# Pandemic Roller-Coaster? Birth Trends in Higher-Income Countries During the COVID-19 Pandemic

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*We use monthly birth data collected by the Human Fertility Database to analyze the impact of the COVID-19 pandemic on birth trends until September 2022 in 38 higher-income countries. We also present estimates of the monthly total fertility rate adjusted for seasonality. Our analysis reveals that the pandemic led to distinct swings in births and fertility rates. The initial pandemic shock was associated with a fall in births in most countries, with the sharpest drop in January 2021. Next, birth rates showed a short-term recovery in March 2021, following the conceptions after the end of the first wave of the pandemic. Most countries reported a stable or slightly increasing number of births in the subsequent months, especially in autumn 2021. Yet another, quite unexpected, downturn in births started in January 2022, linked with the conceptions in spring 2021 when the pandemic measures were mostly eased out and vaccination was gaining momentum. Taken together and contrary to some initial expectations, the coronavirus pandemic did not bring a lasting "baby bust" in most of the analyzed countries. Especially the Nordic countries, the Netherlands, Germany, and the United States experienced an improvement in their birth dynamics in 2021 compared with the prepandemic period.*

## Introduction

The Coronavirus 2019 (COVID-19) pandemic has profoundly affected every aspect of our lives, including family-related behaviors (Settersten et al. 2020; Mayer 2022). Some early media accounts suggested that the

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lockdowns, imposed to prevent the spread of the virus, could lead to a baby boom as couples were spending more time together. However, evidence on past fertility responses to external shocks, such as economic crises, financial turbulences, political upheavals, and outbreaks of infectious diseases, shows that people often postpone or revise their childbearing plans in uncertain times.

Indeed, surveys on fertility intentions in Europe and in the United States conducted in the early stages of the COVID-19 pandemic in 2020 revealed that many women decided to delay or even give up on their childbearing plans (Lindberg et al. 2020; Luppi, Arpino, and Rosina 2020; Arpino, Luppi, and Rosina 2021; Malicka, Mynarska, and Świderska 2021). Especially in the higher-income countries, where couples have access to efficient contraception and most women are employed, the pandemic was initially expected to depress fertility rates as many people struggled with economic uncertainty, worries about the health consequences of the pandemic, and stress related to lockdowns and restrictions to everyday life (Aassve et al. 2020; Settersten et al. 2020; Kearney and Levine 2020; Berrington et al. 2021 and 2022; Mayer 2022). The pandemic also affected reproductive behavior in more subtle ways. Marriages were postponed, younger people and couples not living together had fewer opportunities to meet, some couples reported worsening relationship quality (Bellani and Vignoli 2022; Schmid et al. 2021; Vigl et al. 2022) and less frequent sexual intercourse (Lehmiller et al. 2020; Luetke et al. 2020), families struggled to accommodate home schooling and other needs of their children staying at home, and contact with grandparents—important providers of childcare—was often severely restricted or entirely cut off for many months (e.g., Settersten et al. 2020; Berrington et al. 2021; Mayer 2022). In short, the coronavirus pandemic was often perceived as a disruptive shock, which brought about new uncertainties (Guetto, Bazzani, and Vignoli 2022) and which would accelerate the long-standing trend to low or very low fertility rates.

Considering the time needed to achieve conception and to carry pregnancy to term, the actual impact of the COVID-19 pandemic on birth trends could be observed considerably later than that its consequences for other demographic and family events—deaths, migrations, marriages, or divorces. Initial research, therefore, relied on projecting birth trends from relevant online searches (e.g., Wilde, Chen, and Lohmann 2020; Berger et al. 2021) and on preliminary reports on pregnancies and birth trends, often for selected cities, hospitals, and subnational regions (e.g., Cohen 2021 for the United States). These preliminary assessments often suggested that the early stage of the pandemic would bring about a substantial fall in the number of pregnancies and births. The media reports also speculated on the looming COVID-19 "baby bust" (Pinsker 2020) and "baby crash" in 2021. Later, more solid empirical evidence emerged from births conceived during the first year of the pandemic and born since November 2020 (see Sobotka et al. 2021 and

Aassve et al. 2021 for cross-national comparisons). For most of the higher-income countries, these data confirmed the expected baby bust associated with the first wave of the pandemic and the lockdowns. Sharp falls in the number of births were also reported in middle-income countries of Latin America (e.g., Lima, Soares, and Monteiro da Silva 2022; UN 2021) and in China (Zhang and Li 2021; UN 2021). However, analyses covering a longer period of the pandemic increasingly revealed a more differentiated picture, with birth trends varying substantially over time and across countries. For instance, in Japan, birth trends "returned" to their stable or slightly declining trajectory a few months after the start of the pandemic (Ghaznavi et al. 2022). Similarly, in the United States and in Australia, birth rates recovered after the initial pandemic shock (Kearney and Levine 2022; Bailey, Currie, and Schwandt 2022; Gray, Evans, and Reimondos 2022). Nordic countries (except Sweden) even experienced a sustained upturn in their fertility rates during the pandemic year 2021 (Nisén et al. 2022 for Finland; Lappegård et al. 2023 for Norway), following a decade of falling fertility.

Our study provides a comprehensive overview of birth and fertility trends in higher-income countries in Europe, East Asia, and North America, as well as Chile, Israel, and New Zealand. We analyze monthly data until September 2022 for individual countries and for broader geographical regions, including the European Union (EU). We use the new Short-Term Fertility Fluctuations (STFF) data series (https://www.humanfertility.org/Data/STFF), which is incorporated in the Human Fertility Database (HFD) (STFF 2023a, 2023b). Our analyses expand the research on pandemic birth trends regarding both the number of countries covered and the period analyzed. We give a systematic account of the observed pandemic birth trends until summer 2022 and compare them with the prepandemic period. In addition, our research goes beyond the crude indicators of births and birth rates. For a subset of analyzed countries, we present estimates of monthly total fertility rates (TFR), which allow for a more meaningful comparison of the most recent fertility changes and differences between countries.

We demonstrate that the pandemic has brought about strong fluctuations in births and fertility rates. Notably, births in most countries shifted in parallel during the pandemic. First, in response to the initial pandemic "shock," they dropped in most of the analyzed countries, with the sharpest reductions seen in January 2021. Subsequently, most countries experienced a short-term recovery linked to the end of the first pandemic wave, with a small baby boom reported around March 2021. Later, birth trends varied across countries, frequently showing signs of a modest recovery during 2021, before dropping again in early 2022.

Our paper begins with a detailed review of the expected links between the coronavirus pandemic and fertility, discussing past evidence on the

impact of shocks on birth trends and different mechanisms at play that are likely to amplify or moderate the impact of the pandemic.

## Background: Fertility responses to external shocks

In higher-income countries most individuals have access to efficient contraception and have a strong capacity to prevent unwanted pregnancies (Bearak et al. 2020); most countries also permit abortion on request or for social reasons. Consequently, birth rates can rapidly rise or decline in response to external shocks. Although the pandemic has initially led to disruptions in access to contraception, abortion, and assisted reproduction in some countries, most women and men were able to flexibly react to changing conditions and decide whether to delay, advance, modify, or give up their reproductive plans. We summarize past evidence on fertility responses to external shocks and outline selected pathways and mechanisms that are likely to affect birth trends during the coronavirus pandemic.

### Shocks and fertility fluctuations: Past evidence

Different shocks vary in their severity, duration, and impact on people's lives. Most of these shocks can be grouped into three broader categories: economic crises, disease outbreaks, and political upheavals. Furthermore, policy interventions can also be considered as shocks, which often have a strong temporary impact on fertility, affecting especially the timing of childbearing (Gauthier 2007; Sobotka, Matysiak, and Brzozowska 2019; Bergsvik, Fauske, and Hart 2021).

In the past, the "negative" shocks often led to a downturn in the number of births. In some cases, these downturns were short-lived, especially when the event triggering the fall in fertility persisted for a few months only (for instance, in the case of seasonal flu outbreaks), but often these shocks had a long-lasting negative impact on births (e.g., during the Great Depression of the 1930s). Economic and financial crises were repeatedly linked to fertility downturns, leading to both postponed and reduced childbearing throughout the 20th century (Sobotka, Skirbekk, and Philipov 2011) as well as during the global financial crisis around 2007–2010 (Comolli 2017). At an aggregate level, job losses and job instability, as captured by high and rising unemployment and an increase in temporary employment and part-time jobs, have a strong negative impact on fertility (Adserà 2004; Bellido and Marcén 2019; Matysiak, Sobotka, and Vignoli 2021).

Outbreaks of infectious diseases can directly (e.g., through reduced fecundity or pregnancy loss) or indirectly (due to fear of getting infected, reduced social contacts, lower sexual activity, and other factors) affect fertility. The 1918–1919 influenza pandemic, smaller seasonal flu outbreaks such as the European winter flu in 1957, as well as the 2015–2016 Zika epidemic

in Latin America were associated with a temporary fall in birth rates, later mostly followed by their recovery (Mamelund 2004; Chandra et al. 2018; Boberg-Fazlic et al. 2021; Sardon 2016; Rangel, Nobles, and Hamoudi 2020; Marteleto et al. 2020). Social and political upheavals and regime changes can usher a long-lasting fall in fertility rates, due to economic and policy disruptions as well as ensuing uncertainty about the future (Caldwell 2004). Natural and man-made disasters can also impact birth behavior, initially due to displacement and disruption to people's lives and property (e.g., Seltzer and Nobles 2017), and later due to families trying to "replace" children lost due to the disaster (Nobles, Frankenberg, and Thomas 2015).

*Subjective perceptions of uncertainty contribute to fertility reactions.* During shocks and crises, the impact of "objective" and measurable factors—such as unemployment—on reproductive behavior is augmented by subjective perceptions of risks, uncertainty, and anxiety about the future. Subjective perceptions of economic uncertainty (Kreyenfeld 2015) and factors such as consumer confidence and economic policy uncertainty (Comolli 2017; Comolli and Vignoli 2021) have a nonnegligible effect on fertility. Expanding this line of research further, Vignoli et al. (2020) and Guetto, Bazzani, and Vignoli (2022) emphasize the impact of media narratives, which shape the perceptions and interpretations of the actual conditions and can amplify the sense of uncertainty and insecurity about the future. Research on the Zika pandemic in Brazil in 2014–2017 suggests that a substantial fall in fertility level in the most affected regions was not closely associated with the peak of the infection, but rather with a subsequent declaration of health emergency and official advice to women to consider delaying their reproductive plans (Rangel, Nobles, and Hamoudi 2020).

The main initial impact of the COVID-19 outbreak and the lockdowns introduced in most countries lied in a collective experience of uncertainty about the way the infection and its social, economic, and health consequences as well as government responses to it would unfold in the ensuing weeks and months. Most of this impact was negative, fostering a view that the coronavirus outbreak is not "the right time to have kids." Manning et al.'s (2022) analysis revealed that in the United States subjective uncertainty was more salient for fertility decisions than the actual economic conditions. Partnered women and men reporting being more afraid of COVID-19, more stressed about the future, and more uncertain about their relationship, also reported a stronger desire to avoid a pregnancy. However, in a longer term, the experience of uncertainty could also positively impact fertility among people who have limited agency and whose other pathways for success and self-realization are blocked (Friedman, Hechter, and Kanazawa 1994; Kreyenfeld 2010). Rotkirch (2020) points out that the experience of existential uncertainty can change people's priorities and lead

to a stronger valuation of family life and intimacy in their lives, potentially leading to more births.

*Coronavirus pandemic as a disruption to everyday lives.* Besides initially triggering huge levels of uncertainty and anxiety about the future, the COVID-19 outbreak combined different types of shocks described above, which have jointly affected fertility trends. Although the populations of prime reproductive age did not suffer much from a direct impact of mortality (or pregnancy loss), the fear of becoming infected (e.g., during delivery in a hospital) might have negatively affected fertility plans among prospective parents. Surveys identified increased levels of pregnancy-related anxiety during the pandemic (Moyer et al. 2020).

Arguably, more important was the impact of a looming economic crisis. Initially, the pandemic was widely expected to bring about a massive economic downturn, marked by falling economic activity, rapid rise in unemployment, and loss of income for many people. In June 2020, the World Bank (2020) predicted that the pandemic would "plunge global economy into the worst recession since World War II." Government policies aimed to curb the spread of the pandemic, including lockdowns and social distancing measures, made daily lives of most families with children more difficult due to school closures, work from home, and limited contact of children with grandparents. The lives of the prospective parents were affected by wedding restrictions, restrictions to mobility, and social contacts (Settersten et al. 2020; Mayer 2022). These measures had wide-reaching impact on couples and partnerships, ranging from the fall in the number of marriages through a shift from in-person to online dating up to changes in sexual behavior, with a decline in partnered sex and a rise in "virtual sexuality" (Lehmiller et al. 2020; Ballester-Arnal et al. 2021; Giami 2021; Eleuteri and Terzitta 2021). Analyzing undergraduate students at a U.S. Midwestern university, Herbenick et al. (2022) documented how campus closures disrupted their partnerships and sexual relations. Over time, the pandemic and pandemic-induced reductions in mobility also contributed to a mental health crisis, including a rise in major depressive disorder and anxiety (Santomauro et al. 2021).

*Disruptions in access to contraception, reproductive health, abortion, and assisted reproduction.* The restrictions to mobility, especially in the early stage of the pandemic, often led to disruptions in access to contraception, abortion, and assisted reproduction (Aly et al. 2020 on contraception; Moreau et al. 2021 and Bojovic, Stanisljevic, and Giunti 2021 on abortion; Vermeulen et al. 2020 on medically assisted reproduction). Production and supply chain disruptions, leading to shortages and reduced access to contraception, were also reported in some countries (Aly et al. 2020). These disruptions were mostly short-lived, occurring especially in the early months of the pandemic

(March–May 2020) and varied greatly across countries. They did not affect all populations equally: in the context of the United States, characterized by huge social status inequalities as well as unequal access to health care services, Bailey, Bart, and Lang (2022) show that low-income women with no health insurance experienced an increase in unplanned pregnancies and births during the pandemic. In Moldova, Emery and Koops (2022) found that the lockdowns in the early stage of the pandemic limited access to long-lasting contraception in rural areas, resulting in a higher use of short-term methods, especially condoms. Fluctuations in the use of reproductive health services could also occur due to changes in demand rather than supply restrictions: Vilain et al. (2022) found that while the number of induced abortions in France did not fall significantly during the first two pandemic months, in March–April 2020, it did drop in May–June 2020, suggesting that abortion trends reflected fewer conceptions and pregnancies in the early stage of the pandemic rather than supply restrictions.

*Policies, welfare system, and labor markets moderate the impact of the coronavirus pandemic on fertility.* The impact of rapidly changing life conditions, economic shocks, and uncertainties on fertility depends on policy environment. Countries with more generous welfare systems, with a higher level of support for families, with a lower level of income inequality, and with an overall better functioning economy and labor market provide conditions that may act as a cushion, shielding individuals and families from the negative impact of the pandemic. Family policies that are universal and are not tied to employment activity can potentially contribute to higher fertility in uncertain times (Berrington et al. 2022). Research by Lappegård et al. (2023) on rising fertility rates in Norway during the pandemic highlights the important role of family policies, including generous welfare benefits to families with children, in bolstering economic and social security, and thus creating favorable conditions for childbearing.

A higher level of social trust is another moderating factor. Past research has demonstrated a positive link between trust and fertility, also in times of unfolding economic recession (Aassve, Billari, and Pessin 2016; Aassve, Le Moglie, and Mencarini 2021). A higher level of social trust makes people better equipped for dealing with uncertainty, but it can also be decisive for the successful management of the pandemic as people living in countries with a higher level of social trust are more likely to follow government policies and recommendations, especially those on social distancing or vaccination (Devine et al. 2021). In turn, a more successful management of the pandemic will reduce infection rates and infection fatality (Bollyky et al. 2022). Studies on pandemic birth trends in the Nordic countries also support the view that trust in institutions helped to reduce uncertainty and had a positive impact on fertility (Nisén et al. 2022; Neyer et al. 2022). In the case of Sweden, Neyer et al. (2022) argued that perceived global

uncertainties and trust in institutions were more important for fertility intentions than objective economic conditions.

Specific policies were introduced to minimize the negative impact of the pandemic on income, employment, and well-being. Some of these policies also had a capacity to foster more child- and family-friendly environment, while others had a potential to negatively affect reproductive plans. Massive government interventions to prop up the economy and labor markets and to protect jobs and incomes of millions of workers, including tax credit schemes, furlough schemes in Britain, *Kurzarbeit* (reduced work hours) schemes in Germany and Austria or economic stimulus checks ("Economic Impact Payment") in the United States, helped to avert the projected economic crises, prevented the unemployment from spiraling out of control, boosted family income, and reduced economic uncertainty. As a result, the impact of COVID-19 on higher-income economies was considerably less dramatic in 2020 than initially envisioned. However, some government policies aiming to limit mobility and personal interaction had a negative impact on children and families. These policies, including school closures and limiting after-school and extra-curricular activities, varied largely by country and region in their enforcement, duration, and disruptive impact on children and families (Thorn and Vincent-Lancrin 2021).

*Microlevel perspective: Varying individual responses.* Our study focuses on a broad aggregate-level picture of changing birth rates and the pandemic conditions that contribute to these changes. Past research shows that the effects of uncertainty on fertility vary by age, education, social status, and the number of children (Kreyenfeld 2010, 2015; Alderotti et al. 2021). Correspondingly, pandemic-related fertility trends varied by social groups, age, parity, and other characteristics. For instance, the observed fertility upturn in Norway was strongest among groups of women that were economically most secure during the pandemic—higher-educated, of main reproductive ages (28–35), those already having at least one child, and those working in public administration (Lappegård et al. 2023). Bailey, Currie, and Schwandt (2022) argue that the groups of women showing the largest baby "bump" in the United States in 2021—women with a college education and women having first birth—benefited most from the opportunity to work from home.

The data analyzed here do not allow us to provide a more nuanced picture of specific fertility responses among different population groups or insights about individual reproductive decisions. Rather, our findings should be interpreted as reflecting an aggregate outcome of individual decisions, with the trends varying between groups (Berrington et al. 2021). Similarly, the quick succession of ups and downs in birth trends during the pandemic does not imply that individual men and women are able to "instantaneously" achieve pregnancy when they desire so. Rather, these

seemingly quick fertility responses reflect aggregate-level outcomes of shifts in reproductive behavior, contraceptive use, and patterns of sexual intercourse, which involve at an individual level a high degree of uncertainty and failures to act on fertility intentions, including unplanned pregnancies, infertility experience, and miscarriages.

## Pandemic baby boom? Uncertain prospects of fertility recovery

Whenever fertility changes due to shocks, crises, and other unexpected events, the key question is whether this response constitutes a temporary fluctuation or rather a longer-term "level shift." Because couples often delay reproductive plans in uncertain circumstances, stabilization, or an improvement in the external conditions—such as economic recovery, new policies supporting families, or a pandemic being brought under control—could trigger a fertility recovery. This recovery is often partial and may not fully compensate for the earlier fall in fertility. Fertility recovery may be more protracted and less easily identifiable when a shock has a long-lasting impact or when it brings about a permanent change in people's lives and living standards, as in the case of political and social upheavals. Some of the more recent shocks leading to a fall in fertility, such as political regime change in Central and Eastern Europe after the breakdown of the state-socialist system in 1989–1991 or the financial crisis around 2007–2010, were usually not followed by a sustained recovery in fertility in the subsequent years. Shocks that are relatively brief and do not leave a lasting impact, such as seasonal flu outbreaks in Europe in winter 1957 and 1969, caused only a short-lived baby bust followed by a swift recovery, often reaching or surpassing the initial fertility level within four to five months (Sardon 2005).

In sum, the prospects of fertility recovery following the COVID-19 outbreak are uncertain with respect to its possible timing, intensity, and in the extent to which it might compensate for the initial baby bust (Goldstein 2020). While demographers seemed to have reached a broad consensus about the likely occurrence of the initial pandemic baby bust (e.g., Aassve et al. 2020; Lappegård, Kristensen, and Mamelund 2020; Berrington et al. 2021; Wilde, Chen, and Lohmann 2020), there is no clear agreement about the potential "compensatory" baby boom. These considerations are further complicated by the relatively long duration and uneven progression of the COVID-19 pandemic, which was moving in cycles (waves) of major outbreaks alternating with calmer periods with few infections and limited or no mobility restrictions. This complex progression of the pandemic implies different possible scenarios of eventual fertility recovery, which may be staggered and may follow a nonlinear trajectory.

A most conventional expectation would be of a gradual fertility recovery following the ending of the pandemic (or the time when it is brought permanently under control, with most of the population vaccinated and

the lockdowns and mobility restrictions abandoned) (e.g., Goldstein 2020; Fostik 2021). While the former scenario of an unstable recovery would result in distinct short-term fertility upturns occurring soon after the initial baby bust (like in the case of flu outbreaks analyzed by Sardon 2005), the latter scenario would imply an upward trend in fertility extended over several years.

## Data, methods, and indicators

We use data from the STFF data series launched in March 2021 and embedded in the HFD (STFF 2023a). The STFF dataset aims to provide timely information on monthly trends in the number of births and fertility rates prior to the publication of more detailed vital statistics data and indicators, which are often published with considerable delay. The STFF is therefore especially suitable for studying birth and fertility fluctuations that arise in response to external shocks and major changes in family-related policies.

The STFF features two main sets of data. First, it provides data on monthly live births since January 2000 in the higher-income countries with good quality of vital registration data and almost complete coverage of births in their vital statistics. Second, for a smaller set of countries, it features estimates of monthly period TFR. As of January 2023, the STFF database covers 45 countries, territories, and regions, with the most recent monthly data currently available until October 2022. Most of these data have been released and published by national statistical offices (see detailed information under STFF Metadata; STFF 2023b).

In this study, we focus on countries with a population over one million (to limit fluctuations resulting from small numbers of births) and with data available until at least December 2021. We cover 37 countries from Europe, East Asia, and North America, as well as Chile, Israel, and New Zealand; for the United Kingdom, we include separate data for England and Wales and for Scotland, bringing our entire data set to 38 countries and regions[1] (see Table 1 for the list of countries and months covered and the regional groupings of countries). Our data provide especially good coverage for Europe, with 29 countries grouped into six broader regions (Western Europe, German-speaking countries, Nordic countries, Southern Europe, Central Europe, and Eastern and South-eastern Europe).[2] We also compute the average for the EU, based on the evidence for 17 out of 27 EU countries with birth and fertility data available at least until August 2022 (see Table 1).

Our main period of analysis starts in November–December 2020. Considering the time needed to get pregnant and the duration of pregnancy, which is close to nine months from ovulation to delivery (266 days or 8.7 months on average; Jukic et al. 2013), the onset of the pandemic in early March 2020 and the associated lockdowns around mid-March 2020

**TABLE 1 Overview of countries included in this study and data coverage**

| Region | Country | Most recent data | EU average | TFR estimates | Note |
|---|---|---|---|---|---|
| East Asia | Japan | 6/2022 | | X | |
| | Singapore | 9/2022 | | | Registration |
| | South Korea | 9/2022 | | X | |
| | Taiwan | 6/2022 | | | Registration |
| North America | Canada | 12/2021 | | | |
| | USA | 6/2022 | | X | |
| Western Europe | Belgium | 9/2022 | X | X | |
| | France | 9/2022 | X | X | |
| | Ireland | 12/2021 | X | X | |
| | Netherlands | 10/2022 | X | X | |
| | UK-England and Wales | 12/2021 | | X | |
| | UK-Scotland | 9/2022 | | X | |
| German-speaking countries | Austria | 9/2022 | X | X | |
| | Germany | 8/2022 | X | X | |
| | Switzerland | 12/2021 | | X | |
| Nordic countries | Denmark | 9/2022 | X | X | |
| | Finland | 10/2022 | X | X | |
| | Norway | 12/2021 | | X | |
| | Sweden | 9/2022 | X | X | |
| Southern Europe | Italy | 8/2022 | X | X | |
| | Portugal | 9/2022 | X | X | |
| | Spain | 9/2022 | X | X | |

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**TABLE 1 (Continued)**

| Region | Country | Most recent data | EU average | TFR estimates | Note |
|---|---|---|---|---|---|
| Central Europe | Croatia | 9/2022 | | | Registration |
| | Czechia | 9/2022 | X | X | |
| | Estonia | 10/2022 | | | Registration |
| | Hungary | 10/2022 | X | X | Fluctuations |
| | Latvia | 9/2022 | X | X | |
| | Lithuania | 9/2022 | X | X | |
| | Poland | 12/2021 | | | |
| | Slovakia | 8/2022 | | | Registration |
| | Slovenia | 9/2022 | X | X | |
| Eastern and South-eastern Europe | Bulgaria | 12/2021 | | X | |
| | Russia | 9/2022 | | X | Registration |
| | Serbia | 10/2022 | | | Registration |
| | Ukraine | 1/2022 | | | Registration |
| Other countries | Chile | 12/2021 | | | Late registrations |
| | Israel | 9/2022 | | X | |
| | New Zealand | 3/2022 | | | |

*Country coverage*: The column "EU average" shows 17 countries included in the computation of average relative change in births and monthly TFR level in European Union (EU) countries (countries with data available at least until August 2022 and with a population over 1 million; Romania is excluded due to large fluctuations). The column "TFR estimate" shows all countries for which data were available to prepare ARIMA-based projection of births from October 2020 and for which we could compute estimates of monthly TFRs.
NOTES: "Registration" denotes countries where the monthly birth data were reported by month of registration, especially in the most recent months. This may lead to fluctuations and limit comparability of data over time. "Fluctuations" lists countries, where reported monthly data display large fluctuations; this signals potential data quality issues and may limit data comparisons over time. "Late registrations" lists countries where the most recent data may be underestimated due to delayed registration of births.

affected births since November 2020, with the full impact first seen in December 2020.[3]

## Data quality issues

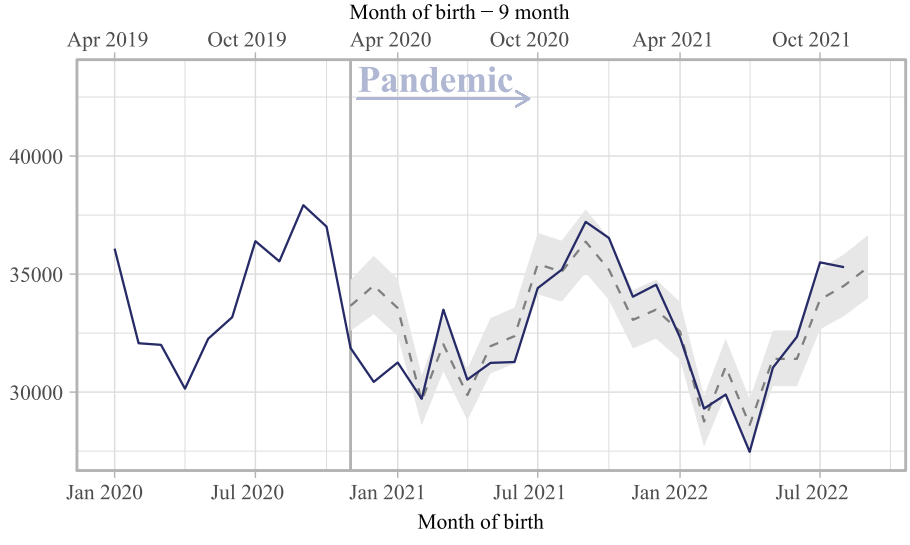
The most recent monthly birth data for 2022 should be interpreted with caution. For some countries, the early-release data are preliminary and subject to subsequent revisions. In addition, many countries report birth data by month of registration rather than by month of occurrence, which might bias analysis of birth trends in times when data collection and reporting were disrupted, as was often the case during the early stage of the COVID-19 pandemic. Registration issues may also affect birth numbers reported in the final month of the year, when some of the late-reported births could be added to the database or when reported data are incomplete at the time the annual statistics was first published (see Table 1).

## Analyzing relative changes in the number of births

Conceptions and births in most countries display a seasonal pattern (e.g., Régnier-Loilier and Divinagracia 2010; Dahlberg and Andersson 2019; Sobotka et al. 2005). Without adjusting for the effects of seasonality as well as of different length of calendar months and the varying number of specific weekdays in each month ("calendar" effect), monthly birth trends cannot be compared between adjacent months. To address these issues and to avoid simple annual comparisons with the periods when birth trends were already affected by the pandemic, we relate the monthly number of births to the same month before the start of the pandemic. This means that our indicator of relative birth trends captures changes over one- or two-year periods, depending on the month and year analyzed.[4] Specifically, we compare births since November 2020 (i.e., births conceived since around the onset of the pandemic in March 2020) with the births born in the same month between November 2019 and October 2020. Thus, births between November 2020 and October 2021 are compared with the births one year earlier, and births between November 2021 and September 2022 are compared with the births in the identical month two years earlier (i.e., from November 2019 to September 2020). To better assess the impact of COVID-19 on changing birth dynamics, we also compare the dynamics in pandemic birth trends to the "yardstick" of prepandemic monthly birth trends prior to November 2020.[5]

However, the number of births, deaths, and other vital events are crude indicators that are not adjusted for the changing population size and its age and sex composition. The absolute number of births may change over time due to compositional factors that are normally controlled for in the standard demographic indicators, such as the TFR. Our focus is

**FIGURE 1 Observed monthly births in January 2020–August 2022 (blue line) and predicted monthly births in November 2020–September 2022 in Italy based on prepandemic birth trends through October 2020 (gray-dashed line together with 90 percent confidence interval)**




on relatively short period of time, especially in 2020–2022, during which changes in population size and composition should have a limited impact on the observed number of births.

We also provide a more robust check of the birth swings since November 2020 by projecting pandemic birth trends from the prepandemic data series (January 2012 to October 2020) based on a seasonal autoregressive integrated moving average (ARIMA) model (see below). These projected trends (and their 90 percent confidence interval) are then compared with the observed number of births. Figure 1 illustrates this projection using an example of Italy, where the number of births dropped well below the projected one (and below the 90 percent range) in the first three projected months, November 2020–January 2021 (graphs for all 27 countries for which we computed ARIMA-based projection are shown in Supplement Figure A6).

In addition, we derive a seasonally adjusted series of the monthly number of births starting from January 2012 to the last month available.[6] We use the R *seasonal* package (Sax and Eddelbuettel 2018), which provides an interface to the seasonal adjustment software X-13ARIMA-SEATS (U.S. Census Bureau 2022). The latter software is among the recommended seasonaly adjustment methods in the European Statistical System Guidelines (Mazzi, Ladiray, and Rieser 2018). The seasonally adjusted monthly number of births is then used as an input for estimating the monthly TFR.

## Estimating TFR by month

To go beyond a crude indicator of monthly births, we present monthly estimates of the TFR from 2020 to September 2022 for a subset of 27 analyzed countries (including two UK regions of England and Wales and Scotland). These should be treated as preliminary estimates, as they rely on projected population data and a simplified computation of the TFR. Conventional TFR computation requires data on births and female population by single years of age or by five-year age groups. However, for most countries, monthly birth data are reported as a total sum, not specified by age or other characteristics of the mother. Therefore, we have derived a simplified method of estimating monthly TFR from the total number of births.

These estimates involved several intermediate steps, which are briefly described here. A more detailed description is provided by Jdanov et al. (2022). First, we adjust the monthly number of births for seasonality and calendar effect using X-13 ARIMA-SEATS. Second, we estimate monthly population exposures, that is, data on the number of women of reproductive age (15–44) by month. These were estimated by linear interpolation from annual estimates and projections of the female population by age in 2020–2022. The projected population in 2021 and 2022 was derived using the Lee–Carter model and extrapolating the annual number of deaths (see Jdanov et al. 2021). These estimates are available only for the countries included in the Human Mortality Database (2022). Third, we combine these seasonally adjusted monthly birth series ($B'_{(m)}$) with monthly population exposures to compute the general fertility rate (GFR): $GFR(m) = B'(m)/P_{F(15–44)}(m)$, where $P_{F(15–44)}(m)$ is the projected number of women aged 15–44 in the middle of month $m$. Fourth, we compute the observed annual ratio between the GFR and the TFR. We use linear interpolations of the ratios in 2016—2020 to project their expected values in 2021–2022.[7] Finally, we derive monthly TFR estimates by multiplying the estimated GFR and the projected monthly *GFR/TFR ratio* ($p$ denotes projected values):

$$\begin{aligned}\mathrm{TFR}\,(m) &= p\,[\mathrm{GFR}\,(m)\,/\mathrm{TFR}\,(m)] \times \mathrm{GFR}\,(m)\\ &= p\,[\mathrm{GFR}\,(m)\,/\mathrm{TFR}\,(m)] \times\ B'\,(m)\,/P_{F(15-44)}\,(m)\,.\end{aligned}$$

The estimated period TFRs should be seen as preliminary crude estimates and interpreted with caution. There are two possible sources of bias affecting these data. First, replacing age-specific fertility rates with a GFR in combination with a projected ratio between GFR and TFR could affect the resulting TFR estimates when the age schedule of fertility changes or when the age structure of the female population of reproductive age shifts. Second, the projected female population of reproductive age in 2021 and 2022 can differ from the actual population, especially when immigration and outmigration rates change rapidly, as has often been the case during

the COVID-19 pandemic due to restrictions to international travel (e.g., González-Leonardo et al. 2023). Our analyses of the past data revealed that the ratio of GFR to TFR was shifting very slowly over time in most countries and therefore did not cause a strong deviation between the estimated and observed TFRs in a short-time perspective. However, changing international migration, often concentrated in prime childbearing ages, had a stronger impact on the quality of TFR estimates and is likely to make our population estimates less precise.

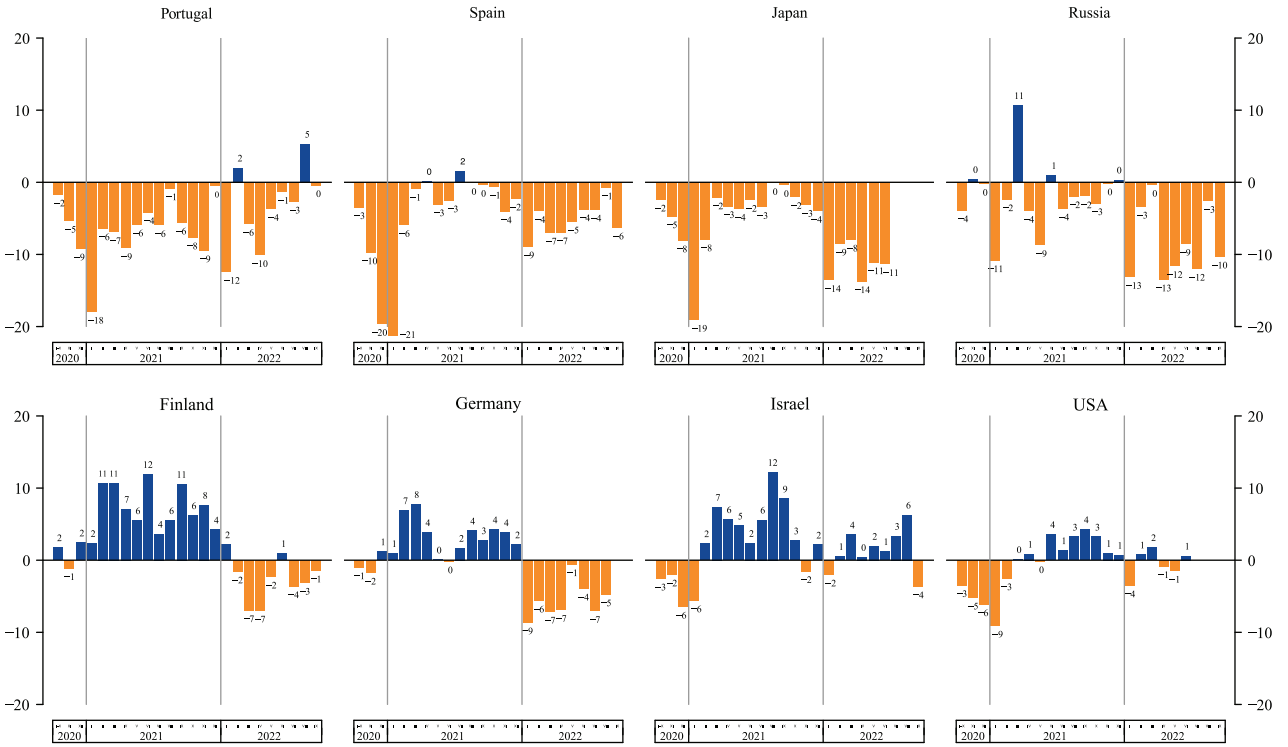
## Results

### Monthly birth trends: Shifts over time and variation between countries and regions

When assessed over a longer period, pandemic birth dynamics varied between countries. Figure 2 illustrates this variation in eight countries. Among them, Portugal displayed a sustained sharp drop in the number of births until early 2022 and Finland followed an opposite trend of a lasting increase in the number of births until December 2021. More common were ups and downs in births during the pandemic, as observed in the United States. Births in Israel also showed fluctuations, but mostly characterized by rising birth numbers. By contrast, Russia displays similar fluctuations, with mostly declining birth trends. Other patterns can be found as well. Japan and Spain show a sharp drop in the number of births in the early stage of the pandemic, especially in January 2021, thereafter, returning to a pre-COVID trend of a moderate fall in births during 2021, and later reporting sharper downturn in 2022. Germany experienced mostly positive birth trends in 2021, with very little sign of any pandemic disruption, but then saw a steep fall in births since January 2022.

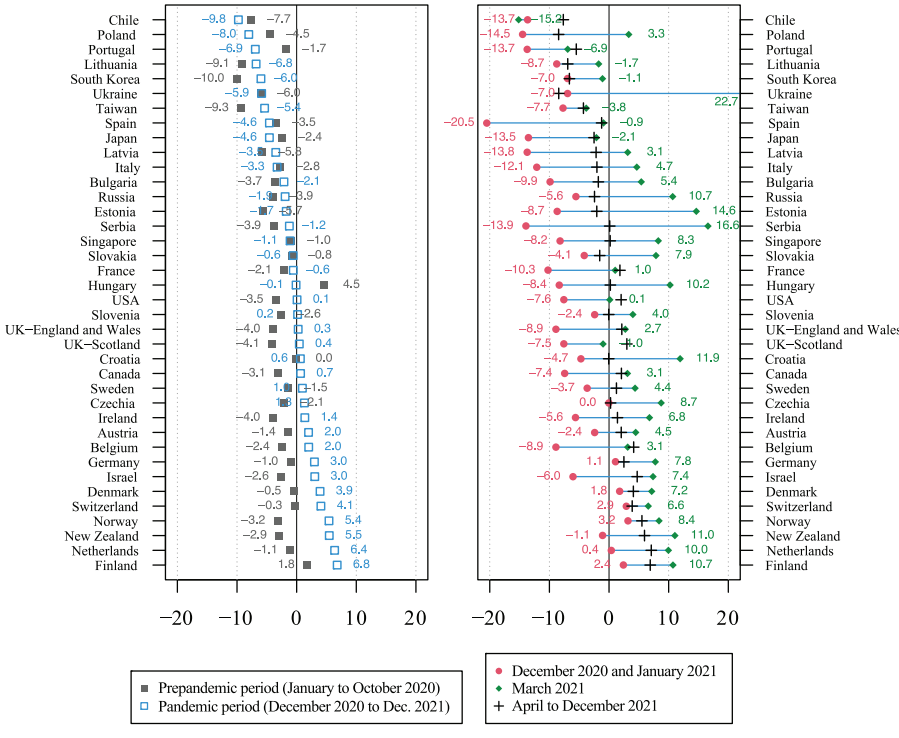
Despite these wide cross-country differences, most countries followed similar shifts over time. Broadly in line with the expectations among population experts, the COVID-19 pandemic had initially brought about a downward shift in the number of births in most of the analyzed countries, especially in December 2020 and January 2021, signaling a fall in conceptions in March, April, and early May 2020. The sharpest drop in births occurred in January 2021. In nine countries including Japan, Italy, Spain, France, and Poland, the number of births dropped by more than 10 percent over a two-month period of December 2020 and January 2021 compared with the same months a year earlier (right panel in Figure 3 and Table A1 in the Supplement). Spain saw the most pronounced "baby bust," with the number of births contracting by over 20 percent in that period. Only seven out of 38 countries analyzed (Czechia, Denmark, Finland, Germany, Netherlands, Norway, Switzerland) did not experience an early pandemic decline in the number of births. Because many countries had already experienced a grad-

**FIGURE 2 Monthly changes in the number of live births compared to the same month in the prepandemic period (percent) in selected countries (November 2020 to September 2022)**




NOTES: The graph compares the monthly number of births to the same month before the start of the pandemic. We take into account the estimated month of conceptions and hence consider only births since November–December 2020 as "pandemic births." For births between November 2020 and October 2021, the benchmark for comparison is the number of births one year earlier (between November 2019 and October 2020). Births between November 2021 and September 2022 are compared with the identical month two years earlier, that is, from November 2019 to September 2020. Births conceived before the pandemic, in January–October 2020 are compared with births in the same months one year earlier, in 2019.

**FIGURE 3 Monthly changes in the number of live births until December 2021 compared to the same months in the prepandemic period (percent). The left panel compares birth trends in prepandemic (January–October 2020) and pandemic periods (December 2020–December 2021); the right panel looks at birth dynamics during the pandemic period in more detail**

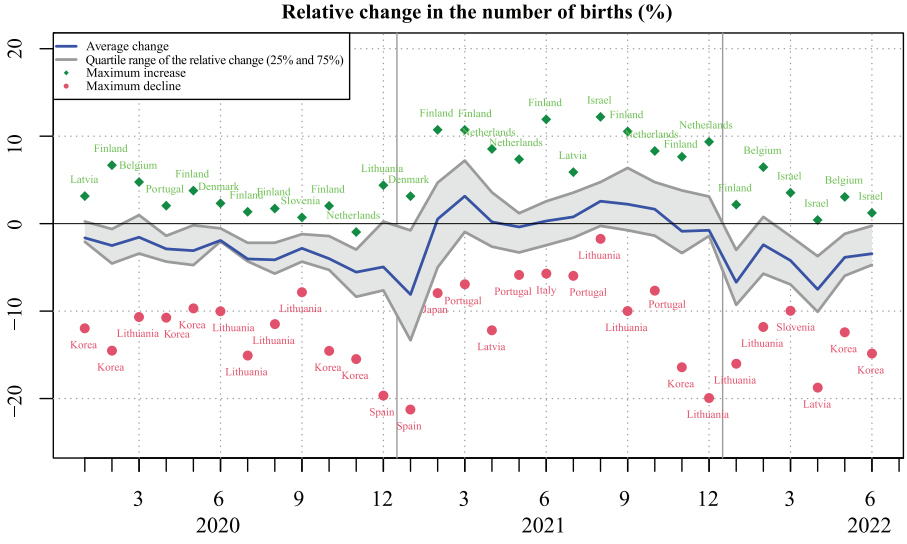



NOTES: See Figure 2. Births conceived before the pandemic, in January-October 2020 are compared with births in the same months one year earlier, in 2019. A comparison for broader regions is provided in Supplement Figure A3.

ual decline in the number of births conceived in the prepandemic period (see also Figure 3 and Figure A1 in the Supplement), the initial pandemic shock mostly accelerated these ongoing declines.

However, this early pandemic fall in the number of births was soon followed by a swift and rather unexpected recovery, with 30 out of 38 countries reporting an upswing in the number of births in March 2021, and nine countries reporting a jump by over 10 percent (Figure 3, Table A1 in the Supplement). This indicates a rise in conceptions from June to early July 2020, that is, at a time when the first wave of the pandemic ended and the associated lockdowns and restrictions eased out. Thus, within a short period of half a year, most countries saw a concerted double shift in birth trends, with a short-lived decline followed by a similarly short-lived minor baby boom. In some cases, the relative birth dynamics shifted by the order of 20 percent between January and March 2021. In the EU countries, births

**FIGURE 4 Monthly change in the number of live births compared to the same month in the prepandemic period (percent); average across 20 countries with good-quality data available until June 2022**




NOTES: see Figure 2. The figure covers all countries with data available until June 2022 except countries with data by month of registration and countries with large fluctuations in monthly births (see Table 1 for country overview and data coverage).

fell by 8 percent in January 2021 compared with the same period a year ago, but they went up by 4 percent in March 2022 (Supplement Figure A2).

Subsequently, from April 2021 until December 2021, birth trends often remained at a slightly higher level than implied by the prepandemic trajectory, although with large cross-country variation (Figures 2 and 3; Supplement Figure A1 and Table A1). Chile, South Korea, Lithuania, Portugal, and Taiwan saw sustained drops in the number of births, exceeding 4 percent on average, while Poland and Portugal reported a fall in births surpassing 8 percent. Except in Poland and Portugal, this fall was consistent with the prepandemic trend, with South Korea and Taiwan even experiencing a deceleration of their prepandemic birth decline. By contrast, Finland, the Netherlands, New Zealand, and Norway experienced sustained birth recovery, with the number of births rising by 5–7 percent on average and Belgium, Denmark, and Israel saw a rise in births by 4–5 percent on average. In the EU, births increased slightly, by 1 percent compared with the prepandemic decline by 2 percent (Supplement Figure A2). The birth recovery was stronger in Canada and the United States, where births rose by 2 percent compared with prepandemic decline by over 3 percent. When summarized across analyzed countries, the number of births remained broadly stable from April to December 2021 compared with the prepandemic period, when births declined slightly in most countries (Figure 4).

Many countries experienced positive dynamics in births in autumn 2021 (especially around September–October 2021), with the sharpest upturns by around 8 percent or more compared with the prepandemic time in Austria, Belgium, Denmark, Finland, Israel, Norway, and Switzerland (and in Hungary and Serbia in November 2021) (Supplement Figure A2). Curiously, these births were often conceived around the time of the ongoing pandemic and associated lockdowns in winter 2020–2021.

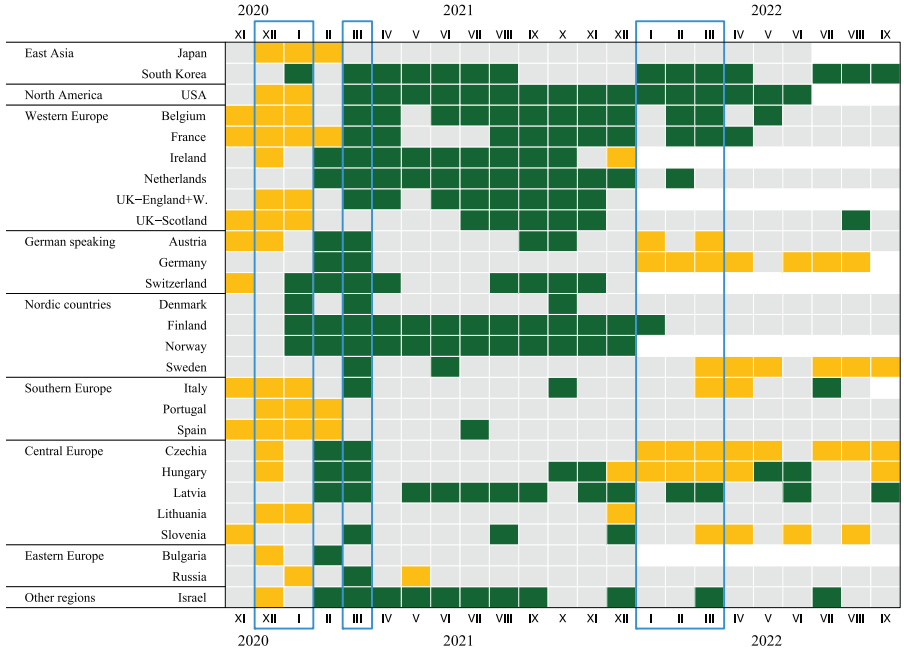
This broadly stable or positive birth dynamics lost momentum at the turn of the years 2021 and 2022. Data for the period starting in January 2022 (and by one to two months earlier in some countries including Canada, Ireland, and Hungary) suggest a sharp drop in the number of births in most countries, often exceeding the initial pandemic baby bust and signaling yet another surprising shift in pandemic birth trends. Compared with the same months before the pandemic, in 2020, the registered number of births in January–September 2022 fell on average by 15 percent in Taiwan (data only until June 2022), by 11 percent in Estonia, Lithuania, and Japan (data until June 2022), and between 5 and 10 percent in another 12 countries including Italy, Germany, Russia, South Korea, Spain, and Sweden (Figure 2; Supplement Table A1 and Figure A1). Among 28 countries with available data, only Israel showed slightly positive birth trends in 2022 and six countries (United States, Austria, Belgium, France, the Netherlands, and Serbia) experienced a stable or only slightly declining birth trajectory.

The pandemic birth dynamics varied by broader regions (Supplement Figure A3). Nordic countries (especially Finland and Norway), German-speaking countries, and Western Europe experienced, on average, the largest positive upturn in births, from a declining trend in the prepandemic period to a rising birth trend until late 2021. In North America, a negative prepandemic birth trend (about −3 percent) was followed by a broad stabilization in the number of births. By contrast, in Central and Eastern Europe and in East Asia, the pandemic did not bring a lasting shift in birth trends and in Southern Europe a prepandemic negative birth trend slightly accelerated further during the year 2021, especially in Portugal.

## Are shifts in birth trends during the pandemic significant?

Changes and fluctuations in births occur also under normal circumstances, unaffected by external shocks and crises. Were ups and downs in births observed during the COVID-19 pandemic qualitatively different from their usual variation? Our analysis of 27 countries shows that in most of them pandemic birth trends since November 2020 indeed significantly differed from the projection based on prepandemic trends until October 2020 (Figure 5 and Figure A6 in Supplement Appendix). The initial three months of the pandemic saw the observed number of births falling below the projected

**FIGURE 5 Birth dynamics during the COVID-19 pandemic: significant differences between projected and actual births in November 2020–September 2022 (based on a 90% confidence interval). Months with significantly higher observed births are marked in green, and months with significantly lower observed births are marked in orange**




NOTES: Projection computed from prepandemic birth trends (until October 2020, that is, covering births conceived prior to the pandemic) and based on a seasonal ARIMA model. Blue frames mark three distinct periods with sudden changes in birth dynamics. Gray fields show months with no significant change from the projected trends; white fields mark months with missing data.

births (using a 90 percent confidence interval) in many countries, with 15 countries experiencing a statistically significant downturn in December 2020 and 11 in January 2021. No country experienced a significant rise in births in the first two months, November–December 2020. Also in line with the descriptive analysis above, birth trends reversed in February–March 2021, with 20 countries observing a significant upturn in births in March (and no country seeing a significant decline).

Subsequently, from April to December 2021—and especially in August–October 2021—the observed number of births in many countries continued exceeding the 90 percent range of the projected births. Only Russia had a short spell of significantly fewer births in the period until November 2021. The United States, four Western European countries and regions (Belgium, Ireland, the Netherlands, and England and Wales in the United Kingdom), two Nordic countries (Finland and Norway), Latvia, and Israel reported significantly higher than predicted number of births for at least eight months during the pandemic. In 2022, this balance changed, with

only a few countries observing higher than expected number of births for at least four months between January and September (South Korea, United States, Belgium, and Latvia) and Czechia, Germany, Hungary, Slovenia, and Sweden reporting a significant decline against the projected trend for at least four months. As the confidence interval of the projected number of births widened over time, observed births in most countries remained within the projected interval in 2022. This could, however, be also interpreted as a signal that the birth trajectory returned to the (mostly declining) prepandemic trend.

On balance, the comparison of the projected and the observed birth trends confirms that the first year of the pandemic was frequently associated with an upturn in the number of births, which was in some countries more pronounced than suggested by the descriptive analysis.

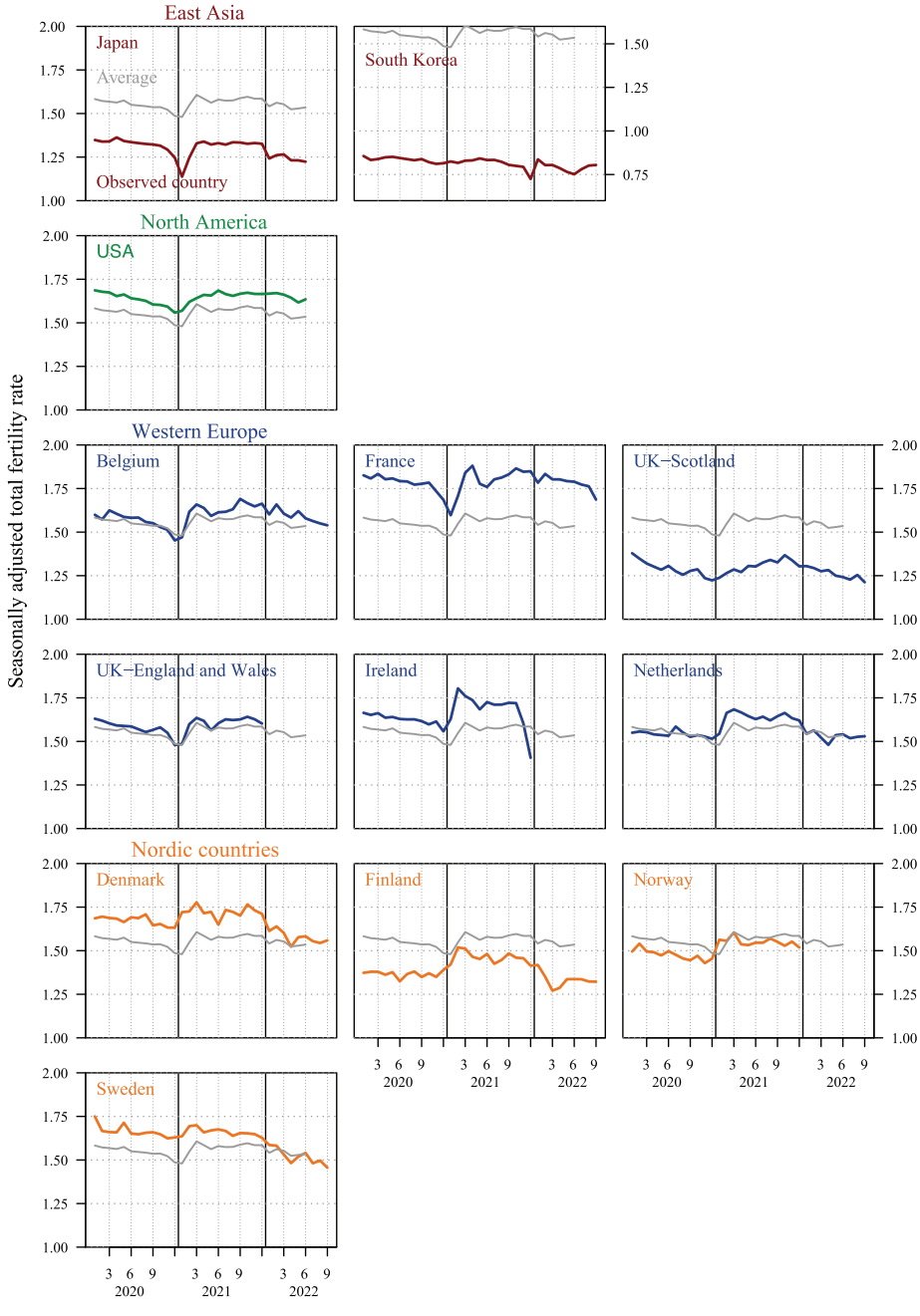
## Pandemic shifts in the estimated TFR

Changes in the estimated monthly TFR in 27 countries are consistent with the observations based on monthly birth trends. Our data reveal relatively large swings in period fertility rates after October 2020 (Figure 6). In many countries, the TFR dropped sharply in December 2020 and January 2021 (Figure 6, Supplement Figure A4 and Table A2). Spain experienced the steepest relative and absolute drops in the TFR in October–December 2020, from 1.20 to an extreme low of 0.99. Nine countries saw their TFRs falling by 0.10 or more between October 2020 and December 2020 or January 2021. The TFR in Italy, Japan, Portugal, and Scotland temporarily fell below 1.3. In most of the "higher-fertility" countries, the TFR also fell substantially, reaching a trough in December 2020–January 2021, when only the high-fertility Israel and Czechia reached a TFR above 1.7.

However, this downturn was mostly short-lived, followed by an upswing in February–March 2021. From March 2021 to December 2021, the TFR in most countries exceeded its prepandemic levels, although with some fluctuations and considerable cross-country variation. In Japan, the TFR returned to its prepandemic level of 1.36, after a brief fall to 1.18 in January 2021.

The jump in the TFR between January and March 2021 was often larger than its preceding drop. It took place in almost all analyzed countries (South Korea is the main exception), including countries that did not experience its short-lived fall such as Germany and the Netherlands. In Belgium, Ireland, France, Italy, Spain, and the United States, the TFR upswing was nearing 0.2 in absolute terms. In the EU, based on the data for 17 countries, the TFR fell from 1.53 in the prepandemic period to 1.46 in December 2020 and then displayed a quick recovery, reaching 1.60 in March 2021 (Figure 7).

**FIGURE 6 Estimated TFR by month, January 2020–September 2022. All analyzed countries and regions with available data are grouped by broader regions and compared with average TFR across 22 countries with available data until June 2022**




NOTES: See the section on Data, methods, and indicators for the methodology behind the presented monthly TFR estimates. The average for all countries covers all 22 countries with available monthly TFR estimates and with the data covered at least until June 2022 (see Table 1). It is computed as the TFR weighted by the number of births across the countries covered.

**FIGURE 6 (continued)**

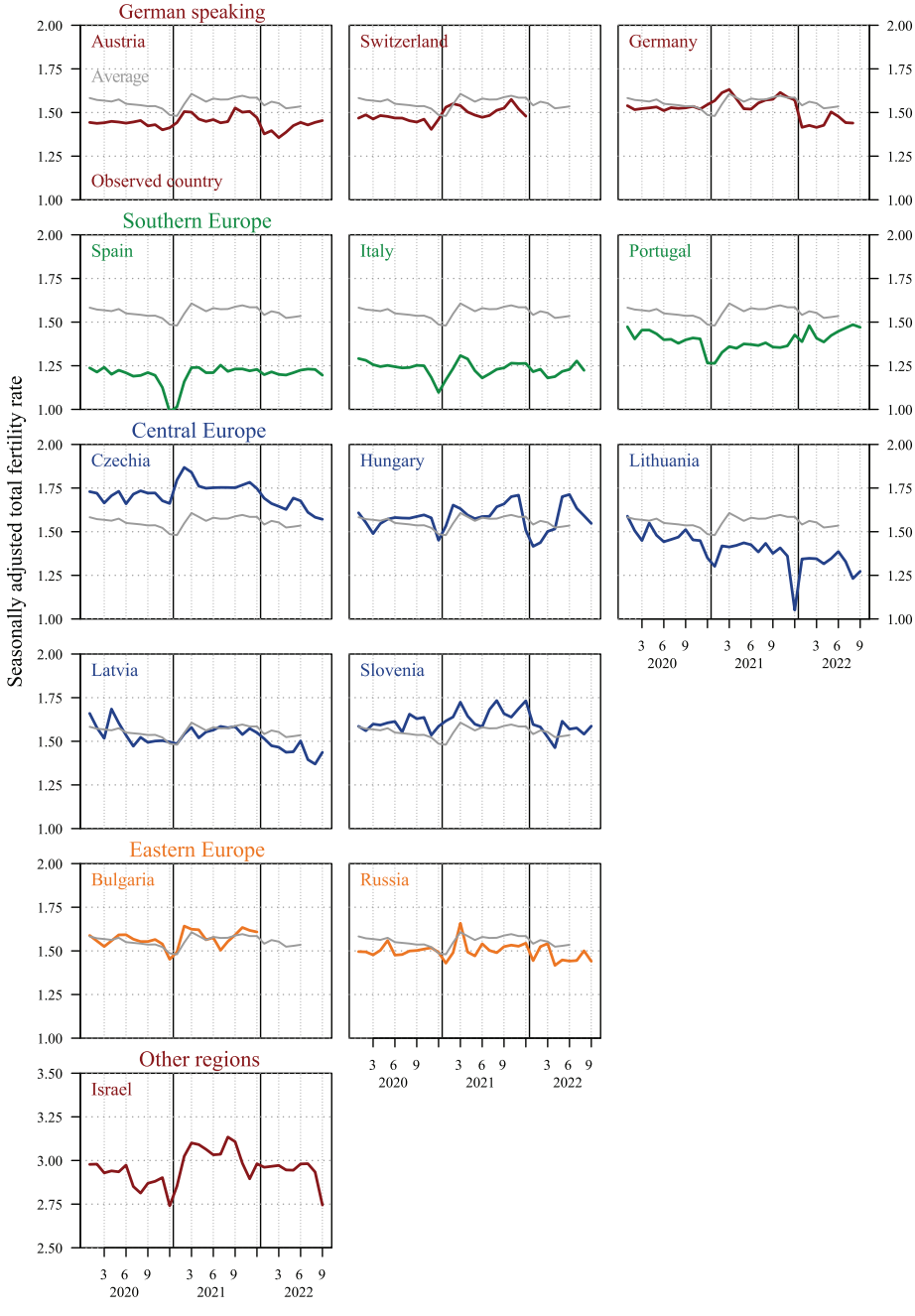
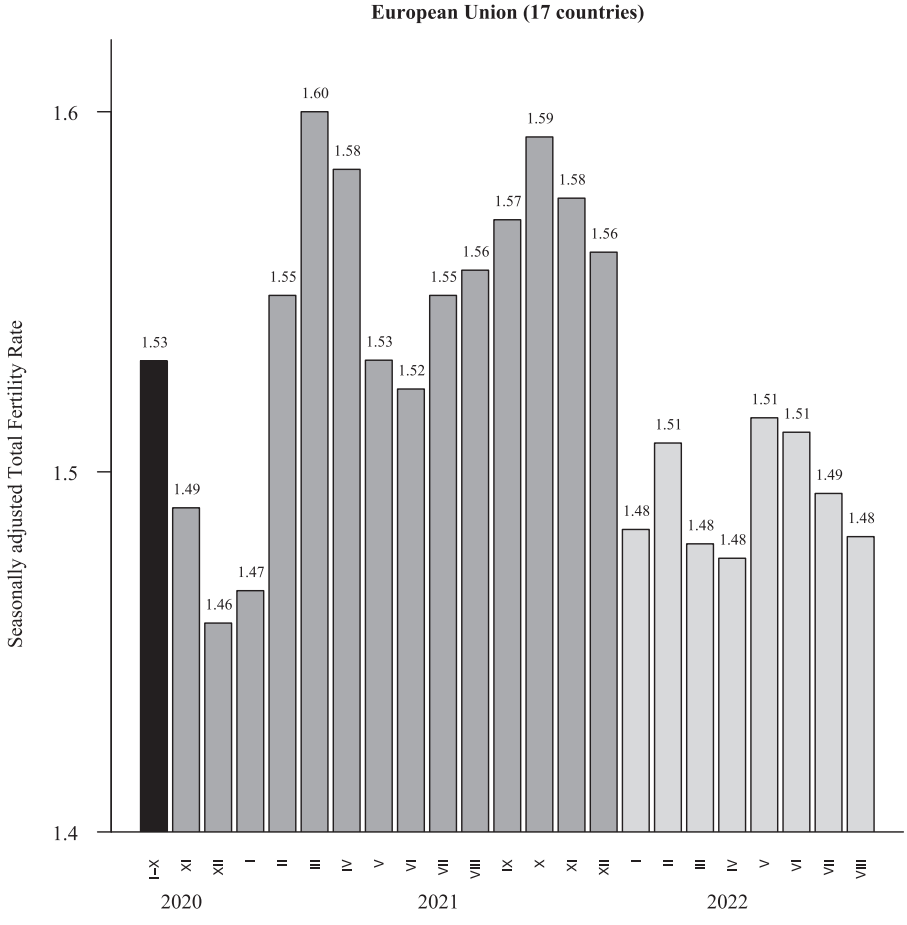


**FIGURE 7 Estimated monthly TFR and monthly number of births in the EU, September 2020–August 2022 (based on 17 countries with available estimates until August 2022)**




Most recently, available data from January to September 2022 show a drop in the TFR in most countries, averaging or exceeding 0.1 in Israel, Germany, Denmark, Finland, Sweden, Czechia, Hungary, Latvia, and Slovenia when compared with April–December 2021. Only Portugal shows a clear upward trend in the TFR (Figure 6). In the EU (17 countries), estimated TFR fell from 1.59 in October 2021 to 1.48–1.51 in January–August 2022, that is, below the prepandemic average of 1.53 during January–October 2020 (Figure 7).

As in the case of longer-term birth trends, the prepandemic TFR (in January–October 2020) does not differ much from the average pandemic-era TFR between December 2020 and December 2021 in most countries. Only in nine out of 27 countries and regions examined in Figure A4 (Supplement) did the absolute TFR difference between the two periods

exceed 0.05, with Portugal and Lithuania recording the most persistent pandemic drop in fertility and Belgium, Czechia, Finland, Ireland, the Netherlands, Norway, and Slovenia displaying a small fertility upswing. The broad stability in TFR was even more apparent when examining TFR trends in wider regions (Supplement Figure A5).

## Discussion

The coronavirus pandemic resulted in distinct short-term shifts in births and fertility rates, with ups and downs proceeding in sync across most of the analyzed countries, although with varying magnitude. When seen from a longer-term perspective of the first two pandemic years, most of the analyzed countries experienced neither a sustained baby boom nor a protracted baby bust during the first two pandemic years. This might seem surprising considering the wide-ranging impact of COVID-19 on individuals and societies, especially during the first pandemic year. In 19 out of the 38 analyzed countries, births between December 2020 and December 2021 increased or declined by less than 3 percent on average compared with the births until October 2020, conceived prior to the pandemic. This is comparable with birth fluctuations in years that are not affected by external or policy-induced shocks. The data for 2022 show a sharper downward trend in most countries, but the observed numbers of births still often remain in line with the projected trends based on prepandemic birth dynamics until October 2020.

Similar conclusions are reached when analyzing monthly changes in period TFRs. If any change could be discerned from the data for the first pandemic year, it is a slight improvement in birth dynamics, with a stabilization or a slight rise in the TFR in most countries after the initial pandemic blip. The second pandemic year then brought an unexpected "return" to a downward fertility trajectory in 2022. A comparison of projected and observed monthly births further confirmed that many countries saw a significantly higher than expected number of births, especially between March and December 2021. The pandemic birth trends varied by broader regions, with the Nordic countries (especially Finland and Norway), German–speaking countries, and Western Europe (especially Belgium, Ireland, and the Netherlands), alongside New Zealand, and Israel, experiencing the largest upturn in births and Southern Europe (especially Portugal), Poland, Japan, and Chile showing an acceleration of the previous birth decline. Countries and regions experiencing positive birth dynamics during the pandemic have more generous and comprehensive family policies, more stable economies, and higher level of trust. Arguably, rapid and robust government interventions to support the economy not only helped saving jobs and provided a financial cushion for many families but also contributed to reducing uncertainty, making it easier for many people to plan a(nother) child. Both labor market recovery and increased household spending since mid–2020 were

associated with the rebound in birth rates (e.g., Kearney and Levine 2022 for the United States). Despite health emergency, relatively many couples were ready to have a child during the later phases of the pandemic if they positively evaluated their economic situation and income prospects (e.g., Luppi, Arpino, and Rosina 2022 for Italy).

The pandemic birth trends are remarkable for their short-term dynamics, with concerted falls and upturns in births observed in most countries. Within a short period between November 2020 and March 2021, most countries saw a roller-coaster shift, with a brief birth decline followed by a minor baby boom. During the downturn phase in December 2020–January 2021, many countries, including Japan and Spain, reached the lowest period TFR on record. A broad stabilization or a slight rise in fertility during the later part of 2021 was interrupted by a new downturn in births in most countries starting in January 2022 and often persisting until summer 2022, the most recent period covered here.

Many of these trends were unexpected. The minor baby bust around January 2021 was often less pronounced than anticipated (e.g., Wilde, Chen, and Lohmann 2020) and weaker than indicated in the surveys of fertility intentions conducted during 2020 (e.g., Lindberg et al. 2020; Luppi, Arpino, and Rosina 2020). The birth recovery in March 2021 was also rather unexpected, as was the generally positive trend in births later in 2021. The next reversal, the fertility decline in early 2022, was also unforeseen, and was especially sharp in some countries that did not experience significant birth declines in the early stages of the pandemic, including Czechia, Finland, Germany, and Sweden.

Our research demonstrates the value of studying short-term fertility trends and fluctuations in uncertain times. The sharp changes in birth trends during the pandemic would remain hidden if we used conventional data collected for calendar years. We have not conducted a formal analysis of the factors involved in the observed ups and downs in pandemic fertility. By the way of speculation, we offer a few insights about the period trends.

The fall in fertility in December 2020 and January 2021 is clearly linked with conceptions in the first few months of the pandemic, likely driven by the new experience of lockdowns, expected economic crisis, and the elevated uncertainty about the future. Although the fall in births was milder than expected, it is unclear whether birth trends were also partly propped up by more unplanned pregnancies due to lower access to contraception and abortion in some countries. The birth recovery around March 2021 is linked with the ending of the first wave of the pandemic and the associated lockdowns as well as better-than-expected economic and labor market trends following massive government interventions. Possibly, some couples concluded that the pandemic was over and decided to have a baby.

Subsequent relatively positive birth trends during 2021 occurred in the context of the ongoing pandemic. Peaks in births observed in some countries in autumn 2021 (especially in September–October) often coincide with the conceptions during new waves of infections and lockdowns in winter 2020. It seems that the protracted pandemic created relatively favorable conditions for procreation among some couples. Based on the existing research, births often took place among women and couples in a more secure situation (in peak childbearing years, with one or two children, with stable jobs and higher education; for example, Lappegård et al. 2023; Zeman and Sobotka 2022) or among individuals who often experienced an improvement in their economic conditions due to government interventions to prop up the economy and who could more easily work from home, for example, in the United States (Bailey, Bart, and Lang 2022; Bailey, Currie, and Schwandt 2022) and in Finland (Nisén et al. 2022). Possibly, fewer career opportunities and limitations in social contacts and leisure activities also contributed to the decision among some couples to have a(nother) child (Berrington et al. 2022).

Finally, the most recent downturn in births in early 2022 is linked with conceptions in spring and summer 2021, when vaccination effort was in full swing and lockdowns and mobility restrictions were being phased out[8] (see Bujard and Andersson 2022 for the analysis of fertility decline in Germany and Sweden). This latest drop in fertility is arguably the least expected trend as a conventional expectation would be of a late-pandemic birth recovery. We offer three mutually nonexclusive explanations of the fertility downturn, which are likely to have different weight across countries. First, the 2022 fall in births may be seen as a return to the prepandemic trend of declining fertility. Indeed, the observed birth trends in many countries during 2022 often follow closely our projections based on prepandemic trends until October 2020. They fall neatly within the projected 90 percent interval in Denmark, Finland, Japan, the Netherlands, Portugal, Russia, Spain, and in Scotland (supplement Figure A6). Second, and likely related explanation, the resumption of more busy work and social life might have paradoxically put a break on fertility plans and contributed to a new wave of birth postponement. In addition, earlier pandemic disruptions to dating, partnering, socializing, as well as marriage limitations, have possibly contributed to fewer people finding a partner and starting a family. Third, the vaccination drive might have motivated some women to temporarily avoid pregnancy due to the fear of possible side effects and of potential negative impact of vaccine on fecundity (a factor also discussed by Bujard and Andersson 2022).

Is the era of pandemic roller-coaster fertility over or should we expect yet more shifts in birth trends in the coming months and years? The coronavirus pandemic may continue casting a long shadow on the lives of many people and families. Overall, we expect that fertility rates are likely to

be depressed in the future, possibly, with new lows to be reached in many countries. The pandemic disruptions to social and intimate life have affected especially the young adults and may negatively impact family formation in the coming years. In 2022, the global economy experienced new headwinds, which also drove inflation to high levels, thus squeezing the budgets of many families and making housing even less affordable. Pandemic-related government interventions to prop up economy and labor markets were being phased out. Finally, and unrelated to the pandemic, the war in Ukraine has accelerated the negative economic trends, causing disruptions in energy markets, and heightening the perceptions of insecurity about the future. This insecurity is further aggravated by the climate crisis, which resonates especially strongly among younger people. Together, these factors are creating highly uncertain conditions for reproduction.

## Acknowledgments

We gratefully acknowledge the contribution of colleagues from the Max Planck Institute for Demographic Research in Rostock (Germany) who helped setting up the STFF data series under the Human Fertility Database and who have been engaged with the data collection and publication. Special thanks go to Karolin Kubisch and Malte Künzel.

## Data availability

Monthly data on live births and estimated monthly TFRs analyzed in this study are available in the Short-Term Fertility Fluctuations (STFF) data series (https://www.humanfertility.org/Data/STFF), which is incorporated in the Human Fertility Database (STFF 2023a). Note that this data series is being regularly updated and subject to revisions and adjustments, especially of the most recent data. Detailed information about data for individual countries is provided in the STFF Metadata document (STFF 2023b). Data, methods, and data quality issues are described in detail in STFF Methodological Note (Jdanov et al. 2022).

## Note

1 Throughout the text, we refer for simplicity to 38 countries rather than referring to 38 countries and regions or to 38 datasets covering 37 countries.

2 We excluded data for Romania, where different and mutually incompatible series of monthly birth data have been published over time. Data for Greece were excluded as they did not cover the whole year 2021 as of January 2023.

3 This assumption excludes preterm births and the possibility that some women, who were pregnant at the time of the COVID-19 outbreak, might have decided to undergo an abortion in the early stage of the pandemic.

4 We considered different specifications of measuring relative changes in the number of births during the pandemic, but none of them yielded satisfactory results. One op-

tion of maintaining a fixed one-year time gap (measuring year-to-year change) implied that our results for December 2021–March 2022 and later months were compared with the "early pandemic births" in December 2020 – March 2021, when birth trends fluctuated strongly and thus also the baseline was shifting rapidly. Another option of using seasonally- and calendar-adjusted monthly births to compare month-to-month changes in births during the pandemic would limit the number of datasets and countries available (see also the next subsection on estimating TFR trends).

5 We also adjust the data for the effect of leap year 2020, when February was one day longer (29 days) than in the years 2019 and 2021.

6 The seasonal adjustment is organized in two steps: (1) estimating a seasonal ARIMA model considering weekday variations of births (calendar adjustment) and potential outliers; and (2) applying a seasonal filter to the calendar/outlier adjusted series. We use the X11 seasonal filter, which is a semiparametric method based on moving averages. The software includes various checks on the ARIMA model selection as well as a wide range of diagnostic checks on model fit and the quality of the seasonal adjustment (for detailed information, see U.S. Census Bureau, 2022). As we limited the set of countries for which the seasonal adjustment was performed, the single models generally passed very well the quality and diagnostic checks.

7 Other base periods were considered as well. However, using the relatively short period of the last five years provided most robust results when projecting the past GFR to TFR ratios.

8 In most countries, the highest number of COVID-19 vaccinations took place between May and July 2021 (earlier in the United States, where the number of vaccinations peaked in April 2021 and in Israel, where it peaked in March 2021 (Oxford COVID-19 tracker 2022)). In parallel, indicators measuring population mobility and easing out of the lockdowns and restrictions, such as the University of Oxford's "stringency index" measuring policies restricting people's behaviour (Oxford COVID-19 tracker 2022) or a "normalcy index" by the Economist (2022), measuring mobility and people's activity outside of home show a fast trend towards fewer restrictions and higher mobility in most European countries, Canada, the United States and Israel between March and July 2021. Only East Asian countries, New Zealand and Chile did not experience a trend towards fewer restrictions and more out-of-home activities in that period.

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