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Recent trends in UK fertility and potential impacts of COVID-19

95 WORKING PAPER MARCH 2021

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FertilityTrends

Improving knowledge on population change
cpc.ac.uk
ISSN 2042-4116

UKRI Economic and Social Research Council

ABSTRACT
This paper examines the recent declines in period fertility in the constituent countries of the UK during the past decade and speculates the mechanisms through which the COVID-19 pandemic could influence childbearing in the UK. Having considered potential forces acting on individuals at different ages and family size, we might expect that the COVID-19 pandemic will depress fertility, particularly among younger people. Because fertility at all ages was declining before the onset of the pandemic, this could mean a further decline in period fertility to historically low levels for the UK. We put forward a number of scenarios to examine the possible impact of the pandemic on numbers of live births. Our projections show that for three scenarios out of four fertility is expected to decline over the next three years leading to significantly fewer births annually compared to the pre-pandemic period.

KEYWORDS
COVID-19; pandemic; fertility; baby boom; baby bust.

EDITORIAL NOTE
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ACKNOWLEDGEMENTS

This work was supported by ESRC grants ES/S009477/1 and ES/R009139/1.

The ESRC Centre for Population Change Working Paper Series is edited by Teresa McGowan.

RECENT TRENDS IN UK FERTILITY AND POTENTIAL IMPACTS OF THE COVID-19 PANDEMIC

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1. INTRODUCTION

There has been much speculation in the media about the likely impact of the COVID-19 pandemic on childbearing – will there be a baby boom or bust? (For example see Clinton, 2020; Sewell, 2020; Shaw, 2020; Hegarty, 2021; Hellen, 2021; Mercer, 2021). Many different factors affect childbearing decisions, including economic factors (Becker, 1981), attitudes and beliefs (Lesthaeghe, 1995), and the level of gender equality both outside and inside the home (McDonald, 2000; Goldscheider et al, 2015). Individuals and couples can generally decide how many children they want and when to have them, although some births are unplanned (Wellings et al., 2013). Given the complexity of the factors affecting childbearing, it is perhaps not surprising that previous predictions of future fertility in the UK have often been wrong (Hobcraft 1996; ONS, 2015). Nevertheless, predicting future numbers of births is important for planning, e.g. for maternity services, schools, and financial commitments through the welfare system. It is useful therefore to examine recent trends in birth rates and to consider the potential ways the COVID-19 pandemic could affect these, at least in the short term.

The aims of the paper are three-fold. First, we will examine fertility trends up to 2019 in the UK's constituent countries, to understand what was already happening prior to the COVID-19 pandemic. Second, we will discuss the possible impact of the COVID-19 pandemic on childbearing behaviour and outline a number of possible future scenarios for fertility rates. Third, we will use these scenarios to project the Total Fertility Rate (TFR) and the annual number of births for the period of 2021-23. This paper investigates trends in period fertility which measures the level of childbearing within a single calendar year. The period TFR indicates the number of children a hypothetical woman would have if she experienced age specific fertility rates (ASFRs) observed in that year throughout her reproductive career (Hinde 1998). To calculate the TFR, the annual number of births to women within each five year age group is divided by the mid-year population of women in that age group, these are then multiplied by five and summed. The period TFR is influenced by both the level and the timing of births. Year on year fluctuations in births can be caused by people postponing or accelerating having a child and hence are influenced by current events, such as economic recession, or a pandemic.

1.1. THE UK IN A NORTHERN AND WESTERN EUROPEAN CONTEXT

Figure 1 shows the trend in total fertility for the constituent countries of the UK and other Northern and Western European countries (Human Fertility Database, 2021). We choose to

focus on this region of Europe because over the past few decades it has tended to have higher levels of fertility than either southern or eastern Europe (Neyer & Andersson, 2008; Goldscheider et al., 2015), and thus levels more similar to the UK. During the 1990s, fertility rates in Northern and Western Europe showed some small declines (Figure 1). However, during the early and mid-2000s, all countries experienced an increase in birth rates. This upswing in fertility came to halt in many countries following the 2008 economic recession with birth rates in many Northern and Western European countries declining from around 2009-10. Some Nordic countries – most notably Finland, and to a lesser extent, Norway have seen very substantial, and unexpected declines in period fertility (Hellstrand et al., 2020). Previously, Nordic countries were seen as examples of high fertility, made possible by family friendly policies and high gender equality (Neyer and Andersson 2008). Demographers have suggested that the recent declines in fertility rates in Nordic countries are related to real and perceived financial and labour market insecurities, together with declines in welfare support which were enacted after the global recession of the late 2000s (Comoli et al., 2020; Matysiak et al., 2021). Welfare retrenchment may have had a similar effect on the postponement of transitions to adulthood in the UK (Berrington et al., 2017).

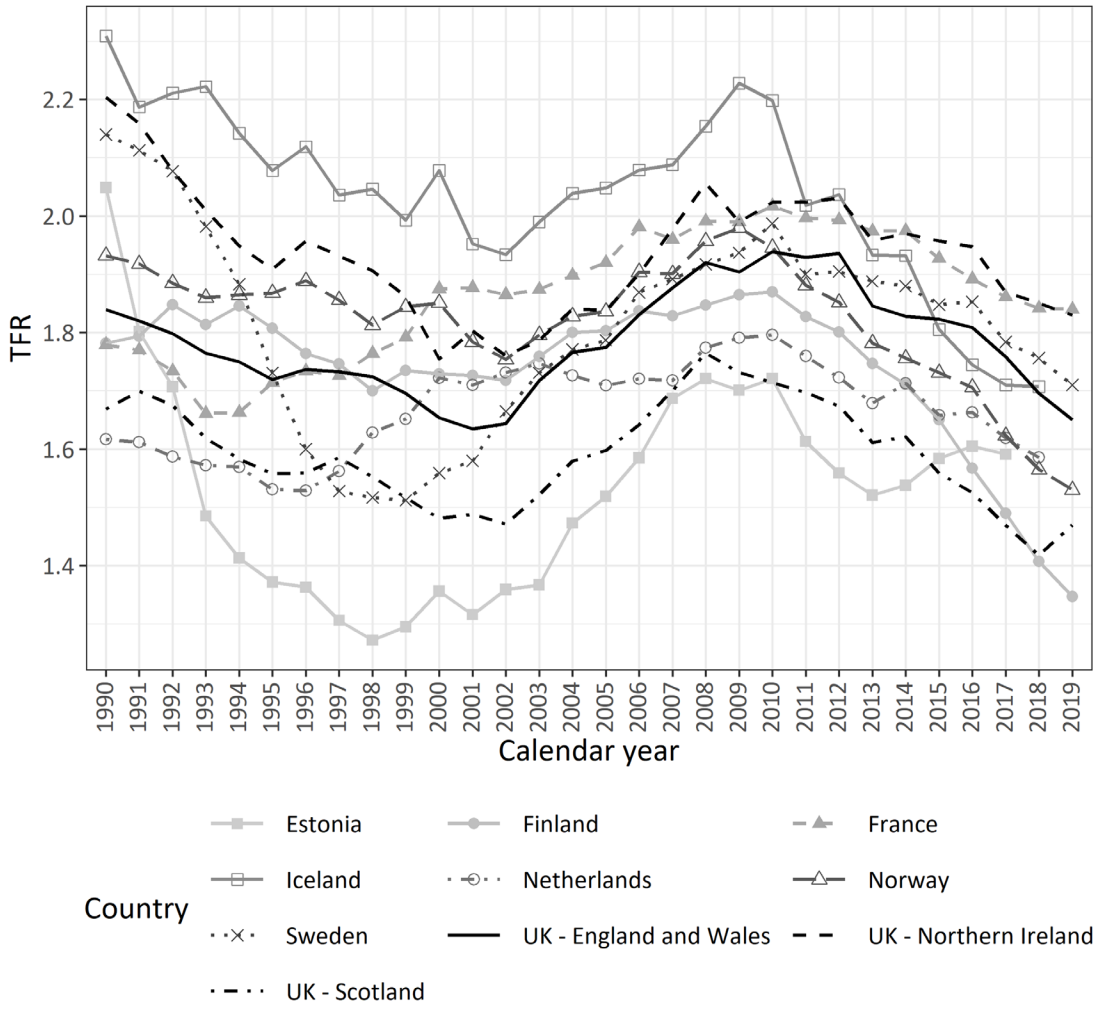

Figure 1: Trend in Total Fertility Rate, Selected North and West European Countries, 1990-2019

Source: HFD (2021)

2. FERTILITY DIFFERENCES BETWEEN THE CONSTITUENT COUNTRIES OF THE UK

2.1. TRENDS IN THE TOTAL FERTILITY RATE

During the 1990s, fertility rates in Northern Ireland fell significantly to become more in line with trends in England and Wales[1] , albeit at a higher level. In 2013, the TFR in Northern Ireland was around 2 births per woman, as compared to 1.8 in England and Wales. Fertility rates in Scotland started to diverge from England and Wales in the 1980s and by 2000, the TFR in Scotland was just under 1.5 births per woman (as compared to 1.7 for England and Wales).

[1] Fertility rates are published separately for Scotland and Northern Ireland, but those for England and Wales are published together (ONS, 2020a).

Scotland, like all the UK countries, experienced an increase in birth rates from 2000 to 2008, followed by an earlier and steeper decline, such that by 2019 the TFR was just below 1.5. The key point to note, however, was that prior to the COVID-19 pandemic, fertility rates were already declining in all countries of the UK and by 2019 were already at some of the lowest levels ever seen in the UK.

2.2. FERTILITY TRENDS IN DIFFERENT AGE GROUPS

Figure 2 shows the ASFRs from 2000 to 2019 in the constituent countries of the UK (ONS, 2020a; NRS, 2020; NISRA, 2021a). Childbearing rates are highest among women in their late twenties and early thirties and lowest among those aged 40-44 and those aged under 20. The trends in ASFRs over the past two decades are similar across the UK, apart from an earlier decline in fertility at ages 25 and over in Scotland. During the first decade of the 21st century, childbearing rates increased among all age groups, apart from those under 20 who saw a dramatic decline (Heap et al., 2020). However, by 2010, fertility rates among those in their early twenties had started to decline, and by 2012, fertility among those in their late twenties had also started to fall.

Fertility rates among those in their thirties continued to slowly increase until around 2015 (2011 in Scotland). This increase in fertility among women in their thirties may have resulted from the recuperation of births that had been postponed (Berrington et al., 2015a), or could be the result of some women having a higher total number of births. In the last few years, fertility rates at ages 35 and over have started to decline. These trends may be due to fewer women having higher order births or could (also) reflect the end of the postponement of births from the twenties to thirties.

Any potential impact of the COVID-19 pandemic on fertility (discussed in the next section) needs to be seen in the context of declining ASFRs. If the impact of COVID-19 is confined to teenagers and/or women aged over 40 then the overall effect on the TFR and number of births will be small, given that childbearing rates at these ages are already low. A more significant impact on the TFR will be seen if it is women in the peak childbearing years e.g. those aged 25-34 who are affected.

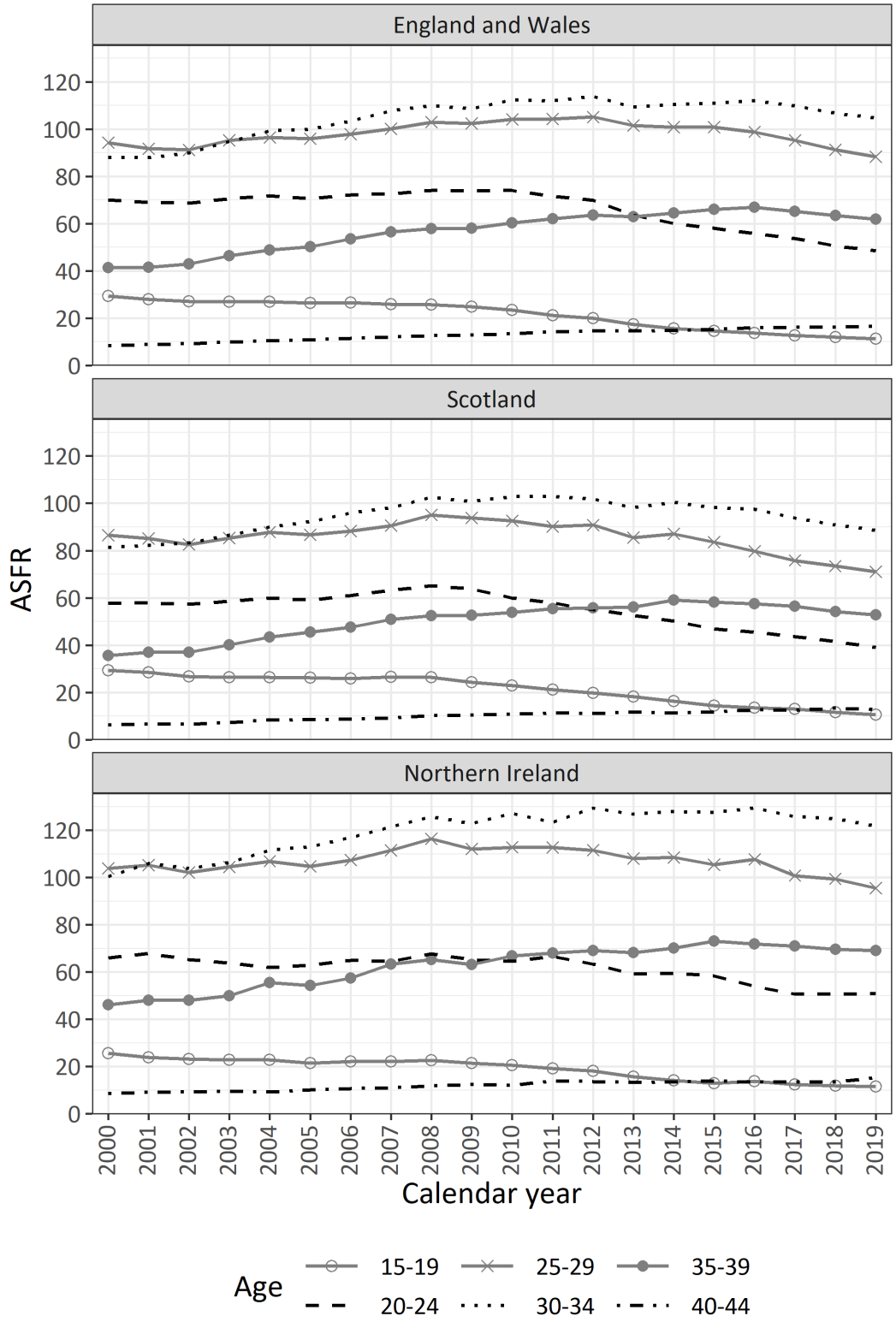

Figure 2: Trend in Age-Specific Fertility Rates for the UK countries, 2000-2019

Sources: ONS (2020a), NRS (2020), NISRA (2021a).

3. POTENTIAL MECHANISMS THROUGH WHICH THE COVID-19 PANDEMIC COULD IMPACT FERTILITY IN THE UK

A number of researchers have suggested that the overall impact of COVID-19 on fertility rates is likely to be negative in high income countries, largely due to increased social and economic uncertainty, and practical concerns such as access to hospitals and other social support during pregnancy and parenthood (See for example Aassve et al., 2020; Lappegård et al., 2020). Information about fertility intentions from surveys carried out in 2020 also provide some tentative support to this argument for high income countries (Lindberg, 2021; Luppi et al., 2021). In the UK, it was reported that fertility plans were most frequently abandoned by those individuals that expected the worst impact of the crisis on their future income (Luppi et al., 2021). Other evidence from social media also points to a possible fertility decline: Wilde and colleagues (2020) found a reduction in google searches in the US for keywords relating to pregnancy suggesting a possible decline in fertility.

Currently, little official data, for example from antenatal booking services, pregnancy scans, abortion notifications, or births have been published at the national level to provide an early indication of the impact of the COVID-19 pandemic on fertility rates in the UK. A freedom of information request elicited from 80 NHS trusts in England show the number of 12-week scans carried out in 2020 fell by 4% on 2019 and 5% on 2018 (Mercer, 2021). However, these data cover the whole of 2020, including the period prior to the start of lockdown and refer to absolute numbers rather than rates which take account of the size of the population of women of reproductive age. Thus, at this point we can only hypothesise *what might happen*. Although the timing and extent of the COVID-19 pandemic and lockdown rules differed slightly between the nations of the UK, the application of rules and impacts on daily life were similar and we see no reason *a priori* to expect a different fertility response in the devolved nations.

Because decisions about childbearing are often made sequentially (Namboodiri, 1972), it is justified to consider separately the potential impact of COVID-19 on childless women in addition to mothers. Moreover, given that the reproductive life span is fixed, younger women have more opportunity to delay their childbearing in response to uncertainties than older women. Parents of children have faced particular challenges during the pandemic, especially when they have had to take on childcare duties due to their children not being able to attend

nurseries and schools. Women, in particular have borne the brunt of this additional childcare and home schooling work (Anders et al., 2020). Given that it is women who tend to have a greater control over their childbearing, this is likely to have an impact on fertility. Thus, in Table 1 we put forward hypotheses about the possible ways in which the COVID-19 pandemic might affect fertility according to age and birth parity. Green upward arrows refer to fertility enhancing effects, whilst red downward arrows indicate a likely downward pressure on fertility. The number of arrows indicates the strength of the force. If no arrow is present, then we do not expect any impact on fertility. These hypotheses should be interpreted as 'informed assumptions' which we will later use to derive some possible scenarios for future fertility trends in the UK. Next, we briefly explain each mechanism.

3.1. ACCESS TO CONTRACEPTION AND ABORTION SERVICES

The COVID-19 pandemic has made access to contraceptives, or at least the perceived access, more difficult (APPGSRH, 2020). Individuals may have been reluctant to contact their healthcare provider at times when the NHS was thought to be "overwhelmed". Many reproductive health appointments were switched from face-to-face to on-line or telephone appointments. Thus, difficulties in accessing contraception have been especially the case for methods which involve intervention by a health practitioner (e.g. Long-Acting Reversible Contraceptives such as Intra-Uterine Devices and Contraceptive Implants). It is unclear how the pandemic has affected the use of emergency contraception and abortion rates, although COVID-19 has driven a shift from surgical to medical abortion. Abortion regulations in England, Wales and Scotland were amended to allow home administration of mifepristone and misoprostol (Bateson et al., 2020). However, teenagers especially may have been put off contacting health services during the pandemic when they have realised they are (at risk of becoming, or are currently) pregnant. As a result of these changes, we would expect an upward trend in birth rates, particularly among teenagers who may be less confident about accessing services.

3.2. FEWER OPPORTUNITIES TO SOCIALISE OUTSIDE THE HOME

The first UK national lockdown in March 2020 encouraged individuals to remain at home. Restaurants, pubs, bars, nightclubs were closed. There was therefore much less opportunity for people to socialise and meet new partners, or to have sex with existing non-resident partners. Dating thus moved online, with less physical contact. Many of those already in a non-resident couple were forced to only meet each other out of doors since overnight stays were banned.

Subsequently, in June 2020 rules were amended to allow support bubbles for those living alone – this meant that couples who lived apart could stay overnight with each other for the first time during the lockdown. However, the rules only covered the situation where at least one of them lived alone. Therefore, for partnerships where both partners lived in shared, multi-person households, there remained difficult decisions to make as to which of the partners was allowed to stay over (Mason, 2020).

From July 2020, the UK lockdown eased. Whilst nightclubs remained closed, other venues were open – so we might have expected opportunities for socialising and meeting dates increased. In September, students returned to further and higher education, but by December 2020 the second lockdown had started and students were encouraged to return to their parental home. We hypothesise that the impact of the national lockdowns would have the greatest impact on young people's sexual activity as they are the most likely not to be already living with their partner. It is also likely to have a greater effect on childless individuals as compared to those who already had a child as these are the ones most likely not to be already living with a partner.

3.3. INCREASED INTER-GENERATIONAL CO-RESIDENCE, LESS TIME ALONE FOR ADULTS

Young adults have been particularly affected by the economic consequences of the pandemic (Gustafsson, 2020). Young people facing job loss and economic insecurity often return to live with their parent(s) (Stone et al., 2014) and appear to have done so in response to the pandemic (Evandrou et al., 2021). During the national lockdowns many students in higher education also returned from their term time addresses to their parental home. Young people were thus removed from the usual levels of social contact that they would normally be experiencing with their peers and the opportunities for having sex were greatly diminished. For parents, the "stay at home" order meant that there would have been less privacy and alone time in the home. Thus, we might expect reductions in sexual activity among older couples as well.

3.4. DIFFICULTIES IN FINDING AND MOVING TO A NEW HOME

There is a reciprocal relationship between housing and fertility. Couples may change their housing situation in anticipation of or resulting from having children or they may decide to have or expand their family when they have secured appropriate housing (Kulu and

Washbrook, 2014). Couples who are currently living apart together often want to wait until they can set up a joint home before becoming parents. Couples who are already living together and who intend to have children might prefer to move to a suitable 'family home' before parenthood. Living with parents, or insecure housing situations, for example privately rented accommodation, are generally associated with lower levels of childbearing (Tocchioni et al., 2019). Thus, factors affecting the ability of couples to set up home together would likely relate to a decrease in fertility.

Whilst it has been legal to move home during the pandemic, the process of searching for and moving into a new home has been made more difficult. For example, many viewings have taken place on-line rather than in-person. The Government announced in the summer of 2020 that it would provide financial support to the housing market through the stamp duty holiday whereby the threshold at which stamp duty was payable was raised to £500,000 in England and Northern Ireland, while the thresholds for Scotland and Wales were £250,000. However, access to the housing market remained difficult with average house prices in the UK increased by 8.5% in the year to December 2020 (ONS, 2021). In April and May 2020, the number of residential house sales fell by half as compared to the previous year (ONS, 2021), although residential transactions increased during subsequent months due to pent up demand. Thus, we hypothesise that difficulties in housing transitions will be associated with a decrease in fertility.

3.5. MORE OPPORTUNITY FOR SEX AMONG THOSE WHO MOVED IN TOGETHER AT START OF LOCKDOWN

Anecdotal evidence suggests that many couples decided to move in together at the start of the lockdown in March 2020 as a way of being able to continue their relationship. Indeed, Government advisors even suggested that couples move in together (Greig, 2020). The extent to which this phenomenon took place, and the extra co-residential partnerships that occurred over and above that which would have happened anyway is difficult to measure. Moreover, other anecdotal evidence suggests that some young adults who were living in the parental home moved in with their boyfriend/girlfriend but continued to live with one set of parents (often alternating between the two sets). It is likely that for many young people, there was a swifter transition from girlfriend/boyfriend to co-residential partner than would otherwise be the case. It is feasible that this would have exerted an upward pressure on fertility rates.

3.6. CONCERNS REGARDING HEALTH RISKS OF PREGNANCY / ACCESS FOR MALE PARTNERS TO HOSPITAL

Couples may decide to postpone having a baby due to concerns about the possible risks of COVID-19 on the pregnancy. At the start of the pandemic there was little concrete evidence on the potential impacts of COVID-19 on pregnancies but couples may well have been concerned. Later on, as evidence began to emerge it was suggested by the Royal College of Obstetricians and Gynaecologists (RCOG) that pregnant women who catch COVID-19 may be at increased risk of becoming severely unwell compared to non-pregnant women (RCOG, (2021). Couples may have been put off trying for a baby due to the fear of an 'overwhelmed' healthcare system (Lockett, 2020), or the possible exposure to COVID-19 that they themselves would have as a result of routine check-ups during pregnancy, and hospital stays during the birth of their child. In the UK, during the first lockdown, many fathers were unable to be present during important antenatal appointments including scans and were not able to witness the birth of their child (Schraer, 2020). For all of these reasons it would seem likely that women/couples of all ages and parity might postpone a planned pregnancy. Given that births to teenagers are less likely to be planned (Wellings et al., 2013), the effect on this age group may be smaller.

3.7. POSTPONED MARRIAGES

The Government-supported UK Weddings Taskforce (2021) estimates that over 200,000 weddings were postponed during 2020. Whilst almost half of all births take place in the UK outside of marriage, there remains a strong inter-connection between marriage and entry into parenthood, particularly for those from socio-economically advantaged backgrounds (Berrington et al., 2015b). Couples often postpone marriage until they can afford a "proper wedding" and the importance of marriage as a public statement of commitment continues (Berrington et al., 2015b). During the COVID-19 pandemic, large weddings have not been permitted: venues and vendors shut down for business, and many couples will have postponed their wedding plans at least once. We hypothesise therefore that the inability to hold large weddings will have a downward effect on fertility.

3.8. ISOLATION FROM SOCIAL SUPPORT, IMPACT OF COVID-RELATED ILLNESS AMONG OLDER RELATIVES

Many lobby groups including the NSPCC (2020) have highlighted a lack of support for new parents during the pandemic. Prospective parents may be concerned about the lack of access to

healthcare, including perinatal services and home visitors during COVID-19. They may also be concerned about the lack of social support from family and friends due to lockdown rules and travel restrictions for migrants with family overseas. New parents often rely on the help of other family members whilst they care for a newborn, and more generally the pandemic has meant that less informal childcare is available. Whilst on-line support, such as trained peer supporters and breastfeeding councillors has been available, there is also an awareness that much of the community support for new parents (antenatal peer groups, public parent and baby groups, opportunities for informal meetups) are not possible at this time. For all of these reasons we would expect there to be a downward pressure on fertility rates. The COVID-19 pandemic increased death rates at the oldest ages. Many individuals have experienced the loss of an elderly family member. The impact of such tragic events on childbearing patterns is difficult to predict. The relationship is likely to be complex, possibly mediated via its effect on individuals' mood and anxiety, financial and housing implications of the death.

3.9. INCREASED ECONOMIC UNCERTAINTY – AFFORDABILITY OF CHILDREN

Micro-economic theories of the family would suggest that reductions in income would result in reduced demand for children due to their direct costs, e.g. for clothes, food, equipment (Becker, 1981). The economic consequences of the COVID-19 pandemic have been severe, particularly for those already vulnerable. Lower-paid workers are more likely than those on higher pay to have been furloughed or lost their jobs (Handscomb & Judge, 2020). A significant minority of those on the lowest incomes are likely to have had to borrow money in order to meet basic needs such as food and heating. Young people were particularly likely to lose their jobs during the first lockdown as industries that traditionally employ younger staff such as pubs, restaurants, hotels and leisure centres closed their doors. According to Gustafsson (2020), one-third of 18-24-year-old employees (excluding students) lost jobs or were furloughed, compared to one-in six prime-age adults. In addition to these immediate financial implications of COVID-19, the pandemic has also increased economic uncertainties as to what the future might hold in terms of a financial recovery and job prospects. Concerns about finding and keeping a well-paid job are likely to have been magnified by the pandemic and are likely to be associated with a delay to entry into parenthood, or a delay in having an additional child due to worries about the costs. Evidence from previous economic recessions highlights the fertility postponing effects, particularly for young childless adults (Goldstein et al., 2013).

3.10. INCREASED ECONOMIC UNCERTAINTY – REDUCED OPPORTUNITY COSTS OF CHILDBEARING

Micro-economic theories of childbearing also highlight the indirect economic costs of childbearing – for example the lost income and promotion opportunities that (for women especially) occur when time is taken away from paid work in order to care for children (Becker, 1981). There are other indirect costs of parenthood which are less quantifiable in nature, such as parents' reduced ability to socialise outside of the home, act spontaneously or travel abroad as easily. We hypothesise that the COVID-19 pandemic could have reduced the opportunity costs of having a(nother) child. The closure of many parts of the UK economy during the first and second lockdowns meant that the chances of finding a new job were reduced. The Institute for Fiscal Studies found that new job vacancy postings on the Department for Work and Pensions "Find a Job" website on 25 March 2020 (just as the first lockdown was announced) were just 8% of the equivalent day in 2019. Thus, for those who were already out of the paid labour force, for example because they were unemployed or undertaking family care, there was less chance that they would be able to find a job. Hence, the economic opportunity costs of having a(nother) child would be reduced. Previous evidence from Germany highlighted heterogeneity in the response to employment uncertainty (Kreyenfeld, 2010). While more highly educated women tended to postpone parenthood when subject to employment uncertainties, those with low levels of education often responded by becoming mothers. For those intending to have another child in the future, the reduced economic opportunity costs of childbearing may have speeded up their transition to having an additional child.

Moreover, the pandemic has encouraged a new focus on home life. Becoming a parent and having a young child can hinder social activities outside of the home, such as travel for holidays, going out with friends to a pub or restaurant, attending a football match, or singing in a choir. All such activities have not been possible (or have only been possible for part of the time) during the pandemic. Thus, couples might view the pandemic as a good time to try for a baby due to the restrictions. Although, it is acknowledged that at the start of the COVID-19 pandemic in the UK, very few people would have predicted the subsequent waves of the pandemic during late 2020 and early 2021, hence would not have been in a position to predict the duration of the lockdown.

3.11. WORKING FROM HOME COULD ENCOURAGE RE-THINKING OF WORK LIFE BALANCE AND LESS POSTPONEMENT

Some people have welcomed the slower pace of life and the time to spend within the home that the lockdown has brought (Soper, 2020; Van Kessell et al., 2021). For some couples, particularly those who were better off, relationships are reported to have improved during the pandemic (Perelli-Harris et al., 2020). It is possible that couples who previously focused on paid work and may have worked long hours, with long commutes, may re-evaluate their life priorities and consider starting a family. This could be particularly the case for those in their twenties and early thirties who had previously been postponing parenthood. Thus, we hypothesise an upward pressure on fertility due to better work-life balance, noting again however, that at the early stages of the pandemic individuals had no knowledge of the future extent of social restrictions during subsequent waves of the pandemic.

3.12. MORE TIME SPENT WITH PARTNER IN HOME

The pandemic has forced many co-resident couples, especially those who have been working from home to spend more time in each other's company. It is possible that the new opportunities to spend time together could increase the frequency of sexual activity and thus increase fertility rates. At the start of the first lockdown many media outlets highlighted how previous baby booms had been caused by the return of partners at the end of the Second World War (Shaw, 2020; Sewell, 2020)

3.13. STRESS OF CHILDCARE / SCHOOLING OF EXISTING CHILD MAY DETER FROM HAVING ADDITIONAL CHILDREN

Less commuting, more home working, and being furloughed may have improved some individuals' work-life balance in the UK (Williams et al., 2021). However, the pressure to combine both domestic and paid work often increased, for example due to additional cooking and cleaning due to more people spending more time at home and less opportunity to eat out in restaurants. Moreover, survey evidence suggests that it is women that have taken on the majority of the burden of childcare and home schooling (Anders et al., 2020). Previous academic research found that increased gender equality within the home, for example in terms of share of domestic chores, or fathers involvement in parental leave, is associated with a greater likelihood of childbearing (Goldscheider et al., 2013; Duvander et al., 2019). It is thus

possible that existing parents (especially women) may be discouraged from having an additional child due to the burdens of caring for existing children under lockdown and the persistently unequal division of labour between sexes brought to light by pandemic-related circumstances. Without detailed longitudinal information on individuals' changing fertility intentions during the pandemic this remains a speculation.

3.14. WEALTHIER FAMILIES SAVING MORE FOR COSTS OF CHILDREN

The economic impacts of COVID-19 on family finances have been very variable. Whilst income declines have been greatest for those already on low incomes, a significant minority of better off families have been able to increase their savings (Davenport et al., 2020). A recent survey suggested that 44% of high income, employed households saved more during the pandemic (Bank of England, 2020). Savings have occurred for example due to fewer opportunities to take holidays, especially overseas, and fewer possibilities for trips out, for example to theme parks, football matches, restaurants, theatres, or concerts. For parents with school age children, there have been fewer outgoings due to cancelled school trips (both in the UK and overseas), and less costs associated with extra-curricular activities and clubs which were cancelled. We hypothesise that, especially for couples in their thirties who have postponed childbearing to later ages, increased savings might encourage higher fertility.

3.15. REDUCED ACCESS TO IVF AND OTHER FERTILITY TREATMENTS

There has been considerable discussion in the media about the impact of the pandemic on access to assisted fertility treatments (ART). At the time of the first lockdown in March 2020, all IVF treatments were suspended. Subsequently, some treatment has resumed at a lower level but several months of closure resulted in a sizeable backlog of untreated couples. In July 2020, new Human Fertilisation and Embryology Regulations came into effect which extended the storage limit of frozen eggs, sperm and embryos by two years so that those undergoing fertility treatment during the coronavirus outbreak have more time to continue treatment (HFEA, 2021). However, delays of even just six months to treatment, especially of older women, reduces IVF success rates. The Human Fertilisation and Embryology Authority (HFEA, 2020) database shows that the number of live births resulting from IVF in the UK in 2018 was 19,728, suggesting that approximately three percent of live births resulted from IVF that year. There may be additional downward pressures on fertility due to couples not being able to access

primary healthcare to investigate unexplained fertility, or to access fertility enhancing drugs. Thus, for those at ages over 35 we would expect a small downward pressure on fertility rates due to restrictions on IVF. There will be little effect at younger ages however.

3.16. OVERALL EFFECT OF COVID-19 ON FERTILITY RATES

A review of the mechanisms shown in Table 1 suggests that, on balance, the COVID-19 pandemic will have a depressing effect on fertility rates, particularly among those aged under 30, and especially young adults who are currently childless and in paid work. It is not possible at this point to test the extent to which these hypotheses are correct, but in the next section we examine some scenarios as to what could happen to birth rates in the UK under different assumptions, informed by this discussion.

	Age group and parity							
Mechanism	**15-19**		**20-29**		**30-39**		**40-44**	
	Childless	**Parents**	**Childless**	**Parents**	**Childless**	**Parents**	**Childless**	**Parents**
Perceived / actual reduced access to contraception and abortion services	↑↑	↑↑	↑	↑	↑	↑	↑	↑
Less sex as fewer opportunities to socialise outside the home due to lockdowns	↓↓	↓↓	↓↓	↓	↓	↓	↓	↓
Increased inter-generational co-residence, less time alone for adults	↓↓	↓	↓↓	↓	↓	↓	↓	↓
Difficulties in finding and moving to a new home	↓↓	↓↓	↓↓	↓↓	↓	↓		
More opportunity for sex among those who moved in together at start of lockdown	↑	↑↑	↑↑	↑↑	↑↑	↑↑	↑	↑
Concerns re health risks of pregnancy / access for male partners to hospital	↓	↓	↓↓	↓↓	↓↓	↓↓	↓↓	↓↓
Postponed marriages			↓↓	↓↓	↓↓	↓	↓	↓
Isolation from social support, informal childcare less available	↓	↓	↓	↓	↓	↓	↓	↓
Increased economic uncertainty – job loss, reductions in working hours: Difficulty in affording direct costs of children	↓↓	↓↓	↓↓	↓↓	↓	↓		
Increased economic uncertainty – job loss, reductions in working hours: Reduced opportunity costs of children		↑	↑	↑↑	↑	↑↑	↑	↑↑
Working from home could encourage re-thinking of work life balance and less postponement			↑↑	↑↑	↑↑	↑↑	↑↑	↑↑
More time spent with partner in home	↑	↑	↑	↑	↑	↑	↑	↑
Stress of childcare / schooling of existing child may deter from having additional children		↓		↓↓		↓↓		↓↓
Wealthier families saving more for costs of children			↑	↑	↑	↑	↑	↑
Reduced access to IVF / other fertility treatments					↓	↓	↓↓	↓↓

Table 1: Potential mechanisms through which the COVID-19 pandemic could affect childbearing in the UK

Note: Green up arrows denote positive impacts on fertility, red down arrows negative impacts. The number of arrows denotes strength of relationship with increased number indicating stronger association.

4. QUANTIFYING THE SHORT-TERM IMPACT OF THE PANDEMIC ON FERTILITY: FOUR SCENARIOS

In this section we put forward a number of possible future scenarios for fertility rates in the constituent countries of the UK. Our aim is not to make predictions of what the future fertility rates will be, but to explore what the implications of different scenarios regarding changes to ASFRs would mean in terms of the overall TFR and number of annual births.

4.1. THE FOUR SCENARIOS

Our first two scenarios assume that recent changes in ASFRs (mainly declines) would cease and thus in the absence of COVID-19 the ASFRs would remain at the levels experienced in 2020[2]. Scenario 1 then adjusts the 2020 rates by COVID-adjustment factors shown in the first column of Table 2, whilst Scenario 2 adjusts fertility by the second column of Table 2 (Section 4.3 discusses the adjustment factors in more detail). The second two scenarios assume that past trends (averaged over the past five years) for each age group will continue over the subsequent three years (see Section 4.2 for the method for projecting the baseline trend). The same adjustments to the ASFRs due to COVID-19 are then applied to this underlying baseline. Given that fertility rates have been declining in all countries of the UK recently, assuming a continuation of recent trends – i.e. declining rates - results in lower projected fertility rates.

Scenario 1: Stable baseline – COVID-19 baby boom. Projected baseline trend is a continuation of 2020 ASFRs i.e. fertility in the absence of COVID-19 is assumed to be stable. Adjustment due to COVID reflects net zero impact on fertility under age 30 and 40+, but some increase in fertility among those aged 30-39 (Table 2). This scenario is based on the idea that at ages 30-39 the impact of postponement due to uncertainties is more limited and there may be some acceleration, especially of second and higher order births, due to lockdown.

Scenario 2: Stable baseline – COVID-19 baby bust. Projected baseline trend is a continuation of 2020 ASFRs i.e. fertility in the absence of COVID-19 is stable. Adjustment due to COVID-19 reflects experience of selected North-West European countries following the 2008 recession (See Section 4.3 and Table 2). It is assumed that fertility rates would fall most

[2] The 2020 ASFRs have been estimated, based on provisional estimates for January to September 2020. See Appendix A for details and sensitivity analysis where we use 2019 ASFRS for 2020 for all constituent countries.

at ages under 30, reflecting the postponement of births due to uncertainty. Fertility rates at the oldest ages are assumed to be less affected, or even continue to increase as they did in Europe following the 2008 recession.

Scenario 3: Declining baseline based on previous five years trend – COVID-19 baby boom. Projected baseline trend assumes a continuation of recent (based on previous five years) trend. For most age groups, this means a projected further decline in fertility even in the absence of the pandemic. Scenario 3 then assumes that the net impact of COVID-19 on fertility will be zero at all ages apart from 30-39 where there will be a slight positive impact (Table 2).

Scenario 4: Declining baseline based on previous five years trend – COVID-19 baby bust. Projected baseline trend assumes a continuation of recent (based on previous five years) trend. For most age groups this means a projected further decline in fertility even in the absence of the pandemic. Scenario 4 then assumes that there will be an additional net negative impact of COVID-19 on fertility for ages under 30, and a slight positive impact for ages 30+. This adjustment due to COVID-19 reflects the experience of selected North-West European countries following the 2008 recession (See Section 4.3 and Table 2).

Age group	**Scenario 1** Stable baseline COVID-19 Baby Boom	**Scenario 2** Stable baseline COVID-19 Baby Bust	**Scenario 3** Declining baseline COVID-19 Baby Boom	**Scenario 4** Declining baseline COVID-19 Baby Bust
15-19	1.00	0.946	1.00	0.946
20-29	1.00	0.972	1.00	0.972
30-39	1.02	1.005	1.02	1.005
40-44	1.00	1.033	1.00	1.033

Table 2: Assumed COVID-19 annual adjustment factors for UK ASFRs under each scenario.

4.2. PROJECTING THE UNDERLYING BASELINE TREND FOR UK COUNTRIES IN ABSENCE OF COVID-19

Scenarios 1 and 2 assume that in the absence of the COVID-19 pandemic, the fertility rates observed in 2020 would continue for the subsequent three years. This assumption would mean a break from the recent past in that recently fertility rates at most ages were declining in the UK. However, we might expect the declines to stop at some point which is why under Scenarios 1 and 2 stability is seen from 2020.

Scenarios 3 and 4 assume that in the absence of the COVID-19 pandemic the recent trend (mostly downward) in ASFR would continue into the near future. This sort of extrapolation, whereby projections are based on recent trends in the data, has previously been implemented successfully in fertility forecasting (Bohk-Ewald et al. 2018). Such trends are commonly estimated using the rates observed over the past five years (Myrskylä et al. 2013 and Schmertmann et al. 2014). This motivates the approach that we take in Scenarios 3 and 4, where our baseline trend is an extrapolation of the most recent five-year trend. We use the observed ASFRs for England and Wales, Scotland and Northern Ireland for the six five-year age groups 15-19,..., 40-44, which are plotted in Figure 2.

We work on the logarithmic scale, which is common when modelling rates. Additive change on the log scale is equivalent to multiplicative change on the original scale. Therefore, for a given country and five-year age group, we estimate the average trend of the log-rates observed between 2015 and 2020 inclusive. This is the straight line joining the 2015 and 2020 log-rates. We generally find a declining trend in ASFRs for all five-year age groups across the UK countries, except for the 40-44 age group where there is a growth in fertility. We extrapolate the trend for the next three years (2021-2023) by recursively adding the slope of the line. Exponentiating to return to the original scale, we calculate the corresponding annual multiplicative factor which is equal to the exponential of this slope. Given the aforementioned recent declines, this straightforward projection of recent trends (without any consideration of a possible COVID-19 impact) would suggest a significant further reduction in period fertility.

4.3. COVID-19 BABY BUST ADJUSTMENT FACTORS BASED ON EXPERIENCE OF NORTH WEST EUROPE FOLLOWING 2008 ECONOMIC RECESSION

Following the 2008 recession some, but not all, European countries saw a decline in fertility which commentators have interpreted in terms of increased socio-economic uncertainty (Goldstein et al., 2013; Comolli, 2017). These countries do not include the UK, which continued to experience an overall increase in the TFR through to 2012 (Figure 1). Appendix Figure B.1 shows the trend in ASFRs for selected European countries where fertility declined subsequent to 2008, when it had previously been increasing or stable. It is clear that in most

countries there was an immediate decline in fertility at younger ages, less so at older ages. We use the response for these countries to inform our baby bust scenarios.

		Age group					
		15-19	20-29		30-39		40-44
			20-24	25-29	30-34	35-39	
Country	Estonia	0.879	0.920	0.966	1.016	1.032	1.059
	Finland	0.955	0.973	0.997	0.998	1.020	1.015
	France	0.978	0.985	0.994	1.005	1.012	1.035
	Iceland	0.943	0.925	0.982	1.001	0.971	1.033
	Netherlands	0.971	0.971	0.991	1.000	1.009	1.027
	Norway	0.902	0.952	0.982	0.996	1.007	1.024
	Sweden	0.993	0.974	0.991	0.994	1.013	1.037
	Average for all countries	0.946	0.972		1.005		1.033

Table 3: Average annual adjustment factors for ASFRs in 2009-2011 compared to 2008 level. Values given to three decimal places.

For a given country and five-year age group, we calculate the average three-year trend of the log-rates observed between 2008 and 2011 inclusive (see dotted lines in Appendix Figure B.1) and the corresponding adjustment factor. We present these adjustment factors for each of the countries in Table 3, together with the overall mean adjustment factor for all the countries. To complement the age ranges shown in Table 1, we average across the age groups 20-29, and across age groups 30-39. An adjustment factor of 0.95 means that the fertility rate for that country and age group decreased on average by 5% year-on-year in 2009-2011 compared to the 2008 level, whereas a value of 1.05 indicates a 5% year-on-year increase. From Table 3, we can see that all of the adjustment factors for the ages under 30 are less than 1, whereas for ages 30+ the majority of the multiplicative factors exceed 1. This confirms our assertions that fertility immediately declined at younger ages following the recession for the selected countries, and tended to increase at older ages. These adjustment factors are then applied to the two baseline trends to identify the COVID-19 Baby bust ASFRs and associated numbers of births.[3]

[3] An alternative way of computing adjustment factors for Scenario 4 would take account of the trend in the ASFRs between 2003 and 2008 for our selected countries rather than simply the 2008 level (see Appendix B for details). As many Northern and Western European countries were experiencing either stable or increasing fertility just prior to the 2008 recession (Appendix Figure B.1), the resulting correction factors tended to be further below one as compared to those in Table 3. Applying these alternative adjustment factors to the (already declining) trend in ASFRs observed for the UK, suggested a very rapid decrease in future fertility that we did not think was reasonable (Results available in Appendix Table B.2). Therefore, we decided on a less extreme approach, namely using the average adjustment factors in Table 3 for Scenario 4 as well as Scenario 2.

4.4. PROJECTED FERTILITY RATES UNDER THE FOUR SCENARIOS

Table 4 shows the estimated TFR for 2020[4] and the projected TFRs for 2021-2023 for all of the countries under the four scenarios. In 2020 there is considerable variation in the estimated TFR with the highest level found in Northern Ireland (1.76 births per woman) and lowest in Scotland (1.33 births per woman). England and Wales is between the two with an estimated TFR of 1.60 in 2020. It seems likely therefore that even before the COVID-19 pandemic, all countries of the UK were experiencing unprecedentedly low fertility.

Only one scenario (Scenario 1) is associated with an increase in the TFR between 2020 and 2023. All others suggest a decline, with Scenario 4 showing the largest decline (Figure 3)

[4] See comments in footnote 1 on accuracy of 2020 ASFRs and sensitivity analyses in Appendix A.

			Year			
		Scenario	2020	2021	2022	2023
Country	England and Wales	Scenario 1 Stable baseline COVID-19 Baby Boom	1.60	1.62	1.63	1.65
		Scenario 2 Stable baseline COVID-19 Baby Bust		1.59	1.57	1.56
		Scenario 3 Declining baseline COVID-19 Baby Boom		1.58	1.55	1.53
		Scenario 4 Declining baseline COVID-19 Baby Bust		1.55	1.50	1.45
	Scotland	Scenario 1 Stable baseline COVID-19 Baby Boom	1.33	1.34	1.36	1.37
		Scenario 2 Stable baseline COVID-19 Baby Bust		1.32	1.31	1.30
		Scenario 3 Declining baseline COVID-19 Baby Boom		1.30	1.27	1.25
		Scenario 4 Declining baseline COVID-19 Baby Bust		1.28	1.23	1.18
	Northern Ireland	Scenario 1 Stable baseline COVID-19 Baby Boom	1.76	1.78	1.80	1.82
		Scenario 2 Stable baseline COVID-19 Baby Bust		1.75	1.73	1.72
		Scenario 3 Declining baseline COVID-19 Baby Boom		1.75	1.73	1.71
		Scenario 4 Declining baseline COVID-19 Baby Bust		1.71	1.67	1.62

Table 4. TFR projections using the 2020 provisional ASFRs for England and Wales and adjusting the 2019 ASFRs for Scotland and Northern Ireland by the same ratio of 2020 to 2019 rates. Values given to two decimal places.

Under Scenario 1, we assume that in the absence of the COVID-19 pandemic, fertility would have remained at the 2020 levels, but that due to COVID-19 we will see a baby boom among those in their thirties. This means that for England and Wales the TFR climbs from 1.60 births per woman in 2020 to 1.65 in 2023. Under Scenario 1, fertility increases to 1.37 births per woman in Scotland in 2023 and 1.82 births per woman in Northern Ireland. However, if we assume that the recent downward trend in birth rates observed in the UK were to continue

in the future in the absence of COVID-19, we see that the effect of the baby boom (Scenario 3) would not outweigh the impact of declining trends; the TFR in England and Wales would be 1.53, 1.25 in Scotland, and 1.71 in Northern Ireland.

Scenarios 2 and 4 assume that the net effect of the COVID-19 pandemic on ASFRs will be negative at younger ages, and (only very slightly) positive at older ages (Table 3). Scenario 2, which assumes that in the absence of COVID-19 fertility would have remained at the 2020 level, shows the TFR reducing from 1.60 in England and Wales to 1.56, whilst in Scotland it reduces from 1.33 to 1.30 and from 1.76 to 1.72 in Northern Ireland. If however, we assume that the COVID-19 pandemic promotes already declining ASFRs then we see the TFR reaching a low of 1.45 in England and Wales, 1.18 in Scotland, and 1.63 in Northern Ireland. These TFRs would be much lower than the low levels of fertility observed in previous baby busts during the 1930s (when the TFR declined to 1.72 in 1933), or the 1970s (when fertility declined to 1.66 in 1977) (Hobcraft, 1996).

The effect of the four scenarios on the TFR from 2015-2023 is shown in Figure 3 together with the two baseline projections. Figure 3 demonstrates the significant impact that the choice of baseline has on the future TFR. In other words, the TFR continues to decline significantly in all countries of the UK if recent historical trends were to continue, as compared to remaining stable at the 2020 level (compare the stable baseline and declining baseline scenarios in Figure 3). However, most importantly, for three scenarios out of four we observe a significant decline in the TFR in all four UK's countries over the next three years.

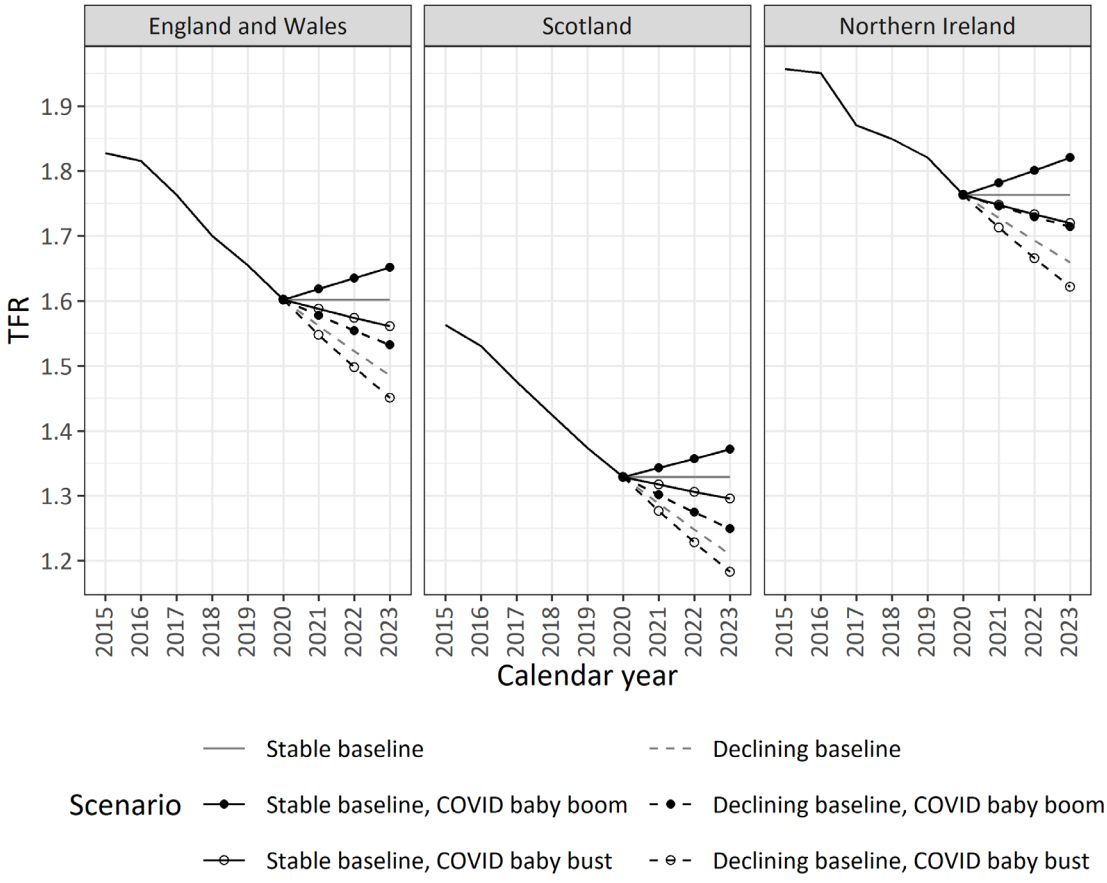

Figure 3: TFR projections for the UK countries, using the 2020 provisional ASFRs for England and Wales and adjusting the 2019 ASFRs for Scotland and Northern Ireland by the same ratio of 2020 to 2019 rates

4.5. PROJECTED NUMBERS OF BIRTHS UNDER THE FOUR SCENARIOS

For planning purposes e.g. maternity services and school places, policy makers need to make assumptions about future numbers of births. Therefore we estimate the effect of our four scenarios on the future numbers of births. We first obtain the mid-year population projections by five-year age group for females for 2021-2023 for England and Wales, Scotland and Northern Ireland from the ONS 2018-based National Population Projections (ONS, 2019) . Next, for a given country, scenario and calendar year, for each age group we compute the projected number of births by multiplying the projected ASFR by the projected mid-year population. We then sum these birth projections across the age groups to obtain a total. We present the resulting number of births in Appendix Table C.1.

In order to visualise how many additional or fewer births are associated with each of the scenarios we plot the projected number of births under each scenario alongside the two

baseline trends (Figure 4). In Scenario 1 (stable baseline, baby boom) the overall number of births would increase from 2021 to 2023. However, in Scenario 3 (declining baseline, baby boom) we see the opposite trend. This is because the presence of the baby boom is insufficient to outweigh the strong declines in fertility based on the trends from 2015-2020.

In Scenarios 2 and 4 (baby bust scenarios) the number of births also declines steadily from 2020 to 2023, with Scenario 4 being the most extreme as we saw in Figure 3. Using the estimated ASFRs for 2020 we estimate the total births in 2020 to be 620,288 in England and Wales, 48,183 in Scotland and 21,513 in Northern Ireland. For England and Wales, by 2023 the number of births could increase by 16,502 (Scenario 1) or decrease by 58,854 (Scenario 4) by 2023. This is an increase of 2.7% or a decrease of 9.5%. For Scotland, under the first scenario the absolute number of births could increase by 3.1% (1,484 births), or under Scenario 4 decrease by 10.7% (5,167 births). In Northern Ireland births Scenario 1 is associated with an increase in the number of births by 1.3% (269 births), whilst Scenario 4 is associated with a decrease by 9.4% (2,030 births).

In terms of the baselines, from Figure 4 we see that the projected number of births under the stable baseline actually decreases year-on-year from 2020 for all of the UK countries, apart from a very slight increase in 2021 for Scotland. This is driven by the decreasing population at risk aged 20-29 across all countries, with the steeper rate of change for Northern Ireland caused by additional decreases in the 30-34 age group. Unsurprisingly, the projected number of births under the declining baseline decreases at a much faster rate. To assess our hypothesised impact of the pandemic on the projected overall number of births, for each scenario we compare the projected number of births in 2023 with that projected under its corresponding baseline. For England and Wales, the baby boom scenario would lead to an extra 20,083 births (compared to stable baseline) and 19,101 births (compared to declining baseline). The baby bust scenario would lead to 14,042 missing births (stable baseline) and 11,580 missing births (declining baseline). The equivalent quantities for Scotland are 1,626 and 1,513 extra births, and 1,039 and 837 missing births. For Northern Ireland, there would be 722 and 692 extra births, and 446 and 382 missing births.

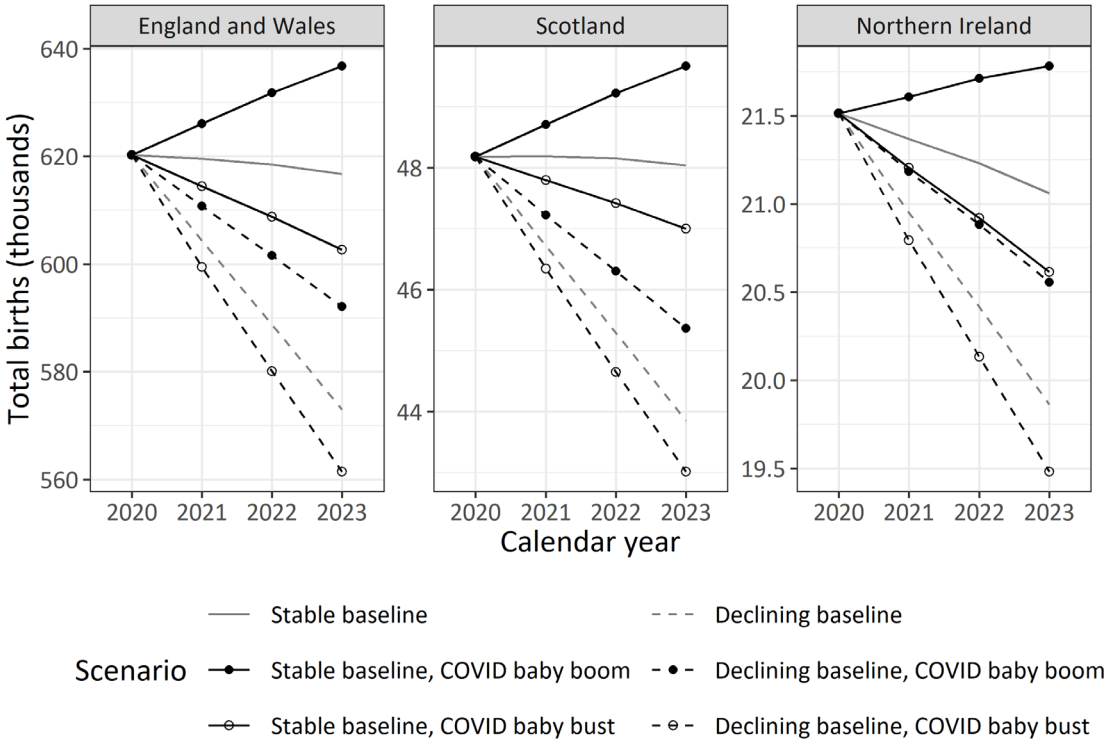

Figure 4: Projected total number of births across ages 15-44 for each of the UK countries and scenarios, using the 2020 provisional ASFRs for England and Wales and adjusting the 2019 ASFRs for Scotland and Northern Ireland by the same ratio of 2020 to 2019 rates.

As shown in Appendix Figure C.1 we can see that the baby bust Scenarios 2 and 4 are reducing the number of births to younger women in particular. Thus the average age of mothers requesting maternity services would increase under these scenarios.

5. DISCUSSION AND CONCLUSION

This paper examined recent trends in fertility and found that in all countries of the UK fertility rates have been declining at all ages, even among older women in their late thirties and forties among whom there had previously been sustained increases associated with the shift of childbearing to later ages (Berrington et al., 2015a). We have shown that although all countries of the UK have seen the same pattern of fluctuations in fertility over the past two decades there are significant differences in the level of childbearing. Fertility rates are persistently lower in Scotland than in England and Wales, and consistently higher in Northern Ireland.

Provisional estimates of the TFR for England and Wales based on the first three quarters of 2020 (ONS, 2020b) suggest that fertility rates for England and Wales had fallen to historically unprecedented low levels before any impact due to the pandemic occurred. A provisional estimated TFR of 1.60 for England and Wales (ONS, 2020b) is lower than that seen during the great recession of the 1930s or baby bust of the 1970s (Hobcraft, 1996). Thus any impact of COVID-19 on fertility rates must be viewed in this already unusual context.

Currently no information on pregnancy rates during 2020, or on live birth rates in the first quarter of 2021 have been published for countries of the UK. We will not know what the impact of the COVID-19 pandemic on fertility rates in the UK between 2021 and 2023 will be until data become available. In this paper, we took a scenario ("what if") approach to examine how potential pandemic-related increases and decreases in ASFRs may impact the TFR and number of births.

We suggested that there are countervailing factors operating among different population subgroups, for example according to individuals' ages and whether children are already present. At younger ages, i.e. those aged under 30, the majority of our postulated mechanisms exert a downward pressure on fertility rates. For example, we believe that the lack of socializing due to the lockdowns and increased economic uncertainties caused by the economic fallout from the COVID-19 pandemic will act to decrease the likelihood of childbearing among younger people. Historical evidence of fertility rates following the 2008 recession from other Northern and Western European countries suggests that it is young people who are most likely to see a decline in rates of childbearing, as births are postponed to later ages (Goldstein et al., 2013). We thus examined a set of future baby bust scenarios where fertility was reduced at the ages under 30 due to the pandemic.

Among those who already have at least one child, and among older couples who are more stable in their housing and financial situation, there are a number of mechanisms through which the COVID-19 pandemic could result in declines in fertility (e.g. concerns about the reduced support from health services or family and friends during the pandemic). However, there are also mechanisms through which the pandemic might result in an increase. For example, couples had more time to spend together at home during lockdown and among those who are currently unemployed, the opportunity costs of having a(nother) child might have been reduced due to the economic consequences of the pandemic. Thus, we additionally examined

a set of baby boom scenarios whereby fertility rates were seen to increase slightly among those aged in their thirties.

Before applying our baby boom and baby bust adjustments to fertility rates we had to project a baseline trend for fertility that represents what would have occurred in the absence of COVID-19. Given that fertility rates in the UK have been declining in recent years, a continuation of recent trends would imply further declines in fertility, even in the absence of COVID-19. On the other hand it could be that, in the absence of COVID-19, fertility rates would stabilize at 2020 levels. We applied our baby boom and baby bust scenarios to both of these baselines, resulting in projections for four scenarios.

The projected TFRs from our four scenarios provided a range of possibilities, with the highest TFRs for 2023 resulting from Scenario 1 – a stable baseline level of fertility from 2020 and an annual 2% increase in fertility rates among those in their thirties. Under this scenario, the 2020 to 2023 increase in TFR would be 1.60 to 1.65 in England and Wales, 1.33 to 1.37 in Scotland, and from 1.76 to 1.82 in Northern Ireland. The lowest projected TFRs resulted from Scenario 4 where we assumed that fertility rates would have continued their recent downward trend in the absence of COVID-19, and that there will be further downward pressures on fertility at ages under 30 (an annual reduction of about 3%) due to the pandemic. Under Scenario 4 the TFR in 2023 would only reach 1.45 in England and Wales, 1.18 in Scotland, and 1.62 in Northern Ireland.

In order to estimate the additional effect of COVID-19 on the future number of births, we compared the projected number of births in 2023 with the number predicted using the different baseline trend which would have occurred in the absence of COVID. If we sum the extra/missing births compared to the relevant baseline from 2021 to 2023 we can see the potential cumulative effect of COVID by the end of 2023. For England and Wales, the different scenarios produced a range from 28,925 missing births (Scenario 2: Baby bust, stable baseline) to 39,912 additional births (Scenario 1: Baby boom, stable baseline). The equivalent range for Scotland was between 2,167 missing births (Scenario 2) and 3,215 extra births (Scenario 1). For Northern Ireland, there could be between 920 missing births (Scenario 2) up to 1,440 additional births (Scenario 1). These differences could have significant implications for service provision.

In 2019, ONS published its 2018-based National Population Projections (NPPs) (ONS, 2019). The principal variant projection assumed that over the subsequent few years, under-20 fertility rates would continue to decline steadily, but that fertility among those in their early twenties would remain stable at the levels seen in 2018. In the subsequent years since this publication, fertility rates at all ages under 30 have continued to decline, showing these earlier assumptions to be incorrect. Thus, even before any effects of the COVID-19 pandemic are factored in, the projected number of births for 2021-22 (mid-year to mid-year) under the 2018-based NPPs (645,846 in England Wales, 50,880 in Scotland and 21,988 in Northern Ireland) are significantly higher than all of our scenarios. Scenario 1 (stable baseline, baby boom) comes closest to the 2018-based NPPs (with 631,800, 49,220 and 21,712 projected births for 2022 calendar year). An examination of some of the potential mechanisms through which the pandemic could affect childbearing suggests that recent declines in fertility rates could well be accelerated by the COVID-19 pandemic, moving the observed number of births even further below the 2018-based NPPs. These factors will need to be considered by ONS when making the next set of NPPs.

6. APPENDIX

APPENDIX A: ACCURACY OF ESTIMATES OF AGE SPECIFIC FERTILITY RATES (ASFRS) FOR 2020 IN THE CONSTITUENT COUNTRIES OF THE UK

ASFRs for the whole of 2020 have not yet been published, but provisional estimates for England and Wales based on NHS registrations for the period January-September 2020 have been published (ONS, 2020b). We use these rates as indicators of ASFRs for the whole calendar year. In comparison with 2019 ASFRs from the same NHS source, the ASFRs for 2020 for England and Wales are slightly lower, suggesting a continuation of the existing decline in fertility prior to the impact of COVID-19 (March conceptions being born in December). We assume that this decline is real and not a result of an under-registration of births during 2020 due to the COVID-19 pandemic. In Scotland and Northern Ireland, only absolute birth counts for 2020 have been published. These are not by age, and estimates of ASFRs are not available. Therefore, in our analyses we make the assumption that the change in ASFRs between 2019 and 2020 in Scotland and Northern Ireland followed the same pattern (i.e. declined in the same ratio) as for England and Wales.

Given that there is some uncertainty as to whether all of the births that took place in 2020 were registered due to disruptions associated with the pandemic, we conduct additional sensitivity analyses where we calculate the projected TFR under each scenario assuming that the real 2020 ASFRs for the constituent countries of the UK were actually the same as for 2019 (See Appendix Table A.1).

If we use the 2019 ASFRs as estimates for 2020 we see that the projected declines in fertility associated with the baby bust scenarios (Scenarios 2 and 4) are smaller (Table A.1). Under Scenario 4, by 2023 the TFR would reach 1.53 children per woman in England and Wales (rather than 1.45 seen in Table 4), 1.24 for Scotland (rather than 1.18 seen in Table 4) and 1.70 for Northern Ireland (rather than 1.62 in Table 4). Figure A.1 shows the projected number of births using the 2019 rates for 2020.

Given that provisional estimates for the numbers of births taking place in 2020 in Scotland (NRS, 2021) and Northern Ireland (NISRA, 2021b) are lower than those recorded for 2019 we prefer to present the results based on estimated 2020 rates in the main analyses.

			Year			
		Scenario	2020	2021	2022	2023
Country	England and Wales	Scenario 1 Stable baseline COVID-19 Baby Boom	1.66	1.67	1.69	1.71
		Scenario 2 Stable baseline COVID-19 Baby Bust		1.64	1.63	1.61
		Scenario 3 Declining baseline COVID-19 Baby Boom		1.64	1.63	1.61
		Scenario 4 Declining baseline COVID-19 Baby Bust		1.61	1.57	1.53
	Scotland	Scenario 1 Stable baseline COVID-19 Baby Boom	1.37	1.39	1.40	1.42
		Scenario 2 Stable baseline COVID-19 Baby Bust		1.36	1.35	1.34
		Scenario 3 Declining baseline COVID-19 Baby Boom		1.35	1.33	1.31
		Scenario 4 Declining baseline COVID-19 Baby Bust		1.33	1.28	1.24
	Northern Ireland	Scenario 1 Stable baseline COVID-19 Baby Boom	1.82	1.84	1.86	1.88
		Scenario 2 Stable baseline COVID-19 Baby Bust		1.80	1.79	1.77
		Scenario 3 Declining baseline COVID-19 Baby Boom		1.81	1.81	1.80
		Scenario 4 Declining baseline COVID-19 Baby Bust		1.78	1.74	1.70

Table A.1. TFR projections using the 2019 ASFRs for 2020. Values given to two decimal places.

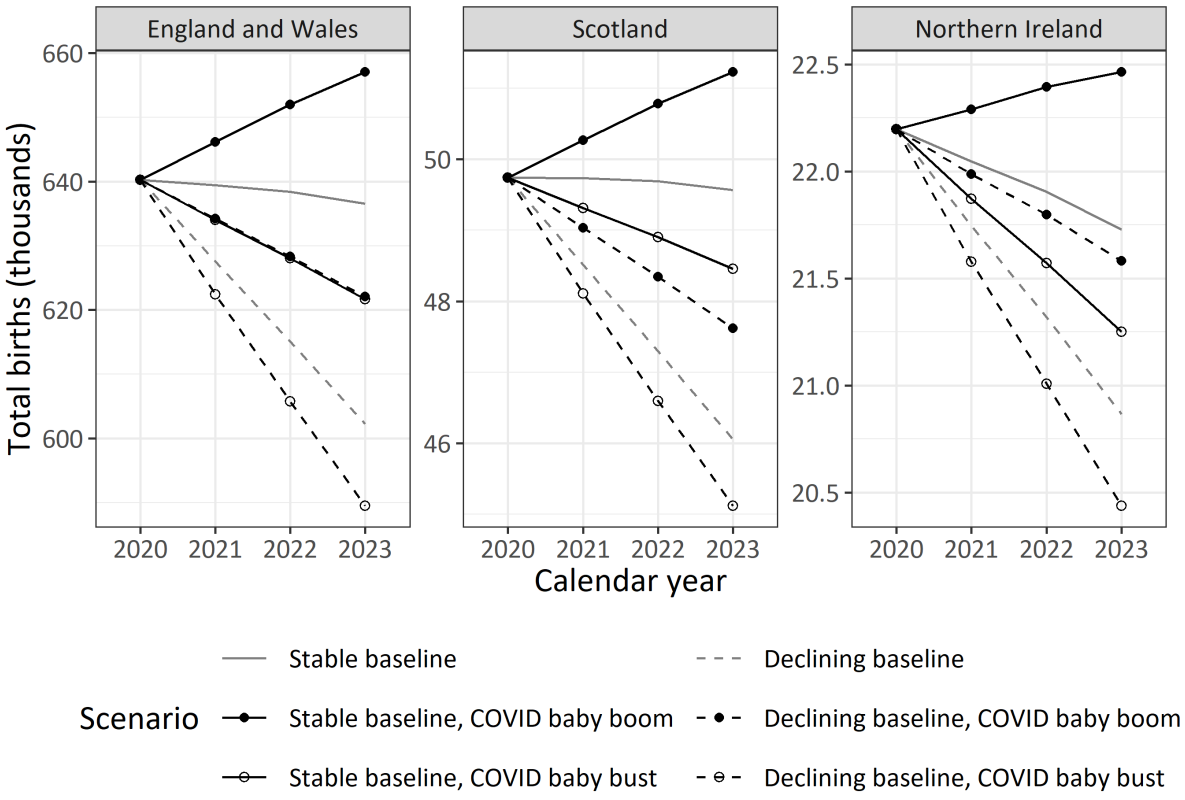

Figure A.1: Projected total number of births across ages 15-44 for each of the countries of and scenarios, using the 2019 ASFRs for 2020

APPENDIX B: METHOD FOR CALCULATING COVID-19 ADJUSTMENT FACTORS BASED ON RESPONSE OF NORTHERN AND WESTERN COUNTRIES TO THE 2008 ECONOMIC RECESSION

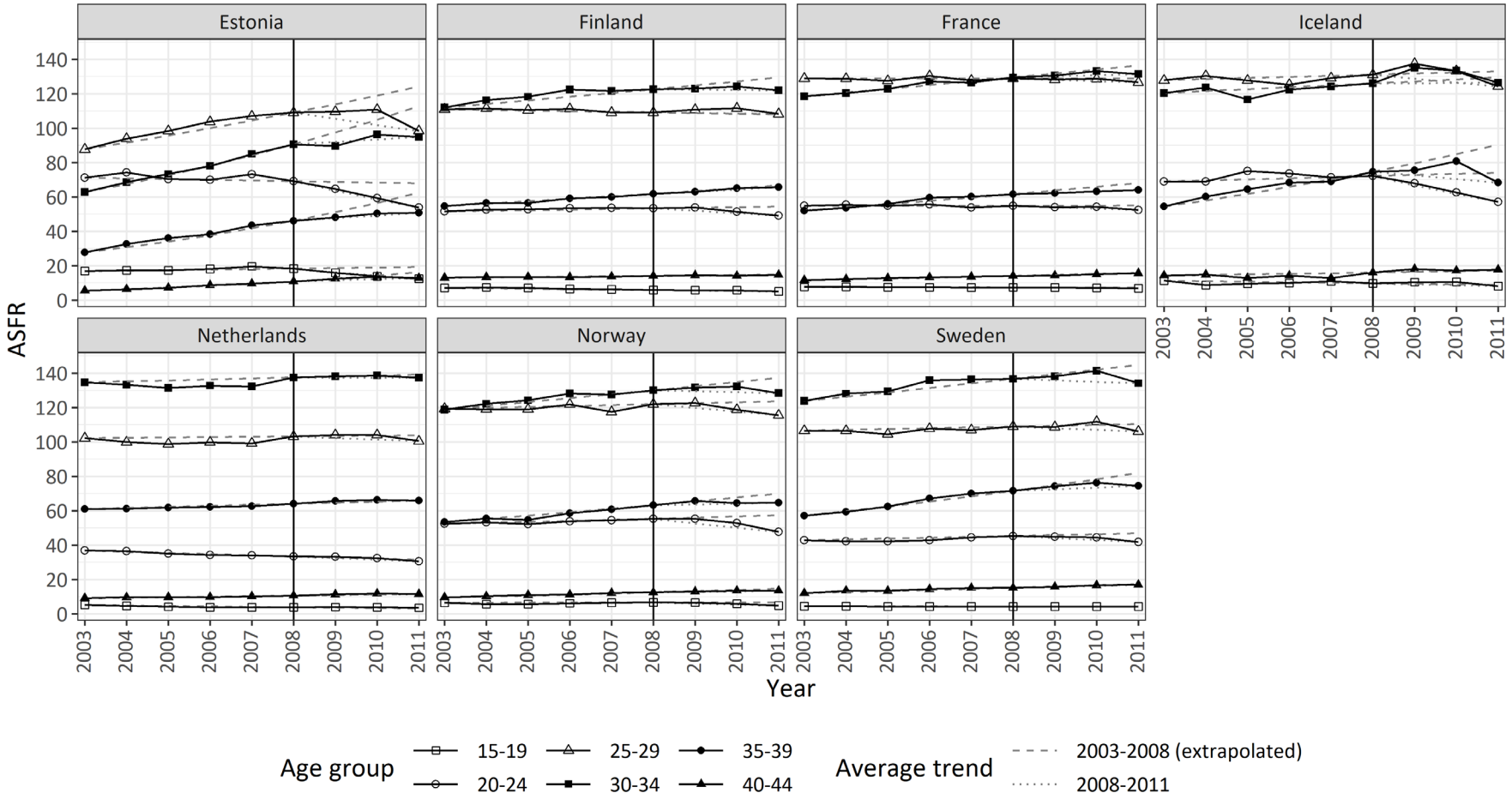

Figure B.1. Trend in Age Specific Fertility Rates, Selected North and West European Countries, 2003-2011. Dashed lines indicate average 5-year trend of 2003-2008 rates extrapolated to 2011; dotted lines indicate average 3-year trend of 2008-2011 rates.

Source: HFD (2021).

Here we briefly describe an alternative approach to determine correction factors for Scenario 4 based on the experience of selected North-West European countries. Data are sourced from the Human Fertility Database (HFD, 2021). For a given country and five-year age group, let α be the multiplicative factor corresponding to the 2008-2011 period (the values in Table 3). Then, let β be the multiplicative factor corresponding to the average five-year trend of the log-rates observed between 2003 and 2008 inclusive (see dashed lines in Figure B.1, where we have extrapolated this trend to 2011 for illustrative purposes). For Scenario 4, where the projected baseline trend is a continuation of the most recent five-year trend, our interest is in the ratio of the multiplicative factors, i.e. α/β. We present these ratios in Table B.1 below.

		Age group					
		15-19	20-29		30-39		40-44
			20-24	25-29	30-34	35-39	
Country	Estonia	0.864	0.925	0.925	0.944	0.933	0.927
	Finland	0.994	0.966	1.001	0.980	0.995	0.999
	France	0.984	0.985	0.994	0.988	0.979	0.996
	Iceland	0.973	0.917	0.977	0.992	0.911	1.010
	Netherlands	1.033	0.991	0.989	0.996	0.999	0.996
	Norway	0.899	0.942	0.978	0.978	0.974	0.971
	Sweden	0.998	0.963	0.987	0.975	0.968	0.991
	Average for all countries	0.964	0.967		0.972		0.984

Table B.1. Alternative Scenario 4: Average annual adjustment factors for ASFRs in 2009-2011 compared to the 5-year average trend in 2003-2008. Values given to three decimal places.

Whereas the interpretation of the adjustment factors in Table 3 is straightforward, here it is slightly more complicated. For a given age group, they represent the average annual multiplicative change in the ASFRs when applied to the continuation of the 5-year trend from 2003-2008. When we apply these adjustment factors to our alternative Scenario 4 we see the trend in TFRs as shown in Table B.2. The reduction in births associated with the COVID-19 pandemic is greater than that seen in our main Scenario 4 with the TFR reducing to just 1.11 in Scotland, 1.36 in England and Wales and 1.52 in Northern Ireland. These trends seem less plausible given historical levels of childbearing in the UK and we do not think that these correction factors are defensible. As mentioned in Section 4.3, the trends in fertility exhibited by our selected Northern and Western countries during this period were characterised by a stable or increasing fertility trend pre-2008, followed by a decline. In the UK, the COVID-19 pandemic has come at a time when fertility rates were already falling significantly. Therefore it is not surprising that the application of these adjustment factors to this very different situation has led to less plausible results, as their effect is to intensify a downward trend rather than reverse an upward trend.

		Year			
	Country	2020	2021	2022	2023
Main Scenario 4 (From Table 4)	England and Wales	1.60	1.55	1.50	1.45
	Scotland	1.33	1.28	1.23	1.18
	Northern Ireland	1.76	1.71	1.67	1.62
Alternative Scenario 4	England and Wales	1.60	1.52	1.43	1.36
	Scotland	1.33	1.25	1.18	1.11
	Northern Ireland	1.76	1.68	1.59	1.52

Table B.2. Projected TFRs under the main, and alternative (more extreme) Scenario 4 where we use the adjustment factors which compare the ASFRs in 2009-2011 compared to the five-year average trend in 2003-2008. Values given to two decimal places.

APPENDIX C: PROJECTED NUMBERS OF BIRTHS UNDER THE FOUR SCENARIOS

	Age	England and Wales			Scotland			Northern Ireland		
		Year			Year			Year		
		2021	2022	2023	2021	2022	2023	2021	2022	2023
Scenario 1	15-19	16614	17093	17640	1312	1336	1372	589	602	623
	20-24	79889	78314	77318	6039	5869	5731	2538	2490	2459
	25-29	165281	163330	161856	12648	12341	12126	5407	5309	5218
	30-34	212125	217222	220103	17018	17657	18023	7734	7847	7900
	35-39	121883	124754	128092	9579	9830	10170	4400	4509	4615
	40-44	30305	31087	31780	2112	2188	2245	940	954	967
	Total	626097	631800	636790	48708	49220	49667	21606	21712	21782
Scenario 2	15-19	15717	15297	14934	1241	1196	1162	557	539	527
	20-24	77652	73990	71004	5870	5545	5263	2467	2352	2259
	25-29	160653	154311	148637	12294	11659	11135	5255	5016	4791
	30-34	209005	210880	210535	16768	17141	17239	7620	7618	7557
	35-39	120091	121112	122523	9439	9543	9728	4335	4378	4415
	40-44	31305	33173	35032	2181	2335	2474	971	1018	1066
	Total	614423	608763	602665	47792	47418	47002	21205	20921	20615
Scenario 3	15-19	15485	14850	14284	1210	1137	1078	565	554	550
	20-24	76137	71130	66928	5750	5320	4946	2437	2295	2177
	25-29	160003	153064	146839	12157	11402	10769	5265	5034	4817
	30-34	208853	210573	210075	16614	16828	16769	7634	7646	7599
	35-39	119622	120167	121093	9351	9367	9461	4330	4369	4401
	40-44	30655	31811	32896	2142	2251	2343	954	984	1012
	Total	610755	601595	592115	47224	46305	45365	21185	20882	20556
Scenario 4	15-19	14649	13289	12092	1145	1018	913	534	496	465
	20-24	74005	67203	61462	5589	5026	4542	2369	2169	1999
	25-29	155523	144612	134847	11817	10773	9889	5117	4756	4424
	30-34	205782	204425	200943	16369	16336	16040	7522	7423	7269
	35-39	117863	116659	115829	9214	9093	9049	4267	4241	4209
	40-44	31667	33945	36262	2213	2402	2583	986	1050	1116
	Total	599488	580134	561434	46347	44649	43016	20794	20135	19483

Table C.1. Projected number of births using the 2020 provisional ASFRs for England and Wales and adjusting the 2019 ASFRs for Scotland and Northern Ireland by the same ratio of 2020 to 2019 rates. Births are rounded to the nearest whole number, so totals may differ slightly from the sums of the values in the relevant cells.

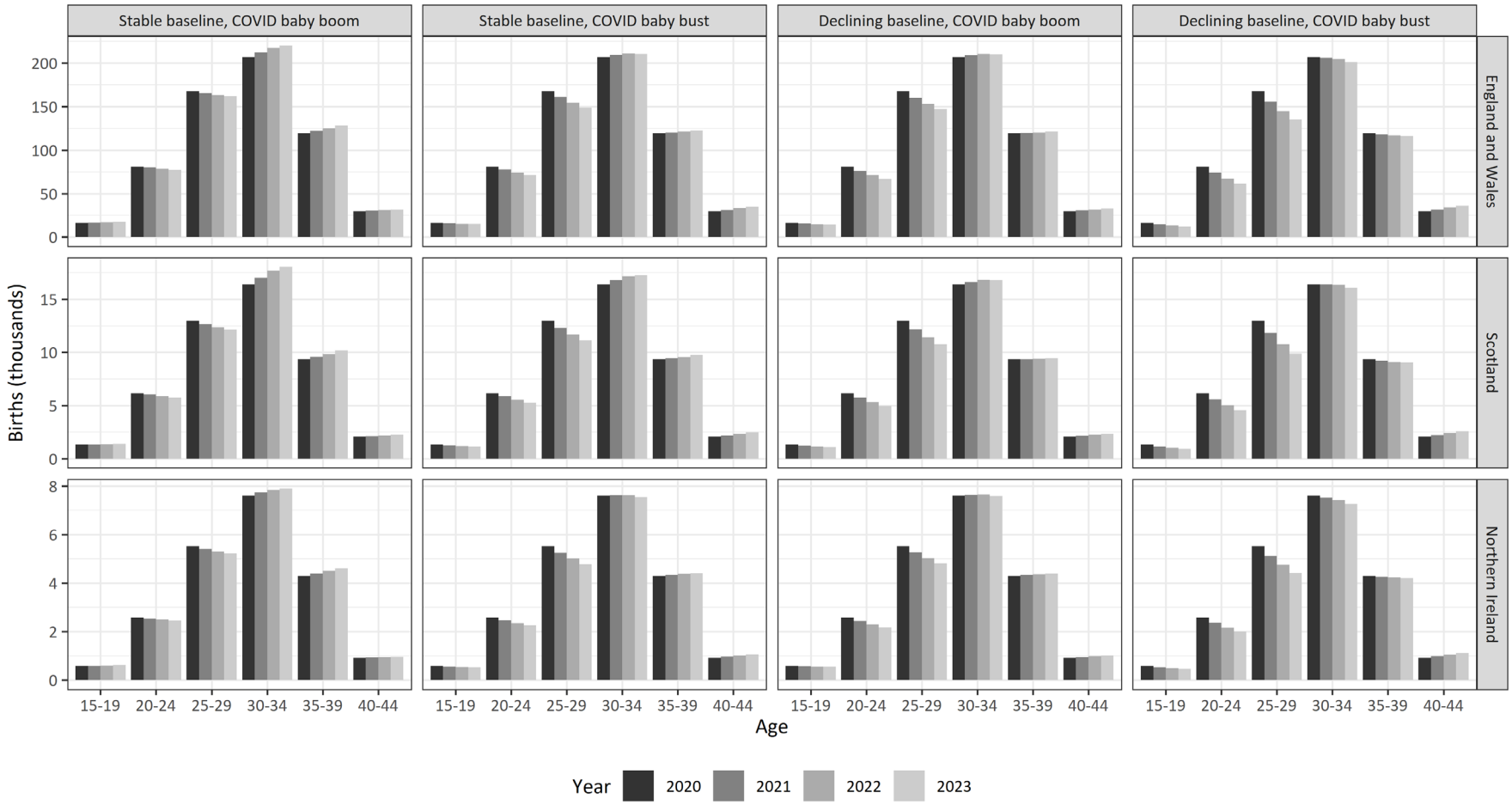

Figure C.1. Projected number of births by age group for each of the UK countries and scenarios, using the 2020 provisional ASFRs for England and Wales and adjusting the 2019 ASFRs for Scotland and Northern Ireland by the same ratio of 2020 to 2019 rates

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ISSN 2042-4116