The Impact of COVID-19 on Fertility in Spain

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The fall in births in late 2020-early 2021 across countries led many to worry about potential negative effects of COVID-19 on fertility (Aasve et al. 2021). Enough time has elapsed since then that we can now study the overall impact of the pandemic and the accompanying containment measures on fertility. One difficulty is that, beyond showing the evolution of births over time, we would like to compare actual births to some counterfactual that measures how births would have evolved in the absence of COVID-19. We do this for one large European country, Spain, which was strongly affected by the first wave of the pandemic in the spring of 2020, and which responded with one of the strictest and longest lockdowns in Europe.

Our analysis reveals three findings. First, we document a large decline in births between November 2020 and February 2021, which corresponds with a large fall in new pregnancies during the spring 2020 lockdown. Second, we show that by the end of 2021, full catch-up had taken place, such that we find an effect on the total number of births which is close to zero. And third, we find strong heterogeneity by women's origin. Native women experienced a substantial drop in births in late 2020-early 2021, which was followed by a significant and lasting catch-up, resulting in an overall *increase* in fertility by late 2021. On the contrary, births to foreign mothers started to fall immediately, in the spring of 2020, and they continued to fall throughout 2020-2021. This suggests significant return migration of fertile-age (and pregnant) foreign national women during the pandemic (and possibly smaller inflows). We also show that the results are sensitive to the method used for constructing the counterfactual.

We contribute to the recent literature on the effects of COVID-19 on births and fertility-related behaviors. Two major peer-reviewed studies in demography study multiple high-income countries (Aassve et al. 2021, Sobotka et al. 2023), while several papers in economics and demography have studied individual countries (e.g. Bailey et al. 2022, 2023 and Kearney and Levine 2023 for the US). These studies tend to find a decrease in the number of births in late 2020 and early 2021, arguably a result of fewer pregnancies conceived during the first wave of the pandemic. They also document some recovery during the rest of 2021.

I. Data and Methods

A. Data: We use administrative data from birth certificates, made publicly available by the Spanish National Statistical Institute (INE). The micro data include month of birth as well as country of birth of the mother (and a number of other variables). We restrict our sample to all births taking place in Spain between January 2009 and December 2021. The monthly number of births (normalized by the number of days in the month) is shown in Figure 1 (Panel A). There is a clear negative trend during the whole pre-COVID period. The time trend is very similar for the subset of Spanish women (Panel B). Panel C displays the number of births to foreign women. For them, the pre-COVID trend is non-linear and slightly U-shaped.

B. The timing of COVID-19 in Spain: The first known COVID-19 cases started emerging in China in January 2020. Through international travel, the virus was transmitted to Italy in February. From there it spread to Spain, where the number of cases increased sharply in early March. Italy was the first European country to introduce a nationwide lockdown on March 9, 2020. The Spanish government followed with similar measures several days later.

On Saturday evening, March 14, 2020, the Spanish prime minister announced that effective in 24 hours, Spain would enter a "state of alarm". The state of alarm entailed a nationwide lockdown, banning all trips that were not of absolute necessity. Those who could were asked to work from home. Lockdown restrictions also mandated a temporary closure of non-essential

shops and businesses. On March 17, 2020, the Spanish government announced a support package of roughly 20% of GDP, including measures to help workers and companies affected by the lockdown. By March 28, 2020, the Spanish government had officially banned all non-essential economic activity. The state of alarm was later extended repeatedly, with the confinement conditions essentially unchanged. Overall, from mid-March through early May 2020, the entire Spain remained under the strictest lockdown in Europe for a total of 8 weeks.

Some easing of restrictions began at the end of April and beginning of May. On April 13, 2020, some workers in selected sectors, such as construction and industry, were allowed to return to work. On April 26, 2020, some restrictions on personal activity were lifted. On April 28, 2020, the government announced a plan to reduce the lockdown restrictions, referred to as "phases". On May 2, 2020, adults were allowed to go outside following a strict time schedule. As of May 11, 2020, after 8 weeks of lockdown, some regions were moved to phase 1 of the de-escalation of restrictions. At this point, roughly half of the Spanish population experienced an easing of restrictions. The state of alarm was finally lifted on June 21, 2020, after 97 days.

The strict lockdown thus lasted from the evening of March 15 to May 10, 2020, i.e. 8 weeks. The state of alarm continued until June 21, 2020, i.e. another 6 weeks. After the summer, the number of COVID-19 cases started increasing again, leading to a second nationwide state of alarm which was imposed on October 25, 2020, and lasted for over 6 months. The second state of alarm was not accompanied by a strict lockdown, and it was lifted on May 9, 2021.

C. Methods: In order to measure the effect of the first wave of the pandemic on births in Spain, we first need to predict the expected (counterfactual) levels of fertility in the absence of the pandemic. Our approach is inspired by Kearney and Levine (2023) and Bailey et al. (2023), who use similar methodologies to examine the effect of COVID-19 on births in the US. While Kearney and Levine (2023) use births in October 2016-September 2020 to predict counterfactual births after COVID-19 hit, Bailey et al. (2023) focus on an earlier and slightly

longer period (January 2015-December 2019). Both papers estimate a model based on a 4- or 5-year pre-COVID period to predict later births.

We implemented both of their approaches on the Spanish data, and found that our results are extremely sensitive to three factors: (1) the length of the period included in the prediction model (number of years), (2) the starting point of the period included in the prediction model (calendar month), and (3) the functional form of the long-term trend (linear or quadratic).[1] Choosing the model that can most accurately predict later births is crucial, as the out-of-sample prediction into the future constitutes the counterfactual, based on which we estimate the causal effect of COVID-19 on births.

In order to address the observed volatility of prediction results in the Spanish data, and in an effort to calculate an accurate counterfactual, we estimate 14 different models, and choose the best one based on five accuracy criteria. The model that we estimate is the following:

$$births_{my} = \alpha + \beta t + (\delta t^2) + \gamma_m + \varepsilon_{my}$$

where ***births*** is the number of births per day in calendar month ***m*** and year ***y***. We predict number of births based on a long-term trend in monthly births per day ***t*** (linear or quadratic) and calendar month fixed effects $\boldsymbol{\gamma_m}$, capturing seasonality of births throughout the calendar year.

Out of the 14 competing models, 7 work with a linear trend, while the remaining 7 estimate a quadratic trend. The time period used to train the model starts in March of years 2009 to 2015, and runs until February of 2019. Thus, the period length included in the training models varies between 4 and 10 years.

The accuracy of the models is then tested by calculating predictions for March 2019-February 2020, i.e. 12 months that are still unaffected by the pandemic. We calculate five different measures of quality of the forecast: Mean Squared Error (MSE), Mean Absolute Error

[1] Neither Kearney and Levine (2022) nor Bailey et al. (2023) discuss the out-of-sample prediction quality of their model, nor do they examine the sensitivity of their results to the *period* chosen for prediction model estimation, or to the imposed *functional form* of the trend.

(MAE), Mean Absolute Percentage Error (MPE), Absolute Mean Error (AME), and Absolute Mean Percentage Error (APE).[2] We rank the models based on each of these five criteria separately, and then calculate the average rank. We choose the model with the highest rank.[3]

We then re-estimate the same prediction model, expanding the training period of the model to also include the original "testing period" (March 2019-February 2020), in order to make use of all uncontaminated (pre-COVID) data. Finally, we predict number of births for months March 2020-December 2021, which we divide into three periods. First, births in the COVID period March-October 2020 were conceived prior to the pandemic (between June 2019 and January 2020), i.e. they should have been unaffected. Second, births in November 2020-February 2021 were conceived during the initial months of the pandemic, coinciding with a very strict lockdown in Spain (mid-March to mid-May 2020). We define the first post-COVID period ("lockdown") relatively broadly as four months (11/2020-02/2021), despite lockdown duration being just 2 months. This is because births conceived in mid-March 2020, at the beginning of lockdown, could have taken place as early as November 2020 if they were premature, and births conceived towards the end of the lockdown in mid-May 2020, could have taken place as late as February 2021. Nevertheless, the main effects resulting from changes in

[2] MSE is the average of squared differences between reality and prediction, MAE is the average of absolute differences between reality and prediction, MPE is the average of absolute differences between reality and prediction as a percentage of the absolute actual values, AME is the absolute value of the average of simple differences between the prediction and reality, and APE is the absolute value of the average of simple differences between the prediction and reality as a percentage of the actual values.

[3] MSE, MAE, and MPE are often used to measure the quality of a prediction. They all rely on the *magnitude* of the prediction error. Since we work with time series data and we would like to avoid a situation where the model systematically overpredicts or underpredicts (even though with a small error in absolute terms), we also include the AME and APE criteria. When calculating the average rank of each model, we create a simple average of the five separate ranks (weight of 0.2 for each rank), as well as a weighted average rank. In the latter, MSE has a weight of 0.4, MAE and MPE a weight of 0.2 each (reflecting the fact that in our data, these two ranks are very highly correlated), and AME and APE have a weight of 0.1 each (reflecting the fact that they are not very commonly used in the literature). In all our samples, the simple average rank and the weighted average rank identify the same model as the best predictor.

conceptions during the lockdown are expected in December 2020 and January 2021. Third, the second post-COVID period ("post-lockdown") includes births in March-December 2021, stemming from conceptions taking place after the end of lockdown, i.e. post-mid-May 2020.

II. Results

The model identified as the best one for all births in the cross-validation exercise uses data from March 2012-February 2019 (7 years) and a quadratic trend. Figure 2 (Panel A) shows our estimates of the impact of the pandemic (and lockdown) on the overall number of births in Spain. We find a sharp decline in births in November 2020-February 2021. The overall decrease is estimated at -8.9% over the 4-month period (see Panel A of Table 1), but in the two most affected months (December 2020 and January 2021) the effect size is even larger, at negative 14-15%. This large, negative effect is consistent with a substantial reduction in conceptions during the lockdown period.

In the subsequent period (March-December 2021), we find an overall increase of 5.7% over the 10-month period. This positive effect is consistent with increased conceptions in the months after the end of the spring lockdown. Overall, including the whole affected period going from November 2020 to December of 2021, our preferred model estimates that births were about 1.6% above our prediction (Panel A of Table 1), i.e. the rebound more than compensated for the large fall in pregnancies during the lockdown months.[4]

Panels B and C of Figure 1 show that the long-term trends in fertility differ among Spanish women and those with foreign nationality. Our model selection exercise identifies a 4-year model with a linear trend as the most accurate for Spanish women, and a 5-year model with a quadratic trend for foreign nationals. Among Spanish women, the pattern is similar to what we observe for the entire Spain: a large fertility decrease in late 2020 and early 2021 is

[4] The second- and third-ranked models estimate overall effects on births very close to zero (-0.7% and -0.3%, respectively). The whole range of estimates is between -2.4% and 5.8%.

followed by a strong recovery (Panel B, Figure 2). However, the negative effect of -7% over the 4-month "lockdown" period is smaller than in the full sample (Panel B, Table 1), and it is followed by a large 9% increase in fertility over the following 10-month period (the recovery is only 6% in the full sample). Overall, we estimate that COVID-19 led to about 13,000 additional births to Spanish women by the end of 2021, a 4.7% positive effect.[5]

Fertility of foreign nationals shows a very different pattern. The decline in fertility starts much earlier, in April 2020 (see Panel C of Figure 2), and it remains negative throughout the entire period. The decrease in births to foreign women between March and October 2020 is 6% (Panel C, Table 1), followed by a large 22% decrease in winter 2020 (versus 7% among Spanish women), and by a further 15% decrease in the spring of 2021 and beyond. We estimate an overall effect of -16.9% (between November 2020 and December 2021).[6] The early fall in births prior to November 2020 among immigrants suggests that the patterns for foreign women are driven by a combination of lower fertility and early departure from Spain in the first months of the pandemic. Many immigrant women likely returned to their home countries (or to countries less affected by COVID-19) during 2020, including pregnant women. Such return migration would explain the "missing births" starting as early as April 2020, as well as the fact that fertility levels remained well below the trend throughout 2021. The former hints at foreign women leaving Spain in 2020, and the latter to them not returning (and/or possibly lower inflows).

III. Conclusions

We study the effect of the first wave of COVID-19 and the accompanying containment measures on births in Spain, covering children born until the end of 2021. We use earlier years to predict number of births in 2020 and 2021 in the absence of the pandemic, carefully selecting

[5] The second- and third-ranked models estimate overall effects on births among natives of 9.8% and 5.5%, respectively. The whole range of estimates is between -3.2% and 14.7%.

[6] Eleven out of our 14 models estimate an overall fall in births among immigrant women. The worse-performing models (that use a linear trend) estimate smaller negative (or even positive) effects.

the best prediction model based on a range of measures of accuracy. We then compare our prediction to actual births. We document a large fall in births in December 2020 and January 2021, and a complete catch-up during the rest of 2021. We also uncover substantial heterogeneity: the fall in fertility was moderate among native women, with a substantial rebound and a positive net effect of 5% by the end of 2021, while the fertility decline among foreign women started early (likely due to outmigration) and was very persistent. Future research should investigate the implications of return migration during the pandemic for demographic as well as other outcomes, in Spain as in other developed countries.

References

Aassve, A., N. Cavalli, L. Mencarini, S. Plach, and S. 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 (PNAS)*, 118 (36).

Bailey, M., L. Bart, and V. Wanner Lang, 2022. The Missing Baby Bust: The Consequences of the COVID-19 Pandemic for Contraceptive Use, Pregnancy, and Childbirth among Low-Income Women. *Population Research and Policy Review* 41: 1549-1569.

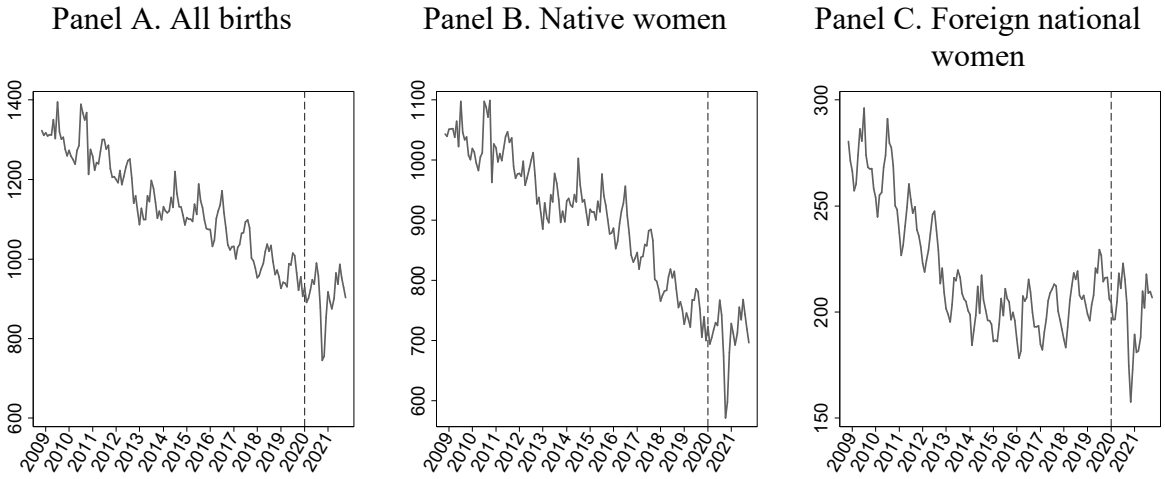
Bailey, M., J. Currie, and H. Schwandt, 2023. The COVID-19 Baby Bump: The Unexpected Increase in U.S. Fertility Rates in Response to the Pandemic. *Proceedings of the National Academy of Sciences (PNAS)* 120 (34).

INE (Instituto Nacional de Estadística – Spanish Statistical Office). 2022. "Estadística de partos, 2009-2021." Microdata on births.

Kearney, M. and P. Levine 2023. The US COVID-19 Baby Bust and Rebound. *Journal of Population Economics* 36: 2145-2168.

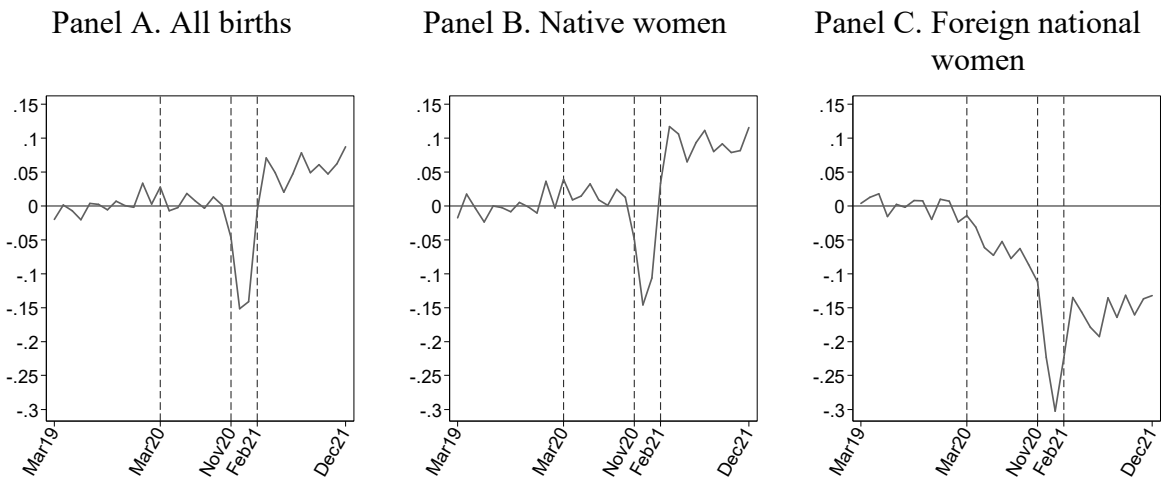
Sobotka, T., K. Zeman, A. Jasilioniene, M. Winkler-Dworak, Z. Brzozowska, A. Alustiza-Galarza, L. Németh, D. Jdanov, 2023. Pandemic Roller-Coaster? Birth Trends in Higher-Income Countries During the COVID-19 Pandemic. *Population and Development Review.*

Figure 1. Monthly number of births in Spain, 2009-2021



Note: Monthly births (per day in the month) in January 2009-December 2021. Year is marked in March of each year. The vertical line marks March 2020. Source: Own calculations based on microdata from INE.

Figure 2. Estimated effect of COVID-19 on the monthly number of births



Note: Differences between actual and predicted values of monthly births per day (as a fraction of predicted values). The vertical lines mark: (1) March 2020, the beginning of COVID-19 pandemic and lockdown in Spain; (2) November 2020, the first month when birth effects from conceptions during lockdown are expected; (3) February 2021, the last month when birth effects from conceptions during lockdown are expected.

Table 1. Estimated effects of COVID-19 on births (March 2020-December 2021)

Period	**Panel A. All births**			**Panel B. Native women**			**Panel C. Foreign women**		
	Cumulative effect	Effect per month	% Effect	Cumulative effect	Effect per month	% Effect	Cumulative effect	Effect per month	% Effect
December 2020		-4,118	-15.1%		-3,023	-14.6%		-1,559	-22.4%
January 2021		-3,848	-14.1%		-2,205	-10.6%		-2,120	-30.3%
March-Oct. 2020	1,580	197	0.7%	3,090	386	1.8%	-3,161	-395	-5.8%
Nov. 2020-Feb. 2021	-9,421	-2,355	-8.9%	-5,652	-1,413	-7.0%	-5,843	-1,461	-21.6%
March-Dec. 2021	15,331	1,533	5.7%	19,076	1,908	9.4%	-10,949	-1,095	-15.2%
Nov. 2020-Dec. 2021	**5,910**	**422**	**1.6%**	**13,423**	**959**	**4.7%**	**-16,792**	**-1,199**	**-16.9%**

Note: Effects are calculated as differences between actual and predicted values of monthly births per day; in the case of relative effects they are expressed as percentages of predicted values. Models are identical to those from Figure 2, i.e. the training period is extended to February 2020 (final model) instead of February 2019 (model selection). All panels show out-of-sample effects: Dark-grey panel in italics shows the two months when full lockdown effects are expected. White panel shows the period after COVID-19 started but before conception effects from lockdown are expected. Dark-grey panel shows a broader period when lockdown effects on births could materialize (4 months). Light-grey panel shows the period when effects from post-lockdown relief on births could materialize.