the topic.

Conclusions and Discussion

To the best of our knowledge, this study has provided the first assessment of potential implications of the COVID-19 pandemic for fertility and infant-health outcomes in the context of Chile. Using novel municipality-level data from Chile covering all births that occurred between January 2017 and December 2021, we estimated trends in fertility and assessed implications of the pandemic period for "quantum" and "quality" of fertility as measured by CBRs and shares of low-weight and preterm births, respectively. Due to the nature of the data, we leveraged a unique combination of monthly and yearly information building a panel dataset of 346 municipalities and leveraging data-visualization techniques and fixed-effects regression analyses. We documented a significant drop in fertility in the wake of COVID – of the magnitude of a reduction of 1.3 live births per 1,000 individuals – which reached a minimum around February 2021 and was followed by an incipient rebound in late 2021. These findings are in line with preliminary existing evidence on actual fertility in high-income societies measured through vital statistics, such as the 3.8% decline in births obtained by Cohen (2021) for the United States, the increasing rate of decline in births from 5.1% in November 2020 to 8.9% in January 2021 documented by Sobotka et al. (2021) across 17 countries, and the significant drop in CBRs found by Aassve et al. (2021) in 7 out of the 22 high-income countries considered, primarily in Southern Europe. As such, our evidence from Chile through high-quality data well complements the idea that the COVID pandemic led to declines in fertility, likely due to increased uncertainty about the future, higher economic instability, forced

lockdowns leading to heightened stress before and during pregnancies alongside higher union instability, and lack of adequate policies to address and/or reconcile work-family and childbearing-childrearing conflicts. Not surprisingly, existing scholarship suggests that economic uncertainty and psychological distress were at their highest peak in Chile during the COVID-19 pandemic, especially among women and in areas that were hardest hit by the pandemic (Duarte and Jiménez-Molina 2021; Narea et al. 2022). While our findings are consistent with the idea of a fertility rebound towards late 2021 – thus suggesting postponement during the first months of the pandemic rather than foregone births – additional data would be needed to reach more solid conclusions. Relatedly, Chile underwent multiple pandemic phases and strict lockdown policies that changed overtime with each respective wave, hence detailed information on such variables would shed better light on the unfolding nature of the pandemic on fertility in the current and future years.

While relatively "rapid" baby busts such as the one we documented above had been studied in the literature (although in countries other than Chile), we provided in this study yet another different focus on the relationship between the pandemic and child health at birth, i.e., what we labelled for convenience the "quality" element. According to our estimates, during the COVID period, we observed an increase in low birth weight and, foremost, preterm births, by 1 and 2.2 percentage points, respectively, corresponding to sizeable increases in the range of 23-30% – a set of estimates which should be taken seriously by policymakers working in the health arena. These findings differ from some results obtained through individual-level data and medical trials, suggesting no differences or even declines in preterm births and low birth weight, especially during lockdowns (Badran et al. 2021). A study from California (Karasek et al. 2021) and a systematic review of 42 studies involving over 400,000 individuals (Wei et al. 2021) instead provide some evidence consistent with the idea that COVID-19 was associated with higher PTB, especially

among people with co-morbidities. Nonetheless, we caution the reader that this is a very recent line of inquiry where the methodologies (e.g., comparing pregnant women with and without COVID), scales of analysis (e.g., a hospital versus a whole country), and types of data (e.g., individual-level versus population-level) are vastly different, ranging from clinical trials with a minimum of a few hundred individuals to population-level estimates at the municipality- and monthly/yearly- levels, as done in this study. Furthermore, in a municipality-level study aggregating shares of births as main outcomes of interest, there is really no way to know how many of the women giving birth were affected directly by COVID versus not, thus leaving multiple interpretations and the discussion of potential underlying mechanisms open.[15] For instance, while it may well be the nature and evolution of the virus that explains the negative associations with infant health – provided that women contracted the virus to start with – we advance here a broader explanation encompassing the overall surrounding economic, sociodemographic, and societal instability that characterized the whole period. Alongside generalized distress brought about by COVID, we caution the reader that another factor behind our findings of declining fertility and worsening infant health may relate to the whole climate of social unrest that exploded in Chile a few months before the first COVID-19 outbreak. Nonetheless, we hope that our findings on declining quantity and quality of births in Chile amidst the COVID-19 pandemic will be informative for politicians and policymakers as they handle the more recent waves of the

[15] The perinatal period, which prepares the mother to take care of her baby, is a highly sensitive period characterized by specific changes at the biological, neurohormonal, physical and psychological levels. The literature on COVID-19 and pregnancies highlights the biopsychosocial etiology of depressive and anxious symptoms during this period due to many stressors and their contribution to consequences such as preterm labor, low quality of mother-baby interaction, low maternal sensitivity and delays in children's development (Olhaberry et al. 2022). Additionally, the current pandemic has increased the risk of mental-health issues in parents, mainly because of social isolation and disruption, as well as changes in face-to-face educational, recreational and productive activities. In particular, pregnant women and young children have been identified as the most vulnerable population groups (Olhaberry et al. 2022).

pandemic, putting in place careful health measures and precautions, devising gradual reopening strategies, and envisioning effective policies, mechanisms, and resources to protect the health of women, especially pregnant women. Besides strengthening healthcare systems and making sure that all women in all areas of the country – including very remote ones – have easy access to healthcare facilities, it is also crucial for governments to invest resources towards making work-family conflicts more manageable, including subsidizing childcare services and providing financial assistance for young couples and soon-to-be parents (especially mothers).

Despite its novel and unique focus on pre- and post-COVID trends in fertility and infant health in Chile, this study presents limitations that lay the ground for subsequent research. First is the nature of the data, which only includes births as monthly-level variables. In order to conduct analogous analyses on infant health, it would be desirable to have access to variables other than births at the monthly (if not daily) level. Such a level of granularity would allow to better identify when COVID hit and code it according to the exact month (or day within the month). Stated otherwise, monthly information on infant health would also allow to more thoroughly consider the etiology of births that are low birth and preterm, whose features originate in utero long before delivery. Relatedly, these data do not include information on births by mother's age group, a feature which limits our ability to obtain age-specific fertility rates and TFR – an arguably better measure than CBR due to its age-standardized nature. Moreover, although there is no real evidence of this from Chile, despite the high quality of administrative data in Chile, birth-level data may suffer from some limitations such as mis-recording or late registration of births, which may in turn affect their actual timing vis-à-vis the lockdown measures. Ultimately, while municipality-level data are nationally representative and rich in content, scholars will have to complement findings from a study of this kind with (i) analyses obtained from individual-level surveys that will be

released in the years to come, and (ii) experimental or quasi-experimental scenarios that, by means of individual-level data collection, may enable to trace a more direct connection between contracting COVID-19 and delivering babies that exhibit poorer health outcomes. Related to the latter point, further research may be targeted towards further unpacking some of the micro- and meso-level mechanisms leading to declines in fertility and increases in LBW and PTB in the Chilean context. While we have here speculated on several possible channels, only more detailed variables may allow us to reach definite conclusions and make reliable causal claims. Among such variables, scholars may turn their attention to data on antenatal visits, hospitalizations, health facilities, COVID fatality cases, vaccination rates, distances to health centers, alongside data at the individual level on fertility intentions, actual fertility, experiences of pregnancy, and detailed characteristics of births. This said, most data are still provisional and subject to constant revisions, hence we see the contribution of our study as novel and insightful within the obvious constraints and challenges that recent COVID-19 data present.

References

Aassve, Arnstein, Nicolò Cavalli, Letizia Mencarini, Samuel Plach, and Massimo Livi Bacci. 2020. "The COVID-19 Pandemic and Human Fertility." *Science* 369(6502):370–71.

Aassve, Arnstein, Nicolò Cavalli, Letizia Mencarini, Samuel Plach, and Seth Sanders. 2021. "Early Assessment of the Relationship Between the COVID-19 Pandemic and Births in High-Income Countries." *Proceedings of the National Academy of Sciences of the United States of America* 118(36):1–3.

Abufhele, Alejandra, Luca Maria Pesando, and Andrés F. Castro. 2022. "Parental Educational Similarity and Inequality Implications for Infant Health in Chile: Evidence from Administrative Records, 1990-2015." Forthcoming in *Research in Social Stratification and Mobility*, 100736, doi: https://doi.org/10.1016/j.rssm.2022.100736.

Agüero, Jorge M. 2020. "COVID-19 and the Rise of Intimate Partner Violence." *University of Connecticut Working Paper Series 2020-05*.

Andrasfay, Theresa and Noreen Goldman. 2021. "Reductions in 2020 US Life Expectancy Due to COVID-19 and the Disproportionate Impact on the Black and Latino Populations." *Proceedings of the National Academy of Sciences of the United States of America* 118(5):1–6.

Araya, Marcela B., Marcela Díaz, Denisse Paredes, and Jovita Ortiz. 2017. "Association between Preterm Birth and Its Subtypes and Maternal Sociodemographic Characteristics during the Post-Transitional Phase in a Developing Country with a Very High Human Development Index." *Public Health* 147:39–46.

Badran, Eman F., Rula M. Darwish, Yousef Khader, Rama AlMasri, Mira Al Jaberi, Mohammad AlMasri, Farah AlSa'di, Leen abu Yosef, and Noor Al-Badaineh. 2021. "Adverse

Pregnancy Outcomes During the COVID-19 Lockdown. A Descriptive Study." *BMC Pregnancy and Childbirth* 21(1):1–8.

Bennett, Magdalena. 2021. "All Things Equal ? Heterogeneity in Policy Effectiveness against COVID-19 Spread in Chile." *World Development* 137(105208).

Berger, Lawrence M., Giulia Ferrari, Marion Leturcq, Lidia Panico, and Anne Solaz. 2021. "COVID-19 Lockdowns and Demographically Relevant Google Trends: A Cross-National Analysis." *PLoS ONE* 16(3 March):1–28.

Boberg-Fazlic, Nina, Maryna Ivets, Martin Karlsson, and Therese Nilsson. 2021. "Disease and Fertility: Evidence from the 1918–19 Influenza Pandemic in Sweden." *Economics and Human Biology* 43:101020.

Bullinger, Lindsey Rose, Jillian B. Carr, and Analisa Packham. 2021. "Covid-19 and Crime Effects of Stay-at-Home Orders on Domestic Violence." *American Journal of Health Economics* 7(3):249–80.

Canals, Mauricio, Cristóbal Cuadrado, Andrea Canals, Karla Yohannessen, Luis A. Lefio, Maria P. Bertoglia, Pamela Eguiguren, Izkia Siches, Verónica Iglesias, and Oscar Arteaga. 2020. "Epidemic Trends, Public Health Response and Health System Capacity: The Chilean Experience in Four Months of the COVID-19 Pandemic." *Revista Panamericana de Salud Publica/Pan American Journal of Public Health* 44:1–8.

Chawanpaiboon, Saifon, Joshua P. Vogel, Ann Beth Moller, Pisake Lumbiganon, Max Petzold, Daniel Hogan, Sihem Landoulsi, Nampet Jampathong, Kiattisak Kongwattanakul, Malinee Laopaiboon, Cameron Lewis, Siwanon Rattanakanokchai, Ditza N. Teng, Jadsada Thinkhamrop, Kanokwaroon Watananirun, Jun Zhang, Wei Zhou, and A. Metin Gülmezoglu. 2019. "Global, Regional, and National Estimates of Levels of Preterm Birth in

2014: A Systematic Review and Modelling Analysis." *The Lancet Global Health* 7(1):e37–46.

Cohen, Philip N. 2021. "Baby Bust: Falling Fertility in US Counties Is Associated with COVID-19 Prevalence and Mobility Reductions." *SocArXiv [Preprint]* 1–12.

Cuadrado, Cristóbal, María José Monsalves, Jean Gajardo, María Paz Bertoglia, Manuel Najera, Tania Alfaro, Mauricio Canals, Jay Kaufmann, and Sebastián Peña. 2020. "Impact of Small-Area Lockdowns for the Control of the COVID-19 Pandemic." *MedRxiv* 2020.05.05.20092106.

Duarte, Fabián and Álvaro Jiménez-Molina. 2021. "Psychological Distress during the COVID-19 Epidemic in Chile: The Role of Economic Uncertainty." *PLoS ONE* 16(11 November):1–16.

Emery, Tom and Judith C. Koops. 2022. "The Impact of COVID-19 on Fertility Behaviour and Intentions in a Middle Income Country." *PLoS ONE* 17(1 January):1–16.

Gajardo, Abraham I. J., Thomas D. Wagner, Kristina Devi Howell, Andrés González-Santa Cruz, Jay S. Kaufman, and Alvaro Castillo-Carniglia. 2022. "Effects of 2019's Social Protests on Emergency Health Services Utilization and Case Severity in Santiago, Chile: A Time-Series Analysis." *The Lancet Regional Health Americas* 5, 100082.

Gluckman, Peter D., Mark A. Hanson, Cyrus Cooper, and Kent L. Thornburg. 2008. "Effect of in Utero and Early-Life Conditions on Adult Health and Disease." *New England Journal of Medicine* 359(1):61.

Goldstein, Joshua, Deniz Dilan Karaman Örsal, Michaela Kreyenfeld, and Aiva Jasilioniene. 2013. "Fertility Reactions to the 'Great Recession' in Europe." *Demographic Research* 29(July):85–104.

Kana, Musa Abubakar, Sofia Correia, Barbara Peleteiro, Milton Severo, and Henrique Barros. 2017. “Impact of the Global Financial Crisis on Low Birth Weight in Portugal: A Time-Trend Analysis.” *BMJ Global Health* 2(2):1–11.

Karasek, Deborah, Rebecca J. Baer, Monica R. McLemore, April J. Bell, Bridgette E. Blebu, Joan A. Casey, Kimberly Coleman-Phox, Jean M. Costello, Jennifer N. Felder, Elena Flowers, Jonathan D. Fuchs, Anu Manchikanti Gomez, Kayla Karvonen, Miriam Kuppermann, Liang Liang, Safyer McKenzie-Sampson, Charles E. McCulloch, Scott P. Oltman, Matthew S. Pantell, Xianhua Piao, Aric A. Prather, Rebecca J. Schmidt, Karen A. Scott, Solaire Spellen, Jodi D. Stookey, Martha Tesfalul, Larry Rand, and Laura L. Jelliffe-Pawlowski. 2021. “The Association of COVID-19 Infection in Pregnancy with Preterm Birth: A Retrospective Cohort Study in California.” *The Lancet Regional Health - Americas* 2:100027.

Le, Kien and My Nguyen. 2021. “The Impacts of Temperature Shocks on Birth Weight in Vietnam.” *Population and Development Review* 47(4):1025–47.

Li, Yige, Eduardo A. Undurraga, and José R. Zubizarreta. 2022. “Effectiveness of Localized Lockdowns in the COVID-19 Pandemic.” *American Journal of Epidemiology* 00(00):1–13.

Lima, Everton C., Camila F. Soares, and José H. C. Monteiro da Silva. 2022. “Rapid Changes in Birth Counts in Brazilian Major Cities during the COVID-19 Pandemic.” *Vienna Yearbook of Population Research* 20:1–21.

Lindberg, Laura, D. VandeVusse, Alicia Mueller, Jennifer Kirstein, and Mariell. 2020. *Early Impacts of the COVID-19 Pandemic: Findings from the 2020 Guttmacher Survey of Reproductive Health Experiences*.

Lopez, Paulina O. and Gérard Bréart. 2012. “Trends in Gestational Age and Birth Weight in

Chile, 1991-2008. A Descriptive Epidemiological Study." *BMC Pregnancy and Childbirth* 12(Usa 2009).

Luppi, Francesca, Bruno Arpino, and Alessandro Rosina. 2020. "The Impact of COVID-19 on Fertility Plans in Italy, Germany, France, Spain, and the United Kingdom." *Demographic Research* 43(December):1399–1412.

Manning, Wendy D. and Krista K. Payne. 2021. "Marriage and Divorce Decline during the COVID-19 Pandemic: A Case Study of Five States." *Socius* 7:4–6.

Marteleto, Letícia J., Gilvan Guedes, Raquel Z. Coutinho, and Abigail Weitzman. 2020. "Live Births and Fertility Amid the Zika Epidemic in Brazil." *Demography* 57(3):843–72.

Narea, Marigen, Kenzo Asahi, Alejandra Abufhele, Amanda Telias, Damián Gildemeister, and Samanta Alarcón. 2022. "The Effect of COVID-19 Lockdowns on Maternal Mental Health and Parenting Practices Moderated by Urban Green Space." *Clinical Psychological Science*.

Naya, Christine H., Darby E. Saxbe, and Genevieve F. Dunton. 2021. "Early Effects of the COVID-19 Pandemic on Fertility Preferences in the United States: An Exploratory Study." *Fertility and Sterility* 116(4):1128–38.

Nobles, Jenna, Elizabeth Frankenberg, and Duncan Thomas. 2015. "The Effects of Mortality on Fertility: Population Dynamics After a Natural Disaster." *Demography* 52(1):15–38.

Olhaberry, Marcia, Catalina Sieverson, Pamela Franco, Macarena Romero, Trinidad Tagle, Daniela Iribarren, Carolina Honorato, and Antonia Muzard. 2022. "The Impact of COVID-19 on Experiences of Pregnancy and/or Early Parenting in Chile." *Infant Mental Health Journal* 43(1):8–23.

Organisation for Economic Co-operation and Development. 2015. *Chidlessness OECD Family Database*. Social Policy Division - Directorate of Employment, Labour and Social Affairs.

Retrieved at: https://www.oecd.org/els/family/SF_2-5-Childlessness.pdf.

Palloni, Alberto. 1988. “On the Role of Crises in Historical Perspective: An Exchange.” *Population and Development Review* 14(1):145–58.

Rangel, Marcos A., Jenna Nobles, and Amar Hamoudi. 2020. “Brazil’s Missing Infants: Zika Risk Changes Reproductive Behavior.” *Demography* 57(5):1647–80.

Rauscher, Emily and David E. Rangel. 2020. “Rising Inequality of Infant Health in the U.S.” *SSM - Population Health* 12:100698.

da Silveira, Mariângela F., Iná S. Santos, Aluísio J. D. Barros, Alicia Matijasevich, Fernando C. Barros, and Cesar G. Victora. 2008. “Increase in Preterm Births in Brazil: Review of Population-Based Studies.” *Revista de Saude Publica* 42(5):957–64.

Sobotka, Tomáš, Aiva Jasilioniene, Ainhoa Alustiza Galarza, Kryštof Zeman, László Németh, and Dmitri Jdanov. 2021. “Baby Bust in the Wake of the COVID-19 Pandemic? First Results from the New STFF Data Series.” *SocArXiv [Preprint]* (March):1–33.

Sobotka, Tomáš, Vegard Skirbekk, and Dimiter Philipov. 2011. “Economic Recession and Fertility in the Developed World.” *Population and Development Review* 37(2):267–306.

Somma, Nicolás M., Matías Bargsted, Rodolfo Disi Pavlic, and Rodrigo M. Medel. 2021. "No Water in the Oasis: The Chilean Spring of 2019-2020." *Social Movement Studies* 20(4): 495-502.

Stefanelli, María De Los Ángeles, María Teresa Valenzuela, Marcela Cárcamo, Cinthya Urquidi, Gabriel Cavada, and Pamela Martín San P. 2016. “Tendencia de La Tasa Global de Fecundidad y El Aumento de La Fuerza Laboral Femenina En Chile. 1960-2011.” *Revista Medica de Chile* 144(5):658–63.

Torche, Florencia. 2011. “The Effect of Maternal Stress on Birth Outcomes: Exploiting a Natural

Experiment." *Demography* 48(4):1473–91.

Torche, Florencia and Alejandra Abufhele. 2021. "The Normativity of Marriage and the Marriage Premium for Children's Outcomes." *American Journal of Sociology* 126(4):931–68.

Torche, Florencia and Ghislaine Echevarría. 2011. "The Effect of Birthweight on Childhood Cognitive Development in a Middle-Income Country." *International Journal of Epidemiology* 40(4):1008–18.

Torche, Florencia and Karine Kleinhaus. 2012. "Prenatal Stress, Gestational Age and Secondary Sex Ratio: The Sex-Specific Effects of Exposure to a Natural Disaster in Early Pregnancy." *Human Reproduction* 27(2):558–67.

Torche, Florencia and Jenna Nobles. 2022. "The Unequal Impact of the COVID-19 Pandemic on Infant Health." Forthcoming in *Demography.*

United Nations. 2020. *World Fertility and Family Panning 2020*. Retrieved at: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/files/documents/2020/Oct/undesa_pd_wfp2019_10_key_messages_10jan2020.pdf

Verdery, Ashton M., Emily Smith-Greenaway, Rachel Margolis, and Jonathan Daw. 2020. "Tracking the Reach of COVID-19 Kin Loss with a Bereavement Multiplier Applied to the United States." *Proceedings of the National Academy of Sciences of the United States of America* 117(30):17695–701.

Wei, Shu Qin, Marianne Bilodeau-Bertrand, Shiliang Liu, and Nathalie Auger. 2021. "The Impact of COVID-19 on Pregnancy Outcomes: A Systematic Review and Meta-Analysis." *Cmaj* 193(16):E540–48.

Wilde, Joshua, Wei Chen, and Sophie Lohmann. 2020. "COVID-19 and the Future of US

Fertility: What Can We Learn from Google ?" *IZA Discussion Paper No 13776*.

Zeitlin, J., K. Szamotulska, N. Drewniak, A. D. Mohangoo, J. Chalmers, L. Sakkeus, L. Irgens, M. Gatt, M. Gissler, and B. Blondel. 2013. "Preterm Birth Time Trends in Europe: A Study of 19 Countries." *BJOG: An International Journal of Obstetrics and Gynaecology* 120(11):1356–65.

Zimmerman, Linnea A., Celia Karp, Mary Thiongo, Peter Gichangi, Georges Guiella, Alison Gemmill, Caroline Moreau, and Suzanne O. Bell. 2022. "Stability and Change in Fertility Intentions in Response to the COVID-19 Pandemic in Kenya." *PLOS Global Public Health* 2(3):e0000147.

Appendix

Appendix Tables

TABLE A1 Fixed-effects regressions using a dummy for pandemic (February 2021 onwards) on monthly CBR (left) and monthly adjusted CBRs (right)

	a. Monthly CBR			**b. Monthly CBR (relative to 2017-2019 avg)**		
	(1)	(2)	(3)	(1)	(2)	(3)
Pandemic-fertility "effect"	-1.693***	-1.646***	-1.307***	-0.110***	-0.112***	-0.078***
	(0.091)	(0.092)	(0.105)	(0.007)	(0.007)	(0.008)
Number of days in lockdown (per month)			-0.031***			-0.003***
			(0.005)			(0.000)
Constant	10.916***	11.326***	11.411***	0.981***	0.958***	0.966***
	(0.039)	(0.122)	(0.123)	(0.003)	(0.010)	(0.010)
Month dummies	No	Yes	Yes	No	Yes	Yes
Observations	20,760	20,760	20,760	20,345	20,345	20,345
Number of municipalities	346	346	346	346	346	346

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Difference in observations between panels a and b due to some municipalities having CBR of zero in the same month for three consecutive years, hence denominator of zero.

TABLE A2 Fixed-effects regressions using a dummy for pandemic (2021 onwards) on yearly CBR (left) and yearly adjusted CBRs (right)

	a. Yearly CBR		**b. Yearly CBR (relative to 2017-2019 avg)**	
	(1)	(2)	(1)	(2)
Pandemic-fertility "effect"	-1.683***	-0.876***	-0.134***	-0.050***
	(0.113)	(0.193)	(0.009)	(0.015)
Age of the mother		-0.042		-0.003
		(0.047)		(0.004)
Number of days in lockdown (per year)		-0.006***		-0.001***
		(0.001)		(0.000)
Constant	10.942***	12.235***	0.979***	1.073***
	(0.051)	(1.347)	(0.004)	(0.106)
Observations	1,730	1,730	1,730	1,730
Number of municipalities	346	346	346	346

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE A3 Fixed-effects regressions using a dummy for pandemic (2021 onwards) on yearly share of LBW (top panel) and PTB births (bottom panel), unadjusted (left) and adjusted ratios (right)

	a. Yearly LBW		**b. Yearly LBW (relative to 2017-2019 avg)**	
	(1)	(2)	(1)	(2)
Pandemic-health "contextual effect"	0.005*	0.010**	0.120***	0.233***
	(0.003)	(0.005)	(0.045)	(0.078)
Age of the mother		-0.000		-0.115***
		(0.001)		(0.022)
Share of female newborns		-0.005		-0.265
		(0.016)		(0.298)
Number of days in lockdown (per year)		-0.000		-0.000
		(0.000)		(0.000)
Constant	0.064***	0.079**	1.026***	4.439***
	(0.001)	(0.034)	(0.020)	(0.637)
Observations	1,730	1,730	1,690	1,690
Number of municipalities	346	346	338	338
	a. Yearly PTB		**b. Yearly PTB (relative to 2017-2019 avg)**	
	(1)	(2)	(1)	(2)
Pandemic-health “contextual effect"	0.015***	0.023***	0.163***	0.158***
	(0.004)	(0.006)	(0.030)	(0.053)
Age of the mother		0.001		0.061***
		(0.001)		(0.015)
Share of female newborns		-0.028		0.415**
		(0.019)		(0.200)
Number of days in lockdown (per year)		-0.000*		-0.000
		(0.000)		(0.000)
Constant	0.084***	0.066	1.016***	-0.918**
	(0.002)	(0.042)	(0.014)	(0.423)
Observations	1,730	1,730	1,700	1,700
Number of municipalities	346	346	340	340

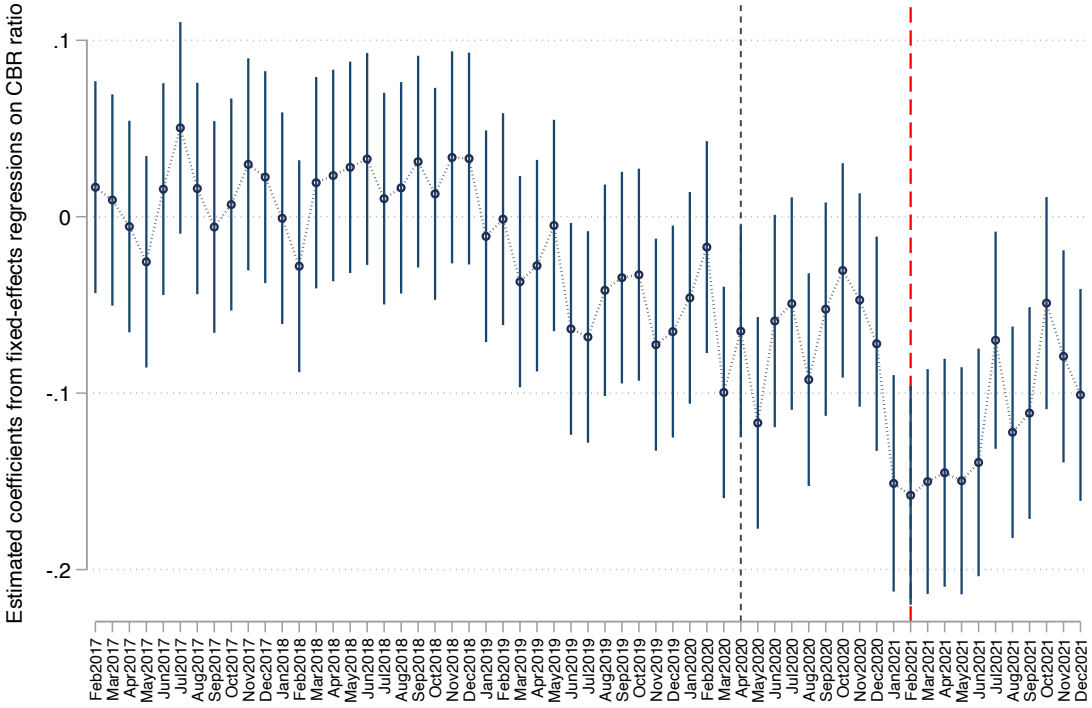
Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Difference in observations between panels a and b due to some municipalities having zero shares of LBW and PTB in the same year for three consecutive years, hence denominator of zero.

Appendix Figures

FIGURE A1 Map of Chile, by region

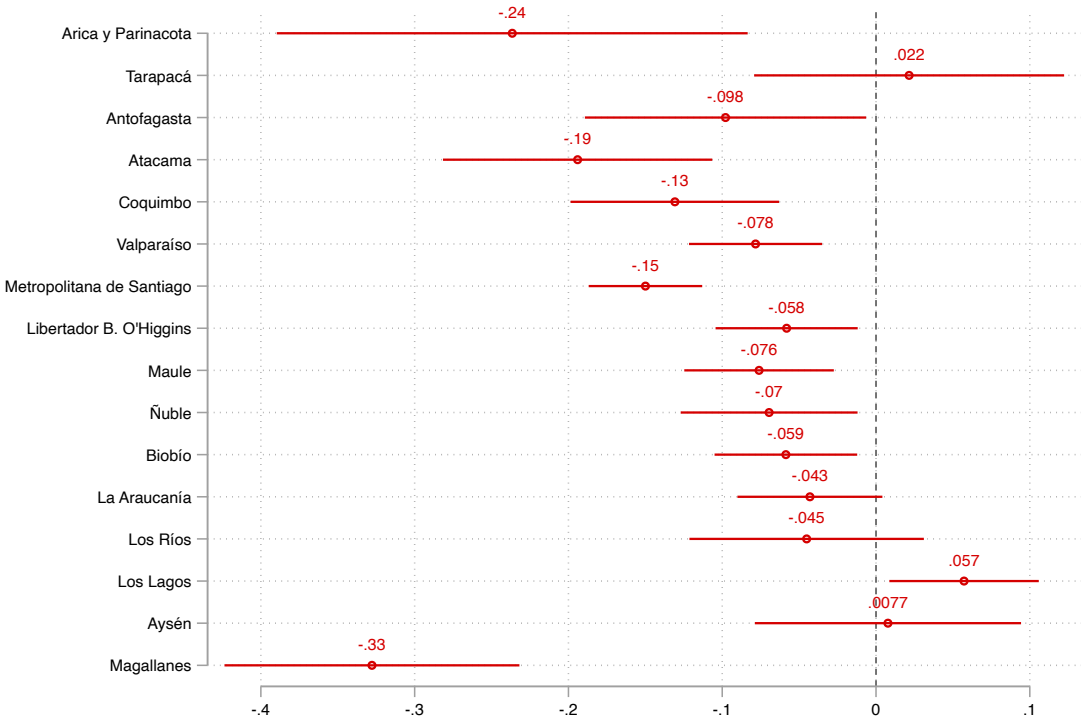
Notes: Adapted from Wikipedia: https://en.wikipedia.org/wiki/Regions_of_Chile

FIGURE A2 Estimated coefficients from fixed-effects regressions on monthly adjusted CBR (or CBR ratio), coefficients for month-year reported



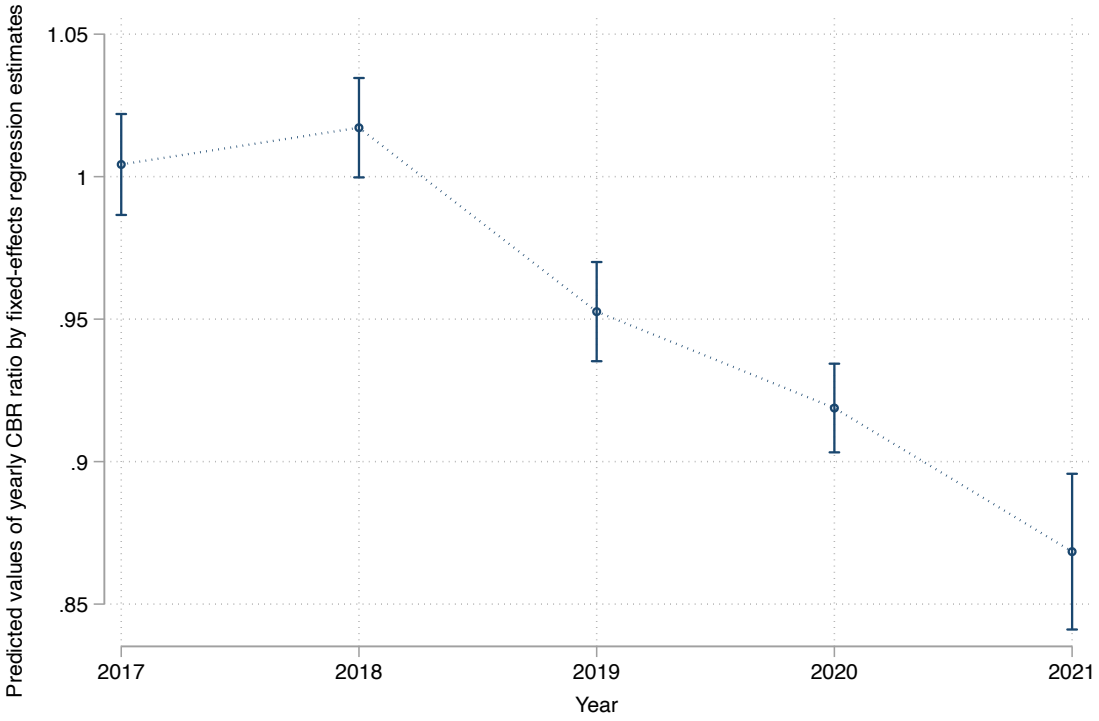
Notes: Monthly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. The black thin dashed line corresponds to the official launch of the nationwide lockdown (April 2020), while the red long dashed line corresponds to the approximate time in which COVID conceptions reach full term (January-February 2021). The omitted reference category is January 2017. 95% confidence intervals reported.

FIGURE A3 Estimated coefficients from fixed-effects regressions on monthly adjusted CBR, by region (pandemic dummy interacted with regional identifier)



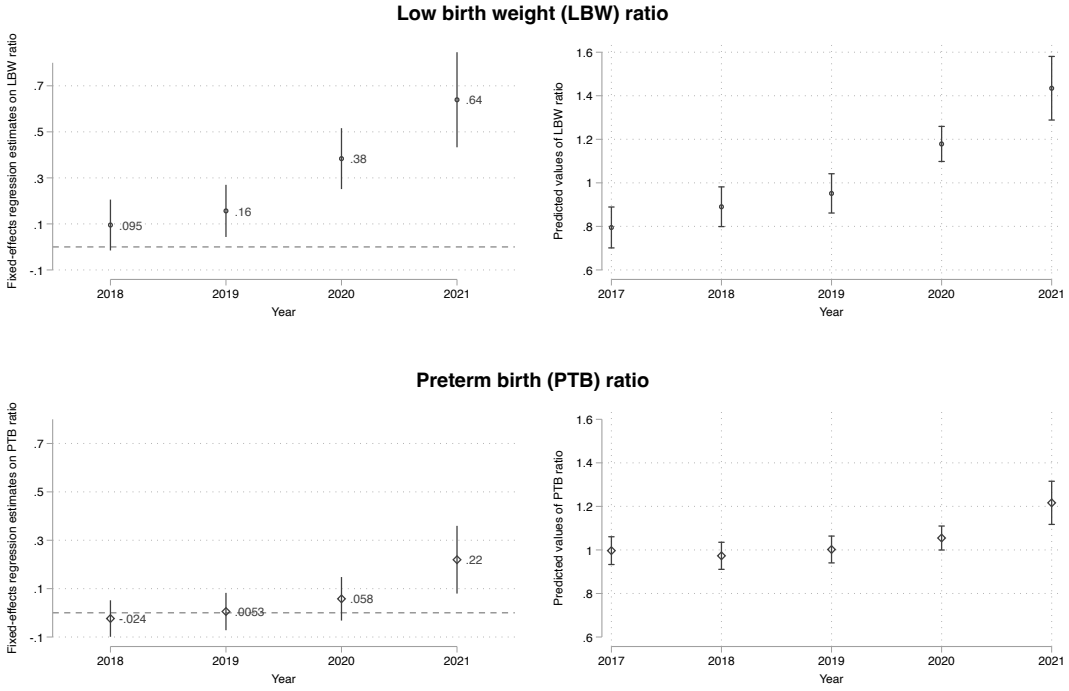
Notes: Monthly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. Regions are sorted geographically from the far North (Arica y Parinacota) to the far South (Magallanes). 95% confidence intervals reported.

FIGURE A4 Predicted values of yearly adjusted CBRs by fixed-effects regression estimates



Notes: Yearly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. 95% confidence intervals reported.

FIGURE A5 Estimated coefficients from fixed-effects regressions (left panel) and predicted values from fixed effects regressions (right panel) on adjusted LBW (top) and adjusted PTB (bottom)



Notes: Yearly data from Minsal – Chilean Ministry of Health, by municipality, merged with information from the Ministry of Science, Technology, Knowledge and Innovation and the National Institute of Statistics. For the left panels, 2017 is the reference category. 95% confidence intervals reported.