Locked in the House, Free Again:
The Impact of COVID-19 on Fertility in Spain

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Abstract:

We focus on a high-income, low-fertility country Spain and estimate the impact of the COVID-19 pandemic on fertility. Specifically, we distinguish between the impact of a strict lockdown during the first wave of the COVID-19 pandemic and the impact of the subsequent post-lockdown relief. Spain was one of the two most COVID-19-affected countries in Europe and it imposed one of the strictest lockdowns on the continent. In the analysis, we exploit the unexpected announcement and immediate implementation of a strict, nationwide lockdown which started in mid-March 2020 and lasted for 8 weeks, until mid-May 2020. Apart from lockdown, we also consider the period of relief after the end of lockdown. We first predict the expected levels of fertility in the absence of the COVID-19 pandemic and lockdown. We choose one of 14 competing models with the best prediction quality based on four cross-validation criteria. Afterwards, we calculate the differences between predicted and actual fertility levels 9 months after the lockdown (lockdown in spring 2020, fertility affected in winter 2020) and also 9 months after the post-lockdown relief (post-lockdown as of summer 2020, fertility affected starting in spring 2021). We find that overall, lockdown had a very negative effect on fertility (-16.2% in the two most affected months) while the post-lockdown relief led to an increased fertility (3.5% during a 10-month period). The net effect for whole Spain is -0.4% but it is driven by a decrease in births to foreign mothers (-17.7% overall). When focusing on Spanish mothers only, the overall effect is positive (4.6%). In a heterogeneity analysis of Spanish mothers by cohabitation status, parity, and age, we find that virtually all groups experienced an overall positive net effect (3-11%) with the exception of very young mothers (ages 15-24).

JEL codes: J13

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1. Introduction

Between early 2020 and early 2022, the whole world was struggling with the COVID-19 pandemic. The disease affected many dimensions of our lives, including fertility. There is a growing literature on the impact of COVID-19 on birth rates, especially in high-income countries. These studies emerge with a delay due to the time necessary to complete a pregnancy (9 months) and to process the data (statistical offices). Apart from births, other important aspects of fertility are contraceptive use and abortions.

In this paper, we study the evolution of fertility in Spain after the arrival of COVID-19 in early 2020. Fertility rates in Spain are low by international standards, and they have been falling persistently since 2008. During the first wave of the COVID-19 pandemic, Spain was heavily affected early on. In an attempt to stop the fast-spreading lethal disease, a strict, nationwide lockdown was imposed starting from mid-March 2020 for 8 weeks.

We use high-quality, population-wide, administrative microdata on births taking place in Spain during 2009-2021 to study the effects of lockdown and post-lockdown relief period on births. We first predict the expected, counterfactual levels of fertility in the absence of the COVID-19 pandemic and the accompanying lockdown. Afterwards, we examine the differences between predicted and actual fertility levels 9 months after the lockdown (spring 2020, fertility is affected in the winter of 2020) and after the general post-lockdown relief (summer 2020, fertility is affected starting in the spring of 2021). Similarly to Kearney and Levine (2022) and Bailey et al. (2022b) for the US, our predictions are based on previous years, accounting for trend and seasonality. In our data, we detect substantial sensitivity of the final result to the time period and the functional form used in the prediction model. We use cross-validation criteria to choose the model that has the highest prediction accuracy.

We document a large drop in births in November 2020-February 2021, corresponding to fewer conceptions in the spring of 2020, i.e. during the period of lockdown. As of March 2021, we find a moderate increase in births (relative to the pre-existing trend) which were conceived starting in the summer of 2020, during the post-lockdown relief. We document these increased fertility levels all the way to the end of 2021 (corresponding to higher conceptions up to the spring of 2021). These findings are similar to those by Kearney and Levine (2022) for the US.

Importantly, the evolution of fertility is very different for native versus foreign women, as was also documented for the US in Bailey et al. (2022b). We find a large decline in births to foreign women, which persists after the lockdown period. In contrast, we find a substantial fertility bump

among native women, for whom the fall in conceptions during the lockdown was relatively small, while the later "rebound" was large.

Overall, combining the large, short-lived negative effect of the lockdown period and the smaller but persistent positive effect of the post-lockdown relief, COVID-19 led to approximately 13,000 additional births to Spanish women by the end of 2021, an overall 4.6% positive effect. It seems that the COVID-19 pandemic has helped to reverse the long-lasting negative fertility trend that Spain has been struggling with since 2008.

In a heterogeneity analysis, we find that women who experienced the largest overall positive effect of around 10% were women in prime fertility age (30-34) and women who had a second child. Women most affected by the large drop in the winter of 2020 were women above 35, who are the most likely clients of in-vitro clinics that had to close during lockdown. Furthermore, young women below 25 saw a large decline too, likely caused by the reduction in social contacts and sexual activity.

We conclude that, in spite of the large fall in conceptions during the early months of the pandemic, native women in Spain increased their fertility in the aftermath of COVID-19. This was compensated by a large decline in births to foreign women, perhaps due to an increase in out-migration and/or a decrease in migrant inflows since 2020. Whether the pre-existing long-term negative trend in fertility will be reversed persistently after COVID-19 remains to be seen, but the baby bump among native women appears to be ongoing.

We contribute to the recently emerging literature on the effects of the COVID-19 pandemic on fertility-related behavior. Most of this literature focuses on the impact on births. For high-income countries, there are currently two major peer-reviewed studies in demography focusing on a multitude of countries (Aassve et al. 2021, Sobotka et al. 2023) and several works in progress in economics or demography concerned mostly with individual countries (see e.g. Bailey et al. 2022 and Kearney and Levine 2022 for the US, Brée and Breton 2021 for France). In general, they 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. Our paper is most closely related to those by Bailey et al. (2022b) and Kearney and Levine (2022) focusing on the US.

The remainder of this paper is organized as follows: In section 2, we provide background information on the COVID-19 pandemic in Spain and on COVID-19-related measures taken by the Spanish government in 2020. In sections 3 and 4, we introduce the data and methodology. Results are presented in Section 5 and discussed in Section 6.

2. Background on COVID-19 in Spain

First COVID-19 cases started emerging in China in January 2020, leading to first lockdowns as of January 23. Through international travel, COVID-19 was transmitted to Italy in February. It started spreading rapidly especially in Northern Italy where it led to an extensive number of casualties. From there, it spread to Spain where the number of cases were increasing geometrically in early March. Italy was the first European country to introduce a nationwide lockdown on March 9, 2020. Albeit reluctantly, the Spanish government followed with similar measures several days later.

On Saturday evening, March 14, 2020, 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. Residents were ordered to stay at home except for going to buy food or medicine, going to work, to the hospital, or other emergencies. While working outside of home was still allowed, 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. This package included the streamlining of temporary dismissal files (known as ERTEs), similar to furloughs.

By March 28, 2020, just 2 weeks after the state of alarm was announced, the Spanish government had officially banned all non-essential economic activity. After these initial moves, the state of alarm was extended repeatedly, with the confinement conditions essentially unchanged. Overall, from mid-March through early May 2020, Spain remained under the strictest lockdown in Europe.

Some easing of conditions began at the very end of April and beginning of May. Notably, on April 13, 2020, some workers in select sectors, such as construction and industry, who could not work from home but were not deemed essential sectors, were allowed to return to work. On April 26, 2020, some restrictions on personal activity were lifted, as children were able to go outside for the first time since the beginning of the confinement period, i.e. after 6 weeks of being locked indoors continuously. This only refers to going outside to play for limited periods of time, as academic activity and school-related activities were not resumed until mid-September 2020.

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 to walk and do sports following a strict time schedule. By May 11, 2020, 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, which allowed social gatherings of up to 10 people, while adhering to social distancing, as well as opening of some businesses, conditional on safety measures being put in place. The state of alarm was finally lifted on June 21, 2020, after 97 days of exceptional restrictions.

To summarize the timeline and duration of the different restrictions, the strict lockdown lasted from the evening of March 15 to May 10, 2020, i.e. for 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. It was lifted on May 9, 2021.

3. Data

Our main data source are administrative microdata from the Spanish administrative registry of births, collected and made publicly available by the Spanish statistical office (INE 2022). These microdata encompass the universe of all 5,303,566 births that took place in Spain in the years 2009 to 2021. The data set includes information on month and year of birth of each child, and socio-demographic characteristics of the parents.[1] We created a time series of monthly birth counts at national level. We restricted the sample to women who are residents in one of the 50 Spanish provinces, thus excluding two province-cities that belong to Spain but are located in North Africa (Ceuta and Melilla, with 0.25% and 0.33% of births, respectively), and mothers who are not residents in Spain (0.35% of births). Rather than number of children born, we count the number of births, such that multiple births are counted only once. We include both live and still births (0.29% of births in our data resulted in death). We have 156 monthly observations for years 2009-2021.

4. Methodology

In order to measure the effect of lockdown during the first wave of the COVID-19 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 (2022) and Bailey et al. (2022b), who use similar methodologies to examine the effect of COVID-19 pandemic on births in the US. While Kearney and Levine (2022) use births in October 2016-September 2020 to track back the conception months and to predict the aftermath of the COVID-19 pandemic in terms of fertility, Bailey et al. (2022b) focus on an earlier and somewhat longer period (January

[1] Data on education and occupation of the mother are unavailable for the year 2021 at the moment.

2015-December 2019) and work directly with births. Both papers estimate a model based on a 4 or 5-year pre-COVID-19 period to predict future births.

Our preliminary analyses that implemented both approaches to the Spanish data showed 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). Neither Kearney and Levine (2022) nor Bailey et al. (2022b) discuss the out-of-sample prediction quality of their model, nor do they examine the robustness of their results with respect (1) to the *period* chosen for prediction model estimation, or (2) to the imposed *functional form* of the trend. Choosing the model that can most accurately predict future births is crucial, as the out-of-sample prediction into the future constitutes the counterfactual, based on which we calculate the causal effect of COVID-19 on births.

In order to provide results that address the observed volatility of prediction results in the Spanish data, and in an effort to calculate the most likely and most precise counterfactual, we estimate 14 different models, and choose the best one based on four accuracy criteria.

The model we estimate is:

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

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

In order to choose the model that best predicts number of births in the absence of the pandemic, we use cross-validation criteria and estimate 14 competing models. Seven models work with a linear trend, while the other 7 models impose a quadratic trend. The time period used to train the model starts in March of years 2009 to 2015, and runs until February 2019. Thus, the period length included in the training models varies between 4 and 10 years. Afterwards, the prediction quality of the models is tested by calculating predictions for March 2019-February 2020, i.e. months that are unaffected by the pandemic. We calculate four different measures of prediction quality for this 12-month period: Mean Squared Error (MSE, squared differences between the prediction and reality), Mean Absolute Error (MAE, absolute differences between the prediction and reality), Mean Absolute Percent Error (MPE, absolute differences between the prediction and reality as a percentage of the predicted value), and Mean Error (MER, simple differences between the prediction and reality). We rank the models based on each of these 4 criteria separately, and then

calculate the average rank. We choose the model with the highest rank.[2] Afterwards, in order to make use of all uncontaminated data, we re-estimate the same model and include also the "testing period" March 2019-February 2020 to train the prediction model. Finally, we predict number of births for months March 2020-December 2021.

We consider two separate COVID-19-related periods during which conceptions might have been affected: the initial months of the pandemic, coinciding with a very strict lockdown in Spain, and the months after that (going as far as our data allow). In our analysis, we focus on births which take place approximately 9 months after conception. We define the first ("lockdown") period conservatively and relatively broadly as November 2020-February 2021, i.e. four months (note that lockdown lasted 2 months). This is due to the fact that births that were conceived in mid-March 2020, at the beginning of lockdown, could have taken place already in November 2020 if they were premature, and births conceived towards the end lockdown in mid-May 2020, could have taken place up to February 2021 if the pregnancy was longer. Nevertheless, the largest effects are expected in December 2020 and January 2021. When calculating changes in conceptions post-lockdown, we work with births in March-December 2021. When we are able to acquire access to birth data with the exact date of birth of the child, we will be able to refine our analysis considerably.

5. Results

5.1 Nationwide effects

The model identified as the best one in the cross-validation exercise includes data from March 2014-February 2019 (5 years) and a linear trend. Figure 1A supports the notion of a linear long-term trend, and Figure 2A visually shows prediction quality in-sample (blue line) and out-of-sample (grey line), considering only data uncontaminated by the COVID-19-related events. In the next step, we re-estimate this model on the entire pre-COVID-19 period, i.e. using data until February 2020. Figure 3A and Table 1 show the estimates of the impact of the first months of the pandemic (lockdown period) and post-lockdown relief on births taking place 9 month later. We

[2] MSE, MAE, and MPE are regularly used to measure the quality of the 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 the future (even though with a small error in absolute terms), we include also the MER criterion. When calculating the average rank of each model, we create a simple average of the four separate ranks (weight of 0.25 for each rank), and a weighted average rank. In the latter, MSE has a weight of 0.4, MAE and MPE a weight of 0.25 each (reflecting the fact that in our data, these two ranks are very highly correlated and almost co-move), and MER has a weight of 0.1 (reflecting the fact that it is not very common in the literature). In all our samples, both the simple average rank and the weighted average rank identify the same model as the best predictor.

find a sharp decline in the number of births in November 2020-February 2021. The overall decrease is estimated at -10.4% over a period of 4 months, but in the two most affected months (December 2020 and January 2021) the effect size is even larger, at negative 16-17%. This large, negative effect is consistent with substantially fewer conceptions during the lockdown period, be it because of fear and uncertainty about the future or because of fewer social contacts between people. In the subsequent period, we see an overall increase, in the magnitude of 3.5% over a period of 10 months. This is a non-negligible effect that, additionally, remains persistent during the entire observed period of 10 months. This positive effect is consistent with an increased number of conceptions in the period after the end of lockdown, which coincided with the summer. People might have decided to catch-up on their pre-pandemic plans and/or might have changed their fertility intentions in response to COVID-19.

5.2 Heterogeneous effects

Different groups of population might have reacted to the initial months of the pandemic and lockdown differently. We have several hypotheses about selected groups of women:

1. Women without Spanish nationality might have reacted differently to Spanish women, mainly due to lacking support networks. Additionally, it is likely that certain share of non-Spanish women might have left Spain and returned to their home country in the wake of a global pandemic. Inflows may also have been affected by the pandemic.
2. Non-cohabiting women had fewer opportunities to get pregnant during lockdown, as social contacts were extremely limited. Thus, we would expect a larger decrease in conceptions during lockdown among non-cohabiting as compared to cohabiting women.
3. Since a larger share of young women is non-cohabiting, compare to other age groups, we expect a more negative fertility effect among young women too.
4. IVF clinics in Spain were closed during lockdown. Thus, we would expect that women in greater need of accessing IVF clinics experience a larger decrease that other women. In general, women of higher age are more likely to be patients in IVF clinics. Thus, we hypothesize a larger decrease in conceptions during lockdown among women above 40 years of age.
5. Low-income women might have postponed any potential plans to have children due to the economic uncertainty. At the moment, our data lack information about education and

occupation of the mother. When this information is released, we will conduct the corresponding heterogeneity analysis.

6. Women with and without children might have reacted differently. Ex ante, it is unclear whether childless women would have reacted more or less strongly than women with children, and whether the number of children (1 or 2+) makes a difference.

5.2.1 Nationality

Figures 1B and 1C show that the long-term trends in fertility differ among Spanish women and those with foreign nationality. Our model selection exercise identified a 4-year model with linear trend for Spanish women and a 6-year model with quadratic trend for foreign nationals (see Figures 2B and 2C). When looking at Figures 3B and 3C, depicting fertility effects of COVID-19 in these two demographic groups, we see vastly different effects.

Among Spanish women, the pattern is relatively similar to what we observed for the entire Spain: a large fertility decrease in late 2020 and early 2021 is followed by a strong recovery. However, the negative effect of -7.0% over a period of 4 months is smaller than in the full sample (see Table 2, Panel A), and it is followed by a large 9.3% increase in fertility over a 10-month period (the recovery is only 3.5% in the full sample). Overall, COVID-19 led to approximately 13,000 additional births to Spanish women by the end of 2021, a 4.6% positive effect. It seems that COVID-19 has helped to reverse the negative fertility trend that Spain has been experiencing since 2008.

On the other hand, fertility of foreign nationals shows a very different pattern. The decline in fertility starts much earlier, already in April 2020 and continues until January 2021. Afterwards, there is a reversal in the short-term trend. Nonetheless, the effect remains largely negative until December 2021 when our sample stops. The fact that we see a 6.2% decrease in births to non-Spanish women already in April 2020, followed by an extremely large 22.5% decrease in winter 2020 (only 7.0% among Spanish women), and by further 15.9% decrease in spring 2021 and beyond, can be explained by the following: The observed pattern is likely caused by foreign women leaving Spain in the wake of the pandemic. Note that Italy and Spain were the first European countries heavily affected by the pandemic. Other countries on the continent remained substantially less affected, at least during the first months, which created incentives for non-Spanish women to return to their home countries or to countries less affected by COVID-19, especially if they were pregnant about to give birth. This would explain the "missing births" starting already in April, as well as the fact that the fertility levels remained well below the

prediction throughout 2021. The former hints at foreign women leaving Spain, and the latter to them not returning back. Unfortunately, it is not possible to conduct a more precise analysis, as population counts of foreigners do not exist at monthly level and even if they existed, it is very likely that departures during the first months of COVID-19 were not administratively recorded.

Given the strong negative effect among foreign women, which is very likely caused by departures from Spain, i.e. by changes in population counts of these women which we cannot observe or measure, all following analyses will be restricted to Spanish women only. If we considered all women irrespective of their nationality, the results would be biased: those groups were foreigners are overrepresented would show larger negative effects of COVID-19 and a smaller recovery, and vice versa.

5.2.2 Cohabitation

During the 8-week long lockdown, people in Spain were not allowed to leave their homes except for essential reasons. Lockdown was enforced by the police, which regularly checked people in the streets and in public transport, and investigated why they had left their homes. Thus, lockdown led to a stark limitation of social interactions, which were suddenly limited only to people living within the same household. Arguably, this must have led to a decrease in sexual activity among people who were not residing in the same household. Thus, it is possible that the observed negative fertility effect in the winter of 2020/21 might be entirely driven by or at least stronger among non-cohabiting women. In terms of fertility recovery, we might expect that it takes place somewhat later among non-cohabiting women, as they might first need to look for a partner. Additionally, lockdown in Spain ended in phases where different provinces would lift restrictions at different time and to a differing extent. Thus, some non-cohabiting women with a partner might have needed to wait longer until they met.

Both of these hypotheses are confirmed in our data. As shown in Figures 3D and 3E and in Panel B of Table 2, the negative effect on births in November 2020-February 2021 was somewhat more pronounced among non-cohabiting women. We see an 11-15% decrease in the two worst months, as compared to 6-11% decrease among cohabiting women in the same period (Table 2). In fact, it seems as if cohabiting women did not experience any negative effect at all – the overall effect in late 2020 and early 2021 is only -0.4% for cohabiting women. However, this statistic is deflated by an earlier onset of recovery among Spanish cohabiting women, which we can visually observe in Figure 3D: these women experience a large positive effect on their fertility already in February 2021 (16.3%; figure not shown). Among non-cohabiting women, the positive effect starts one

month later, consistent with our hypothesis that these women might need longer to find a partner, to get back to regular social life or to meet their partner living in a different place, depending on the speed of lifting restrictions in their province. In contrast, cohabiting couples could start trying to become pregnant as soon as it became clear that the first wave of the pandemic is slowly coming to an end. Nevertheless, it seems that both groups of women increased their fertility similarly by the end of 2021 – by approximately 10-11% (see Table 2).

5.2.3 Age

As already noted, IVF clinics in Spain were closed during lockdown. Thus, we expect women above 40, possibly above 35 years old, to experience a larger decrease in fertility in late 2020 and early 2021 than women in their prime fertility age. This effect would be driven by the inability of women in this age group, who need an in-vitro fertilization, to access the medical procedure during clinics closures. A similar fertility effect is expected also among very young mothers, aged below 19 and possibly below 24, as these women tend to be non-cohabiting. Thus, we expect them to copy the negative effect of lockdown found among non-cohabiting women. In both groups – women above 35 and women below 25, we expect a larger decrease in conceptions during lockdown, albeit for different reasons.

Panel A in Table 3 shows fertility effects of COVID-19 by age group. As hypothesized, the negative fertility effect in late 2020 and early 2021 is the largest among very young and relatively older women. In the two worst months, it reaches around -19% among women below 25, -16% among women aged 35-39, and -27% among women above 40, a very large effect size comparable to that of foreigners. What is interesting is the differential effect during recovery – while older women caught-up with their fertility (7.6% for ages 35-39 and 13.2% for women above 40), younger women not only did not recover but their fertility levels have remained negative (-2.3% among women aged 20-24 in March 2021-December 2021). Overall, the biggest winners are women in their prime fertility age: women aged 30-34 experienced a much smaller negative effect in the winter (2-9%) and a very large positive effect afterwards (13.4%).

5.2.4 Parity

We have documented that women with different demographic backgrounds have reacted differentially to COVID-19, to the accompanying lockdown, and to the relief in the post-lockdown period. As certain demographic characteristics tend to correlate with parity, we examine whether and to which extent women with different number of children reacted to the pandemic. Panel B in Table 3 shows results for childless women, women with 1 child and those with more than 1

child before the onset of the pandemic. It seems that overall, the end of the pandemic motivated women to have their second child – the positive effect in March-December 2021 is an impressive 15.1%. On the other hand, the biggest loser during the first wave of the pandemic were childless women: we observe a 13-18% decrease in the number of first births in December 2020 and January 2021. This might be driven by women below 25 and women above 35 – young non-cohabiting women tend to be childless and so do more mature women who are seeking an IVF procedure.

6. Discussion and Conclusion

In this paper, we focus on the impact of the first wave of the COVID-19 pandemic on fertility in Spain. Broadly speaking, fertility levels depend on fertility intentions, sexual activity, contraceptive use, availability of fertilization services, and abortion access. We have no information on any potential changes in contraception access in Spain during the pandemic. In terms of abortions, González and Trommlerová (2022) have shown that the supply of abortions in Spain remained unrestricted during the pandemic. At the same time, sexual activity decreased among non-cohabiting women in Spain, thus temporarily reducing their demand for abortions. In this study, we found evidence consistent with three factors affecting fertility: limited sexual activity, limited access to in-vitro fertilization, and changing (increased) fertility intentions.

Our main and very robust result is that the onset of the pandemic, accompanied by a strict 2-month long lockdown in March-May 2020, led to a substantial decrease in the number of births 9 months later. A conservative estimate documents a 10% decrease in the number of births in November 2020-February 2021. A more realistic estimate establishes a 16% decrease in the two most affected months (December 2020-January 2021). We conjecture that this is mainly caused by temporarily decreased fertility intentions because the decline is found universally, in all demographic groups. Additional factors include: Limited social contacts seem to have led to lower sexual activity and fewer pregnancies among non-cohabiting women (and among young women). Closures of IVF clinics seem to have affected very negatively the fertility levels of women above 35 and mainly above 40 years of age; the decline was around 27% in the two worst months. Finally, the overall result is to some extent exaggerated by changes in population size. More specifically, some fraction of foreign women seems to have left Spain permanently and we are unable to account for it in our estimation. Thus, we focus only on Spanish women and among them, the overall negative effect of the first wave of COVID-19 in the spring of 2020 is somewhat milder at -7% (-11% to -15% in the most affected months).

Nevertheless, the post-lockdown relief during the summer of 2020 seems to have motivated people to recover their lost fertility, as fertility levels of Spanish women increased by an incredible 9.3% over a 10-month period (March-December 2021). Overall, combining the negative effect of the lockdown period and the positive effect of the post-lockdown relief, COVID-19 led to approximately 13,000 additional births by the end of 2021, an overall 4.6% positive effect. Thus, it seems that the COVID-19 pandemic has helped to reverse the long-lasting negative fertility trend that Spain has been struggling with since 2008.

In a heterogeneity analysis, we found that women who experienced the largest overall positive effect of around 10% were women in prime fertility age (30-34) and women who had a second child. Estimation of heterogeneous effects by socio-economic background is currently not possible, as educational and occupational variables are not accessible yet for the entire data set.

We conclude that, in spite of the large fall in conceptions during the early months of the pandemic, native women in Spain increased their fertility in the aftermath of COVID-19. This was compensated by a large decline in births to foreign women, perhaps due to an increase in out-migration and/or a decrease in migrant inflows since 2020. Whether the pre-existing long-term negative trend in fertility will be reversed persistently after COVID-19 remains to be seen, but the baby bump among native women appears to be ongoing.

Our paper is most closely related to papers by Bailey et al. (2022b) and Kearney and Levine (2022) focusing on births and conceptions in the US. In terms of other aspects of fertility, the evidence on the impact of COVID-19 on abortions is scarce. Marquez-Padilla and Saavedra (2022) and González and Trommlerová (2022) focus on Mexico and Spain, respectively, and they both find that lockdown led to a substantial decrease in elective abortions. This seems to be driven by lower sexual activity during lockdown among women who do not cohabit with any partner, resulting in fewer unwanted pregnancies. In terms of the effect of COVID-19 on contraceptive use, Bailey et al. (2022a) focus on low-income women in the US, find a negative effect and predict the potential effect on (unwanted) pregnancies.

In future work, we plan to complement our birth data with abortion data, in order to draw a more complete picture of lockdown effects on fertility-related outcomes in Spain. In particular, we hope to be able to say more about potential changes in fertility intentions, which are a strong determinant of births. Furthermore, we hope to distinguish the effect of lockdown on fertility intentions from that on sexual activity and contraceptive use.

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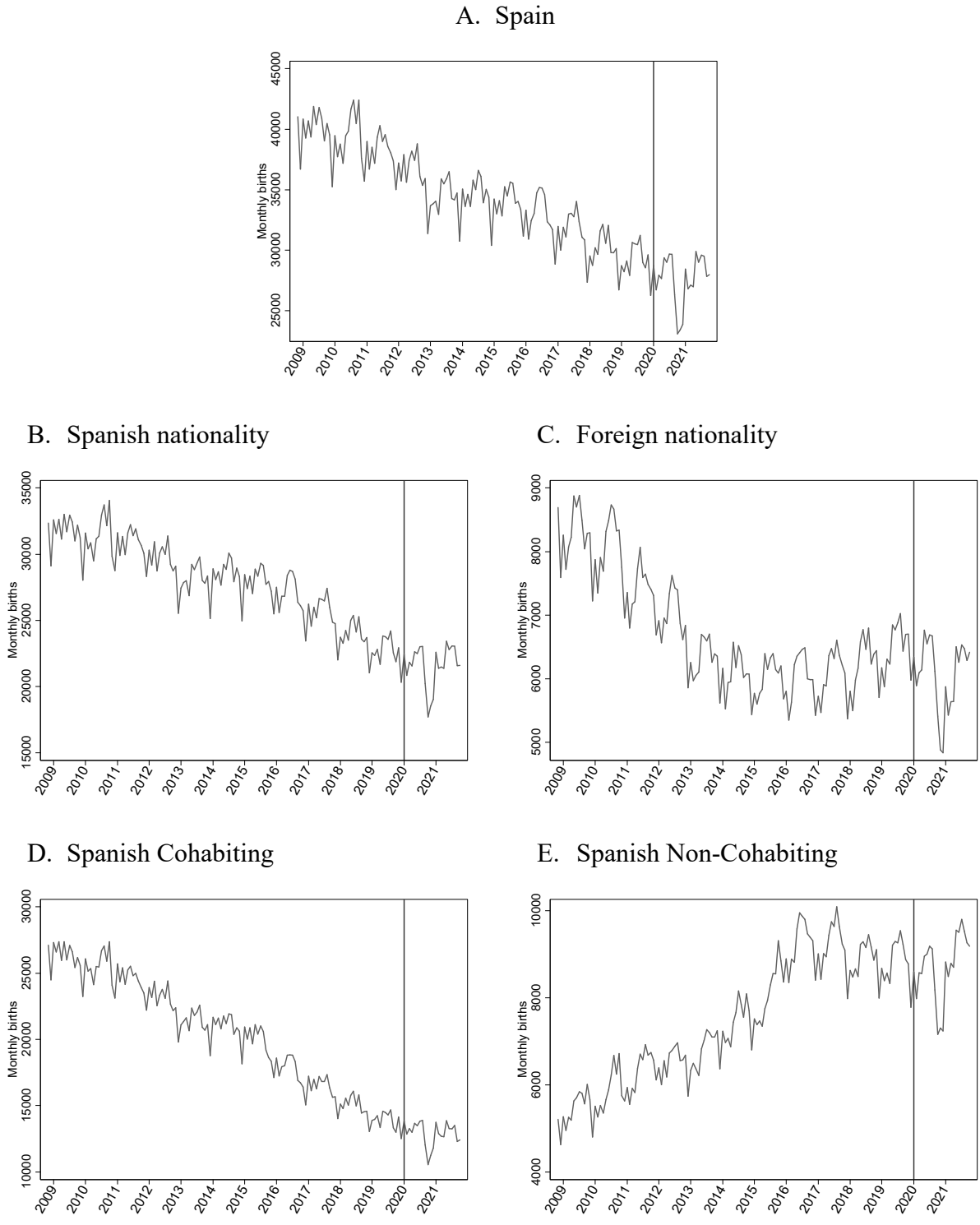
Figures

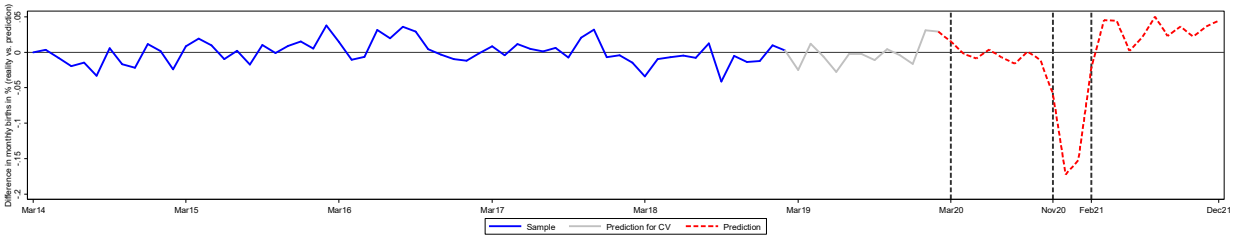
Figure 1: Long-term trends in monthly births in Spain in 2009-2021



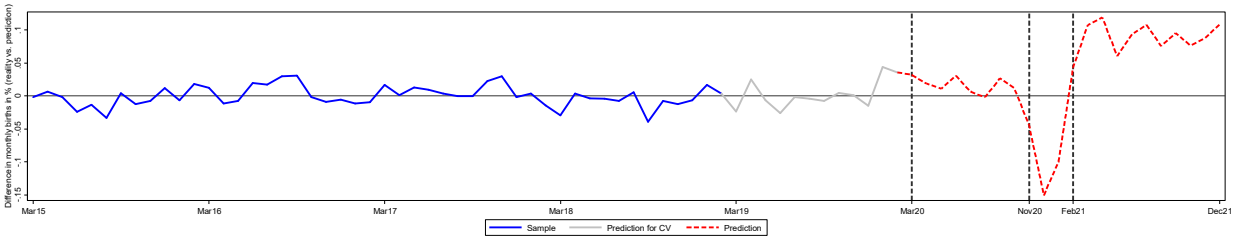
Notes: Births in January 2009-December 2021. Year is marked in March of each year. The vertical line marks March 2020, the beginning of COVID-19 pandemic and lockdown in Spain.

Figure 2: Differences in % between actual and predicted values of monthly births in Spain

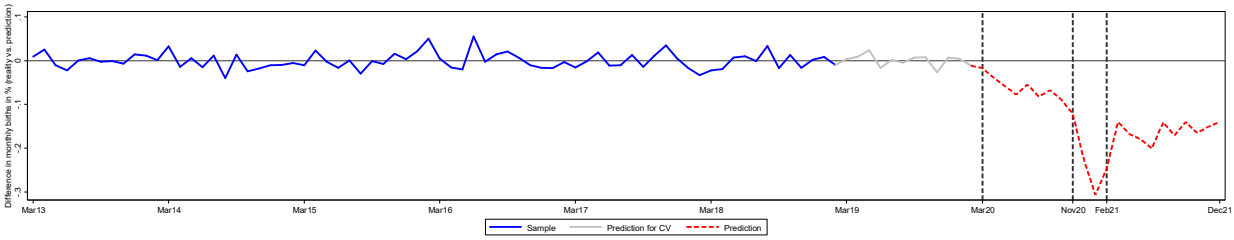
A. Spain (March 2014 – February 2019/December 2021, linear trend)



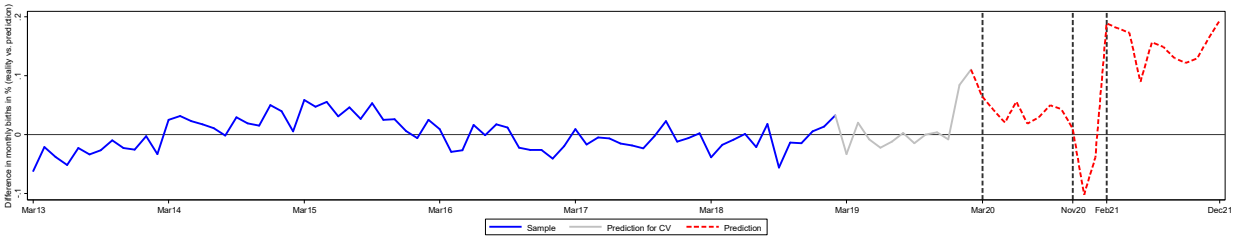
B. Spanish nationality (March 2015 – February 2019/December 2021, linear trend)



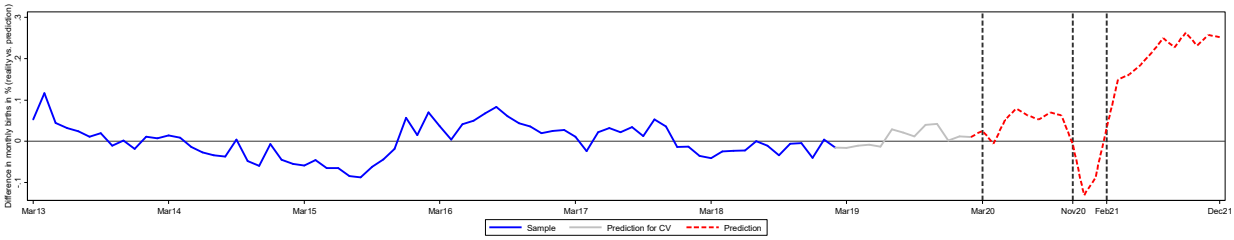
C. Foreign nationality (March 2013 – February 2019/December 2021, quadratic trend)



D. Spanish Cohabiting (March 2013 – February 2019/December 2021, linear trend)



E. Spanish Non-Cohabiting (March 2013 – February 2019/Dec. 2021, quadratic trend)

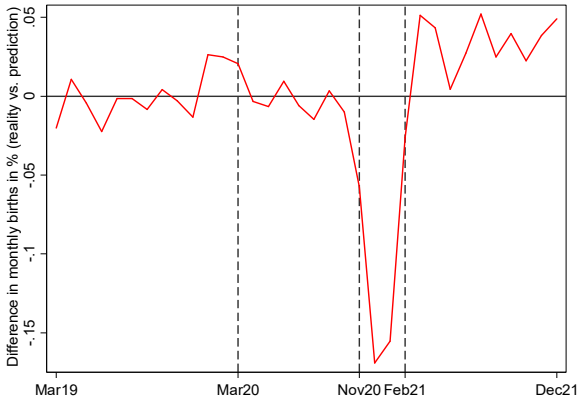


Notes: Differences between actual and predicted values of monthly births as a percentage of predicted values. Blue line depicts the period used to train the model (starting in March of different years, ending in February 2019; linear or quadratic trend). Grey line depicts predictions in the

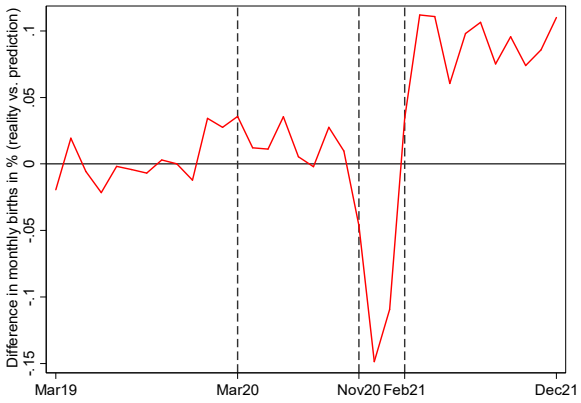
testing period (March 2019-February 2020). Red dashed line shows predictions in the (post-) COVID-19 period (March 2020-December 2021). The vertical lines mark: (1) March 2020, the beginning of COVID-19 pandemic and lockdown in Spain; (2) November 2020, the first month when birth effects from conceptions during lockdown are expected; (3) February 2021, the last month when birth effects from conceptions during lockdown are expected.

Figure 3: Estimated effects of lockdown and post-lockdown on monthly births in Spain

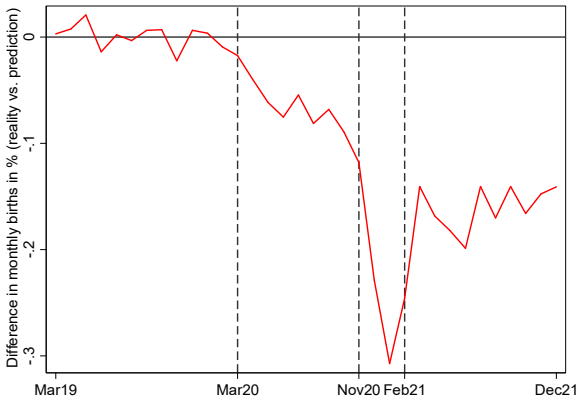
A. Spain



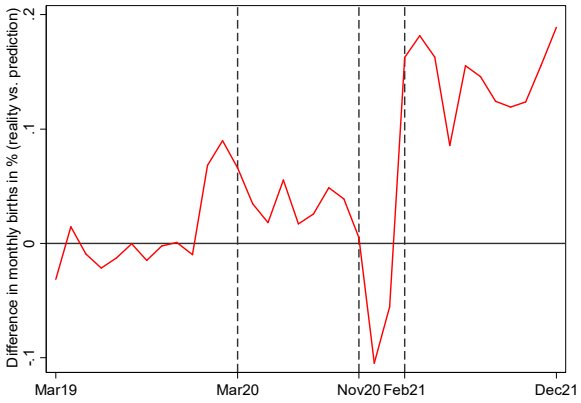
B. Spanish nationality



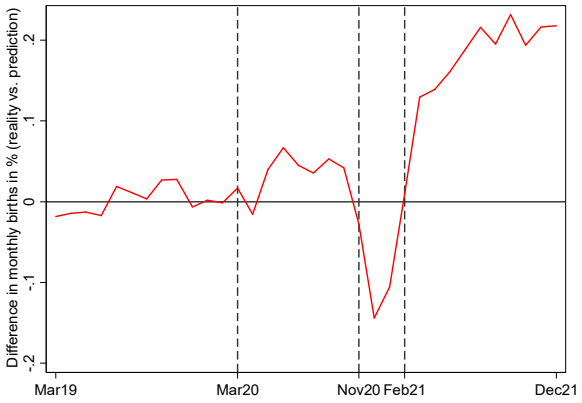
C. Foreign nationality



D. Spanish Cohabiting



E. Spanish Non-Cohabiting



Notes: Differences between actual and predicted values of monthly births as a percentage of predicted values. Models are identical to those from Figure 2 but the training period is extended to February 2020 instead of February 2019. 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.

Tables

Table 1: Estimated effects of lockdown and post-lockdown relief on births

Month	Year	Absolute effect	Relative effect
3	*2020*	*579*	*2.1%*
4	*2020*	*-85*	*-0.3%*
5	*2020*	*-184*	*-0.7%*
6	*2020*	*262*	*1.0%*
7	*2020*	*-174*	*-0.6%*
8	*2020*	*-431*	*-1.5%*
9	*2020*	*106*	*0.4%*
10	*2020*	*-301*	*-1.0%*
11	2020	-1,605	-5.7%
12	2020	-4,704	-16.9%
1	2021	-4,312	-15.5%
2	2021	-643	-2.6%
3	2021	1,391	5.1%
4	2021	1,117	4.3%
5	2021	121	0.4%
6	2021	721	2.7%
7	2021	1,478	5.2%
8	2021	701	2.5%
9	2021	1,131	4.0%
10	2021	653	2.3%
11	2021	1,032	3.8%
12	2021	1,312	4.9%
Period		**All months**	**Per month**	**Overall effect**
03/2020-10/2020		*-227*	*-28*	*-0.1%*
11/2020-02/2021		-11,264	-2,816	-10.4%
03/2021-12/2021		9,656	966	3.5%
11/2020-12/2021		**-1,608**	**-115**	**-0.4%**

Notes: Effects are calculated as differences between actual and predicted values of monthly births, expressed as percentages of predicted values. Models are identical to those from Figure 3, i.e. the training period is extended to February 2020 instead of February 2019. White panel depicts in-sample deviations between reality and predictions. Grey panels show out-of-sample effects: Dark-grey panel shows a broader period when lockdown effects on births could materialize, and light-grey panel shows the period when effects from post-lockdown relief on births could materialize.

Table 2: Estimated effects of lockdown and post-lockdown relief on births by nationality and cohabitation status

Panel A: Split by nationality

Spanish				Foreigner			
Period	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**
12/2020		-3,093	-14.9%	12/2020		-1,604	-22.9%
1/2021		-2,276	-10.9%	1/2021		-2,165	-30.7%
03/2020-10/2020	*2,923*	*365*	*1.7%*	*03/2020-10/2020*	*-3,377*	*-422*	*-6.2%*
11/2020-02/2021	-5,720	-1,430	-7.0%	11/2020-02/2021	-6,166	-1,541	-22.5%
03/2021-12/2021	18,842	1,884	9.3%	03/2021-12/2021	-11,572	-1,157	-15.9%
11/2020-12/2021	**13,123**	**937**	**4.6%**	**11/2020-12/2021**	**-17,737**	**-1,267**	**-17.7%**

Panel B: Split by cohabitation status (Spanish women only)

Spanish Cohabiting				Spanish Non-Cohabiting			
Period	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**
12/2020		-1,233	-10.5%	12/2020		-1,208	-14.5%
1/2021		-659	-5.5%	1/2021		-864	-10.6%
03/2020-10/2020	*3,936*	*492*	*3.8%*	*03/2020-10/2020*	*2,391*	*299*	*3.5%*
11/2020-02/2021	-180	-45	-0.4%	11/2020-02/2021	-2,244	-561	-7.0%
03/2021-12/2021	16,391	1,639	14.4%	03/2021-12/2021	14,559	1,456	18.9%
11/2020-12/2021	**16,211**	**1,158**	**10.1%**	**11/2020-12/2021**	**12,315**	**880**	**11.3%**

Notes: See Table 1.

Table 3: Estimated effects of lockdown and post-lockdown relief on births by parity and age

Panel A: Split by age group (Spanish women only)

Spanish Age 15-19				Spanish Age 20-24				Spanish Age 25-29			
Period	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**
12/2020		-74	-19.7%	12/2020		-209	-15.5%	12/2020		-322	-10.2%
1/2021		-70	-18.9%	1/2021		-326	-24.5%	1/2021		-201	-6.5%
03/2020-10/2020	*116*	*15*	*3.9%*	*03/2020-10/2020*	*-20*	*-3*	*-0.2%*	*03/2020-10/2020*	*157*	*20*	*0.6%*
11/2020-02/2021	-105	-26	-7.3%	11/2020-02/2021	-812	-203	-15.7%	11/2020-02/2021	-545	-136	-4.5%
03/2021-12/2021	124	12	3.5%	03/2021-12/2021	-301	-30	-2.3%	03/2021-12/2021	1,743	174	5.6%
11/2020-12/2021	**19**	**1**	**0.4%**	**11/2020-12/2021**	**-1,112**	**-79**	**-6.1%**	**11/2020-12/2021**	**1,198**	**86**	**2.8%**

Spanish Age 30-34				Spanish Age 35-39				Spanish Age 40-49			
Period	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**
12/2020		-612	-9.1%	12/2020		-1,319	-19.2%	12/2020		-717	-28.9%
1/2021		-149	-2.2%	1/2021		-932	-13.5%	1/2021		-601	-25.1%
03/2020-10/2020	*1,159*	*145*	*2.0%*	*03/2020-10/2020*	*358*	*45*	*0.6%*	*03/2020-10/2020*	*444*	*55*	*2.3%*
11/2020-02/2021	-52	-13	-0.2%	11/2020-02/2021	-2,658	-665	-9.9%	11/2020-02/2021	-1,594	-398	-16.7%
03/2021-12/2021	8,900	890	13.4%	03/2021-12/2021	5,062	506	7.6%	03/2021-12/2021	2,975	297	13.2%
11/2020-12/2021	**8,849**	**632**	**9.6%**	**11/2020-12/2021**	**2,404**	**172**	**2.6%**	**11/2020-12/2021**	**1,381**	**99**	**4.3%**

Panel B: Split by parity (Spanish women only)

Spanish Parity 1				Spanish Parity 2				Spanish Parity 3+			
Period	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**	**Period**	**Cumulative effect**	**Effect per month**	**Relative effect**
12/2020		-2,048	-18.1%	12/2020		-699	-9.8%	12/2020		-219	-9.7%
1/2021		-1,435	-12.9%	1/2021		-489	-6.7%	1/2021		-212	-9.5%
03/2020-10/2020	*3,451*	*431*	*3.8%*	*03/2020-10/2020*	*84*	*10*	*0.1%*	*03/2020-10/2020*	*-298*	*-37*	*-1.6%*
11/2020-02/2021	-3,698	-925	-8.5%	11/2020-02/2021	-817	-204	-2.9%	11/2020-02/2021	-459	-115	-5.2%
03/2021-12/2021	9,654	965	9.0%	03/2021-12/2021	10,657	1,066	15.1%	03/2021-12/2021	1,981	198	9.1%
11/2020-12/2021	**5,956**	**425**	**3.9%**	**11/2020-12/2021**	**9,839**	**703**	**10.0%**	**11/2020-12/2021**	**1,522**	**109**	**5.0%**

Notes: See Table 1.