Office for National Statistics
Swyddfa Ystadegau Gwladol

2016-based national population projections

Update note – fertility assumptions

Papers regarding the proposed fertility, mortality and migration assumptions for the 2016-based national population projections were issued in June 2017 to key stakeholders. Consultation meetings were held during June by ONS and National Records of Scotland (NRS) to discuss the proposals. In addition, the Welsh Government (WG) and the Northern Ireland Statistics and Research Agency (NISRA) invited key stakeholders within Wales and Northern Ireland to comment on the proposed assumptions by correspondence.

As a result of this exercise, the following changes to the original fertility proposals were agreed by the NPP committee and should be noted when reading the attached paper. Where no update is provided, the original proposals were agreed.

Proposal	Reference	Change agreed
Long-term fertility assumptions for the countries of the UK	All data relating to Scotland	Following consultation the proposed long-term assumptions for England, Wales and Northern Ireland were agreed. The long-term fertility assumptions proposed for Scotland were considered to be too high in relation to current levels. The long-term total fertility rate assumption for Scotland was subsequently set at 1.65 which is lower than the figure proposed in this paper (1.70).
Long-term fertility assumption for the UK	All data relating to the UK	As a result of a change to the long-term total fertility rate assumption for Scotland, the long term total fertility rate for the UK is decreased by 0.01 to 1.84 which is lower than the

		figure proposed in this paper (1.85).
Levels of the variant fertility assumptions	All data for the UK and constituent countries	Following consultation it was agreed to move to asymmetric variants for the UK and all constituent countries. This means that the high fertility variant will be +0.1 above the long-term total fertility rate assumption and the low fertility variant will be -0.2 below the long-term total fertility rate assumption. This was the preferred option presented within this paper, but the consultation confirmed the move towards asymmetric variants for the 2016-based assumptions.

It should be noted that there can be small rounding differences between the assumptions presented in this consultation paper and figures used in the projections.

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NATIONAL POPULATION PROJECTIONS CONSULTATION

2016-based national population projections: fertility

Paper prepared by the Office for National Statistics Population Statistics Division for NPP consultation

June 2017

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1. Executive summary

1.1. Long-term assumptions

Table 1 shows the assumptions for long-term average completed family size (CFS) for the United Kingdom and constituent countries used in the 2004-based to 2014-based national population projections, as well as ONS' proposed 2016-based assumption. For the 2012-based projection the assumed long-term fertility in the individual countries was increased from the 2006, 2008 and 2010 based rounds. This resulted in a long term total fertility rate (TFR) projection of 1.89 for the UK. This was maintained for the last round (2014-based).

There is considerable uncertainty about the direction of fertility change in the long-term, and this was reflected in the opinions of the expert panel that advises ONS on projections.

Table 1: Long-term assumptions for completed family size, 2004-based projections to 2014-based projections, and 2016-based for discussion

	2016-based proposed	2014-based	2012-based	2010-based	2008-based	2006-based	2004-based
England	1.85	1.90	1.90	1.85	1.85	1.85	1.75
Wales	1.85	1.90	1.90	1.85	1.85	1.85	1.75
Scotland	1.70	1.70	1.75	1.70	1.70	1.65	1.60
Northern Ireland	2.00	2.00	2.00	1.95	1.95	1.95	1.80
United Kingdom	1.85	1.89	1.89	1.84	1.84	1.84	1.74

Source: Office for National Statistics (ONS)

The factors that could influence fertility are discussed in detail in the consultation paper, not because the fertility projection is intended to be a forecast, but in order to produce principal and variant projections that are considered plausible by users.

A range of options have been considered for the long term TFR target for this projections round, and the likelihood and plausibility of each assessed.

ONS would like to propose that the long term assumption be 1.85 for the 2016-based projections round, a small decrease compared with the 2014-based.

These proposals are open for discussion both at the formal consultation meetings and informally between the devolved administrations and ONS. Some questions for consideration are noted in section 1.8. ONS is keen to

hear views on both the level of the long-term assumption and the most plausible short-term trend in each country.

1.2. History

Until recently, the long-term assumption for total fertility rate used in UK projections had been gradually reduced: from 2.32 in the 1971-based projections and 2.11 in the 1981-based projections to 1.90 in the 1991-based round and 1.74 in the 2000-based to 2004-based projections. The increase made in the 2006-based projection round, to 1.84 children per woman, was the first time that the UK long-term fertility assumption had been raised since the 1960s. At that time, assumptions were raised in all four UK countries[i]. For the 2008-based round, the assumptions were kept at the same level except in Scotland where a faster convergence with the UK was assumed than previously. After consideration, the assumptions were kept the same in the 2010 round, and the differentials between the countries were maintained at the same levels. The 2012 round raised the principal projections of all four countries by 0.05, to put the UK long term projection at 1.89. The 2014 round maintained the long term assumption of 1.89 for the UK with a 0.05 decrease for the long term assumption in Scotland.

1.3. Recent trends in UK fertility

Following declines in the 1990's fertility rates hit an all time low in 2001 at a TFR of 1.63. The TFR then increased until 2008, when the TFR reached 1.91, the highest since 1974. Between 2008 and 2012 the TFR fluctuated slightly but remained fairly stable at around 1.9.

However in 2013 there was a substantial drop in the UK TFR (the largest single year change since 1975). While the 2012-based principal projections did assume a small drop in TFR in the first year of the projection, the size of the actual decline was unexpected, and so was below even the low variant of the projection.

Among women who have completed their childbearing, average achieved fertility has fallen from 2.22 children for the 1945 cohort to 1.90 for the 1969 cohort. In terms of the average family sizes that women born in different years have achieved at certain ages, it appears that the previous steady decline (a clear pattern for the 1945 to 1965 cohorts) could be levelling out among the most recently-born cohorts of women.

1.4. Reasons for decreasing the UK assumption

The key arguments for decreasing the fertility assumptions for the UK, England, Wales, Scotland and Northern Ireland in the 2016 projections round are summarised below:

- Six (of eight) of the expert panel predicted a long-term TFR of between 1.60 and 1.86.
- The mean and median long-term TFR assumption from the experts was 1.79 and 1.80 respectively, lower than the current long-term assumption.
- Period fertility in 2015 has been maintained at lower levels, lower than the 2008-2012 period which played a role in supporting the 2012 based assumptions rise and slightly lower again than the 2013 and 2014 TFR which informed the 2014-based assumptions.
- Eurostat assume lower TFRs for the UK than ONS; decreasing the assumption will bring these closer together.
- Continued falls in teenage fertility and increased educational enrolment may be shortening women's effective childbearing window.
- The impact on fertility of international migration and economic stability is very uncertain following the vote in 2016 for the UK to leave the European Union. Also global fertility rates are generally falling.
- If the 2014 based projection is updated to include 2015 data, it results in a long-term TFR of around 1.85.

1.5. Reasons for maintaining the UK assumption

The key arguments for maintaining the fertility assumptions for the UK, England, Wales, Scotland and Northern Ireland in the 2016 projections round are summarised below:

- The expert panel cautioned against frequent changes of long-term assumption, stating that stability is desired by users.
- Two (of eight) of the expert panel predicted a long-term TFR of 1.90.
- The UN assume higher TFRs for the UK than ONS; decreasing the assumption will increase this gap.
- The current achieved family sizes for the 1970 -1985 cohorts suggests that they are catching up with the achieved family sizes of the 1969 cohorts and may exceed the completed fertility of the 1969 cohort by the time they have finished childbearing, if the projected rises in older age fertility rates occur. The CFS for the 1969 cohort was 1.90, near to the 2014 based long-term projected TFR, so this supports maintaining the assumption.
- Net migration levels remain high despite political will to decrease them. Net migration levels are likely to be more uncertain following the vote in 2016 for the UK to leave the European Union. Women born outside the UK tend to have higher fertility levels (TFR) than UK born women.

1.6. Recommendations

The cases for maintaining or decreasing the assumption are fairly balanced, but ONS is of the view that the collective opinions of the experts (predicting lower levels of fertility) and continued current low levels of period fertility are the current strongest factors for setting the long-term assumptions. This leads ONS to recommend that the long-term TFR assumption be decreased to 1.85 for the UK, on the strength of the collective expert opinions, coupled with continued low levels of period fertility currently.

Based on a recommended long-term TFR of 1.85 for the UK, ONS would like to propose the use of asymmetric high and low fertility variant projections. For the UK this would result in a high long-term TFR of 1.95 (+0.1) and a low long-term TFR of 1.65 (-0.2).

1.7. Key factors that may influence the short-term trend in fertility

The NPP expert panel thought that the UK TFR in 2020 was most likely to decrease to around 1.78 on average. Most experts cited reasons relating to the UK leaving the European Union playing a role in decreasing fertility in the short term. For example; economic uncertainty, job insecurity, uncertainty about long term prospects and changes in migration patterns.

The age specific fertility trends predicted by the experts are broadly in line with this. Some factors that are deemed likely to affect fertility in the short-term are outlined below:

- In the short term the majority of the expert panel felt that fertility for women aged 30-39 and 40+ would continue to increase, and none predicted decreases for these age groups.
- The majority of experts felt that fertility rates for women in their 20’s would decrease slightly.
- All experts agreed that teenage fertility would continue to decrease.

The majority of the scenarios developed thus far show a small decrease in the TFR in the short term. This encompasses declines for younger age groups, and rises for older age groups, in line with the long term projections targets, and expert advice.

1.8. Some questions for consideration and discussion during the consultation period

ONS propose basing the assumptions for all four UK countries on a similar age-trend scenario, as in the previous round, unless there is strong evidence to suggest that differing country trends would be appropriate.

(Note this will give different outcomes for each country, based on the 2016 starting point and recent trends).

ONS would value input on these questions during the consultation period:

- Is there sufficient evidence to reduce the UK long term assumption to 1.85?
- Are Total Fertility Rates in the four UK countries likely to converge over time?
- Are the assumed reductions in the under 20 fertility too high in the scenarios presented in this consultation?
- Are users content that age specific fertility rates (ASFR) for those aged 40+ will remain above those aged under 20 throughout the projection period?
- Are there other factors likely to significantly affect future fertility in England, Wales, Scotland or Northern Ireland that ONS has not considered?
- Should ONS set different long term assumptions for England and for Wales?
- What is the most plausible short-term trend for the TFR to take and should this be similar in all four countries?
- Would users find asymmetric high and low variants around the principal fertility projection of more use?
- Should the replacement level fertility variant for the UK be updated?

2. Introduction

2.1. Outline

This paper discusses recent trends in fertility and their underlying causes, in order to provide a rationale behind the proposed long-term fertility assumptions. Section 3 provides some brief technical notes for reference.

Section 4 describes recent trends in period fertility in the UK and highlights recent changes in the age patterns and parity composition of fertility. Section 5 examines cohort fertility, comparing the childbearing experiences of women born in different years.

Section 6 summarises the views of a group of experts on future UK fertility levels and trends, plus the factors that may be driving them. Section 7 considers in more detail several of the possible underlying influences on fertility. These include the impact of international migration on fertility, macro-level factors such as education, and the possible impacts of the economic climate and policy changes relating to families. Section 8 briefly considers UK fertility in the context of international fertility rates and projections.

Possible future trends in fertility are discussed in section 9, along with projection scenarios to aid discussion of the most plausible principal projection path.

Finally, section 10 outlines the next steps in producing the fertility component of the national projections, as well as discussion of fertility variants, including the replacement level fertility variant.

2.2. Annexes

For the four constituent countries of the UK, a summary of the rationale for the long-term assumptions can be found in Annexes A to D. These annexes contain additional information on

- period and cohort fertility in each country
- country-specific information on underlying factors where readily available, and
- outcomes from the UK fertility scenarios applied to each country's data.

3. Technical notes

3.1. Data availability

Fertility rates up to 2015 have been used in the period analysis (section 4); cohort analysis (section 5) and the projection scenarios (section 9). When projections are published later in 2017, 2016 data will be incorporated.

Cohort analysis in this document is based on live births and population estimates up to and including 2015. Women born in 1970 had reached age 45 by 2015 and can be considered to be the most recent cohort to have completed fertility. (Note that although fertility measures published routinely by ONS go up to age 44 or 49, age 46 has traditionally been used as the upper limit in the projections system. A long-term aim is to streamline the upper age limits used for fertility.)

3.2. Rounding

Fertility assumptions are normally presented rounded to the nearest 0.05, so as not to give a false impression of the likely precision of fertility forecasting. However, as with previous projections, it is not possible to achieve this degree of rounding at both individual country and UK level. For example in the 2014-based projections, the assumptions for individual countries were rounded but when combined in the UK projection gave a long-term family size of 1.89 for the UK as a whole. The fact that the UK result does not round to 0.05 should not be taken to imply a greater degree of precision for the UK than for the constituent countries.

3.3. Cohort and period measures

Long-term fertility assumptions are formulated in terms of the average number of children (completed family size or CFS) for women born in different years. This cohort measure is more stable than the equivalent calendar year (*period*) measure, the total fertility rate (TFR). The TFR represents the hypothetical average number of children born per woman if women experienced the age-specific fertility rates (ASFR) of the year in question throughout their childbearing lives.

Completed family size is affected only by changes in the number of children women have, and not by the timing of births within women's lives. In contrast, period rates such as the TFR will rise or fall if births are brought forward or delayed for any reason.

3.4. Sex ratios

A sex ratio of 105 boys to 100 girls has been used to split projected births since the 1987-based round. This ratio will continue to be used for the UK and constituent countries in the 2016-based round.

During the 2004-based projection round, consideration was given to adding a decimal place to the sex ratio to improve precision and because the UK sex ratio in the previous decade had averaged just above 105. The decision was taken not to add a decimal place, since the effect of doing so on the projected population was marginal. The UK sex ratio fluctuates each year with no clear trend over time (for example, it was 105.2 in 2009, 105.3 in 2010, 105.1 in 2011 and 105.4 between 2012 and 2015) so adding a decimal place would imply a level of accuracy in projections that does not exist.

These annual fluctuations are relatively larger in Wales, Scotland and Northern Ireland compared with England, so it was also decided during the 2004-based round not to use different sex ratios for the four countries of the UK.

3.5. Timing issues

This consultation report makes extensive references to policies and trends over time. At the time of writing the 2017 General Election date has been set for 8th June 2017, leaving uncertainty surrounding the future government and their policies. The UK also voted on the 23rd June 2016 to leave the European Union which also presents further uncertainties about the future particularly with regard to the economy and migration.

Any references to the current government refer to the Conservative government in power from 2015, any references to the coalition government refer to the 2010 – 2015 Conservative – Liberal Democrat government, and any references to the previous government refer to the previous labour government, in power until May 2010. In the event that any statements refer to any government or policies announced after the 2017 general election, this will be made clear in this paper.

4. Recent trends in period fertility

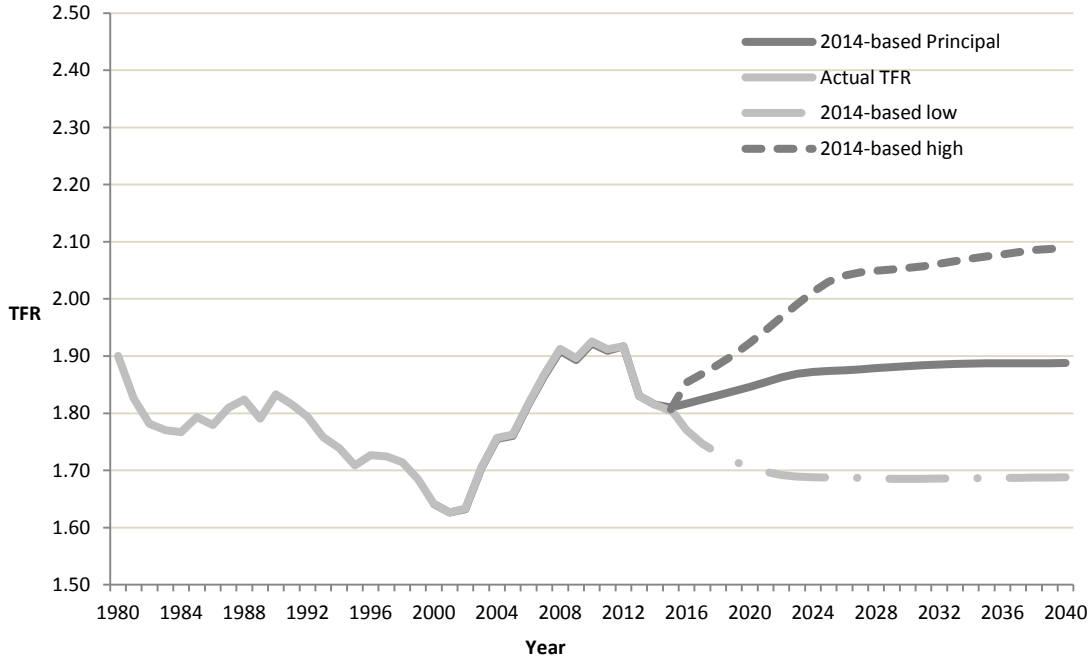
4.1. Total Fertility Rates

Figure 1 shows the trend in the UK TFR from 1980 – 2015, and the 2014-based projection assumptions up to 2040.

Following declines in the 1990's fertility rates hit an all time low in 2001 at a TFR of 1.63. The TFR then increased until 2008, when the TFR reached 1.91, the highest since 1974. Between 2008 and 2012 the TFR fluctuated slightly but remained fairly stable at around 1.9.

However in 2013 there was a substantial drop in the UK TFR to 1.83 (the largest single year change since 1975). While the 2012 based principal projections did predict a small drop in TFR in the first year of the projection, the size of the actual decline was unexpected, and so thus was below even the low variant of the projection. The TFR has continued to decline to 1.80 in 2015.

Figure 1: Actual and projected TFR for UK, 1980 – 2040



Sources - Total fertility rate (TFR) calculated by the Office for National Statistics (ONS) using birth registration data and population estimates from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA). 2014-based National Population Projections from ONS.

A key consideration for the 2016-based population projections will be whether this decline in fertility will be sustained and there will be further declines, or whether the fertility will stay at this level or increase in 2016.

4.1.1. Provisional 2016 births figures

The TFRs for the UK and constituent countries are not yet available for 2016, but provisional quarter 1 and quarter 2 births for 2016 have been provided in the tables below. These figures are shown in table 2 and table 3, along with previously published figures for Q1 and Q2 2010-2015.

Both tables show that 2016 appears to have comparable (in fact slightly higher overall) numbers of births to 2015 for the first 2 quarters of the year, which indicates that barring any radical change in the mid-year population estimate of childbearing age women, the TFR for 2016 is likely to be similar to the 2015 TFR.

Table 2: Quarterly births figures for quarter 1 2010 – 2016-RESTRICTED

Year and quarter	Number of live births (thousands)					
Q1 birth figures	United Kingdom	England and Wales	England	Wales	Scotland	Northern Ireland
2016	188.7	169.5	161.4	8.1	13.3	5.9
2015	186.1	166.8	158.8	8.0	13.3	5.9
2014	188.9	168.9	160.6	8.3	13.9	6.1
2013	190.6	170.6	162.2	8.4	13.9	6.1
2012	201.2	179.8	171.0	8.8	14.8	6.6
2011	196.3	175.0	166.3	8.7	14.6	6.7
2010	195.8	174.7	165.9	8.8	14.7	6.4

Source: Office for National Statistics (ONS) National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA)

Table 3: Quarterly births figures for quarter 2 2010 – 2016 -RESTRICTED

Year and quarter	Number of live births (thousands)					
Q2 birth figures	United Kingdom	England and Wales	England	Wales	Scotland	Northern Ireland
2016	194.5	174.5	166.2	8.2	13.9	6.1
2015	193.5	173.8	165.5	8.3	13.8	5.9
2014	191.4	171.4	163.2	8.1	14.0	6.0
2013	190.7	170.8	162.6	8.2	13.9	6.0
2012	201.0	180.5	171.8	8.6	14.3	6.2
2011	200.5	179.7	170.8	8.8	14.7	6.2
2010	197.1	176.1	167.5	8.6	14.7	6.3

Source: Office for National Statistics (ONS) National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA)

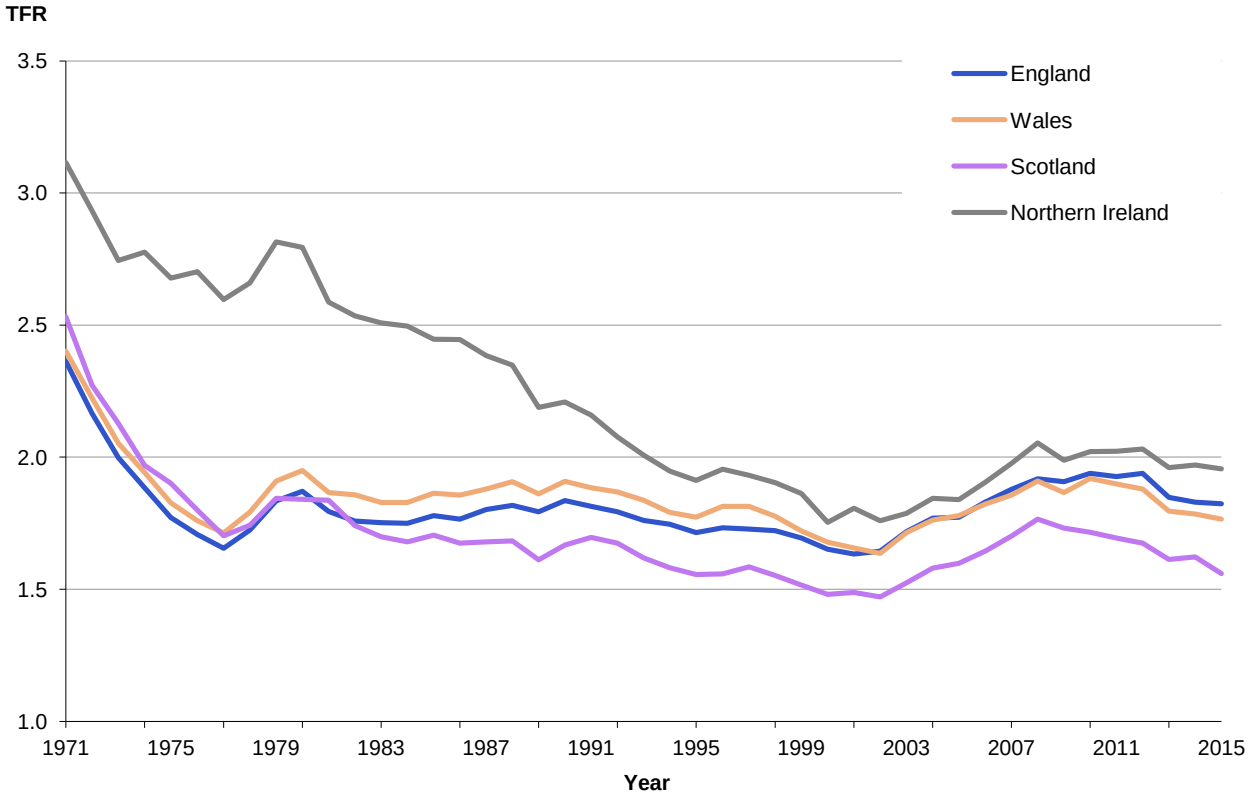
4.2. Differences in TFR between UK countries

Figure 2 shows the differences in TFR for the countries of the UK over time. It is clear that Northern Ireland has traditionally had a much higher TFR than the other countries. Over time the difference between Northern Ireland and the other countries has narrowed, and remained roughly constant since 2000.

In contrast there is little difference between the TFRs of Scotland, England and Wales in 1971, but from 1980 onwards the Scottish TFR has dropped slightly and by 2015 is about 0.3 lower than England and 0.2 lower than Wales.

The Welsh TFR was slightly higher than the English TFR until 2002, when it converged and since then the fertility rates for England and Wales have been very similar, although diverging in the most recent years. All four countries show a similar trajectory over time, though Scotland's TFR declined from 2008 onwards compared to the roughly stable TFRs that England, Wales and Northern Ireland had between 2008 and 2012. In 2013 the TFR fell in all four countries of the UK, as figure 2 shows. TFR has continued to decline in all four UK countries since 2013.

Figure 2: TFR for constituent countries of UK, 1971-2015



Sources - Total fertility rates (TFRs) calculated by the Office for National Statistics (ONS) using birth registration data and population estimates from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

4.3. Age-specific fertility rates, UK

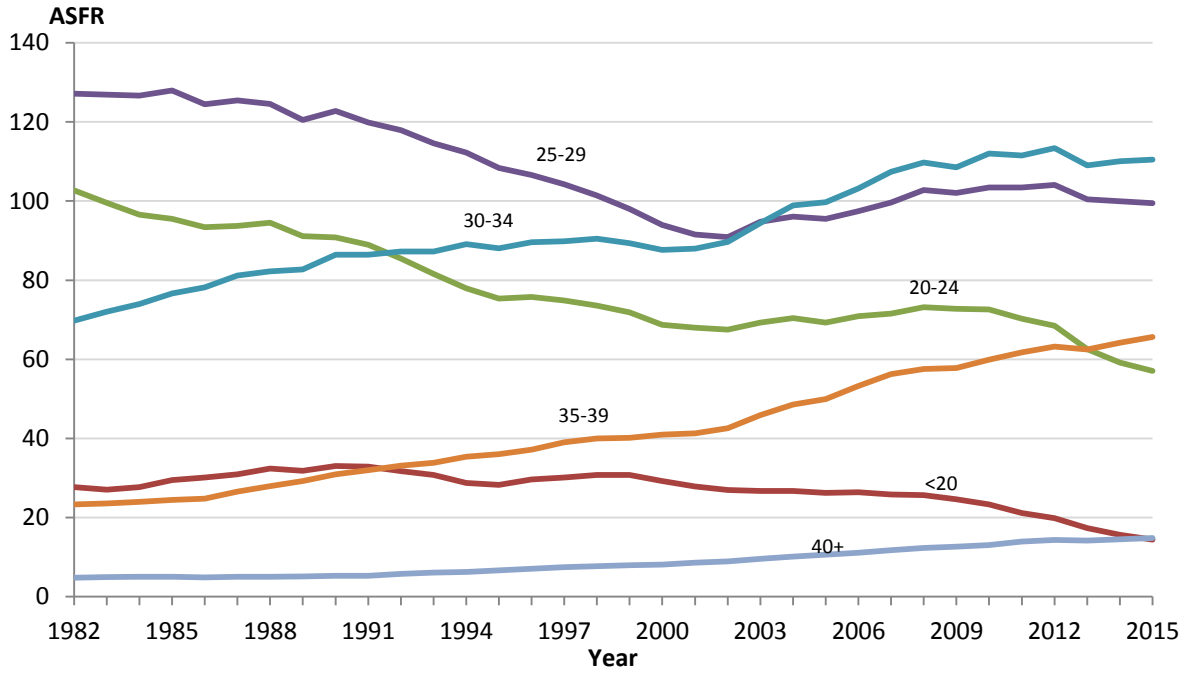
From 1982 to 2002 the general trend in the UK and all constituent countries was a decline in fertility rates at lower ages, and rises at older ages; this can be seen in figure 3. From 2002 to 2008 fertility rates for all age groups increased, with the exception of 20-24 year olds who had roughly stable fertility rates, and women aged under 20 who saw continued declines.

In 2004, the 30-34 age group overtook the 25-29 age group as the group with the highest age specific fertility rate.

From 2009 onwards there were small decreases for younger women, and continued small increases for women aged over 30.

In 2013, all age groups except women aged over 40 saw decreases in fertility rates. Over the last two years decreases have continued for women aged under 20 and women aged 20-24. Women aged 25-29 have seen quite stable rates, with women aged over 30 seeing continued increases. In 2015 women aged over 40 had higher age specific fertility rates than those aged under 20.

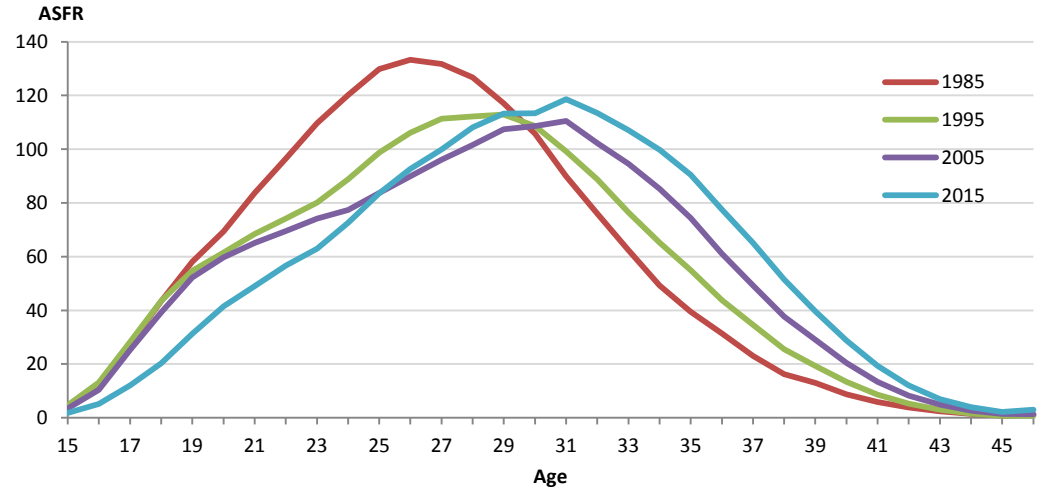
Figure 3: UK age-specific fertility rates 1982 - 2015



Sources – Age Specific Fertility Rates (ASFRs) calculated by the Office for National Statistics
(ONS) using birth registration data and population estimates from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

Figure 4 shows the age specific fertility rates by single year of age for 1985, 1995, 2005 and 2015. It is clear to see from this chart that fertility has been gradually moving to later ages, as seen by the move of the peak age of fertility to the right (from 26 in 1985, to 31 in 2015). The drop in the ASFRs at the youngest ages is also clear when the 2005 and 2015 curves are compared.

Figure 4: UK ASFRs by single year of age, 1985 - 2015



Sources – Age Specific Fertility Rates (ASFRs) calculated by the Office for National Statistics (ONS) using birth registration data and population estimates from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

4.4. Mean age at childbearing

Changes in the age patterns of fertility over the past two decades have led to steady increases in the mean age of childbearing in the UK and constituent countries. The figures in table 4 are age standardised, to allow for changes over time and differences between countries, in the age distribution of women of childbearing age.

Table 4: Mean age at childbirth (age-standardised), UK and constituent countries, 1985- 2015

	UK	England	Wales	Scotland	Northern Ireland
1985	27.3	27.3	26.9	27.0	28.2
1990	27.7	27.7	27.0	27.4	28.3
1995	28.2	28.2	27.5	28.0	28.7
2000	28.5	28.5	27.8	28.4	28.9
2005	29.1	29.1	28.4	29.1	29.5
2010	29.5	29.5	28.8	29.6	29.9
2015	30.3	30.3	29.6	30.3	30.5

Sources – Age standardised mean age at childbirth calculated by the Office for National Statistics (ONS) using birth registration data and population estimates from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

The UK mean age of childbearing has continued to rise in recent years, from 27.3 in 1985, to 29.1 in 2005. Since then it has increased even faster, to 30.3 in 2015. This rapid rise has occurred in all 4 UK countries, with Northern Ireland having the highest mean age of childbearing in 2015, of 30.5. The largest change in mean age of childbearing between 1985 and 2015 occurred for Scotland, with an increase of 3.3 years.

4.5. Birth order

Following changes to data collection at registrations, as a result of changes to the Population Statistics Act implemented in 2012, birth order information is now collected for all women in England, Wales and Scotland. Previously this

information was only collected for married women. (Full information was already available for Northern Ireland).

While these new data provide excellent opportunities for assessments of changes in births over time, at present there is not sufficient comparable data available to do meaningful comparisons between years.

In 2015 (the most recent year for which full data are available) it was estimated that 38% of births in England and Wales and Northern Ireland were first births. This estimate for first births in England and Wales is lower than previous estimates for England and Wales (the estimate for 2011, the last full year to use the older method was 42.7%), but as noted the figures use different methodologies and so are not directly comparable.

The contribution of each birth order to the England and Wales TFR is shown in table 5. Due to the changes in the data collected from 2012 onwards these data are not directly comparable to previous years and so only results for 2013 onwards are shown.

Table 5: Contribution of birth orders to TFR (2013-2015)

Year	All live births	England and Wales				
		First birth	Second birth	Third birth	Fourth birth	Fifth and later birth
2013	1.85	0.69	0.67	0.30	0.11	0.07
2014	1.83	0.69	0.66	0.29	0.11	0.07
2015	1.82	0.70	0.66	0.28	0.11	0.07

Source: Office for National Statistics (ONS)

4.6. Period parity progression ratios

Parity progression ratios (PPRs) show the proportion of women who go on to have a birth of the next order. These are simple to calculate for cohorts who have finished childbearing but provide information that is somewhat out-of-date. From the order-specific fertility rates estimated as part of the birth order probability model for England and Wales, it is possible to produce up-to-date PPRs for calendar years (using the synthetic parity cohort approach[ii]).

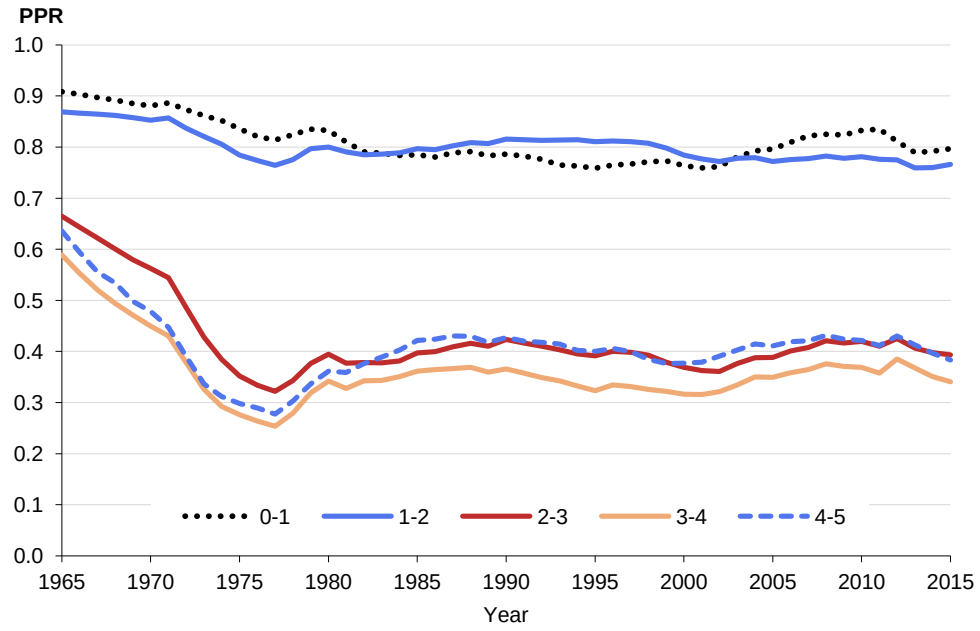
Although complex to estimate, period PPRs are straightforward to interpret. For example the PPRs for 2015 for England and Wales indicate that (at current rates) 80% of women will have a first birth while 77% of those who have a first birth will go on to have a second birth. Progression to higher order

births is lower, with only 39% of women with two children going on to have a third birth, and 34% of those going onto a fourth.

Figure 5 shows that since 2001, progression to first birth (black dotted line) has steadily increased until 2011, while progression to second birth (solid blue line) has stabilised for England and Wales. Since 2003, women have been more likely to have a first birth than to go on to have a second, contrary to the pattern seen during the 1980s and 1990s. This is likely to be a result of strong recuperation at older ages, combined with smaller increases in fertility at younger ages up to 2008. This could be due to older women who postponed childbearing starting families, i.e. having first births, but possibly not having time to have further children.

In 2013 it can be clearly seen that all progression ratios have decreased, showing that the decline in fertility was caused by a fairly uniform slowing in fertility rather than drops in progression from any single parity of births.

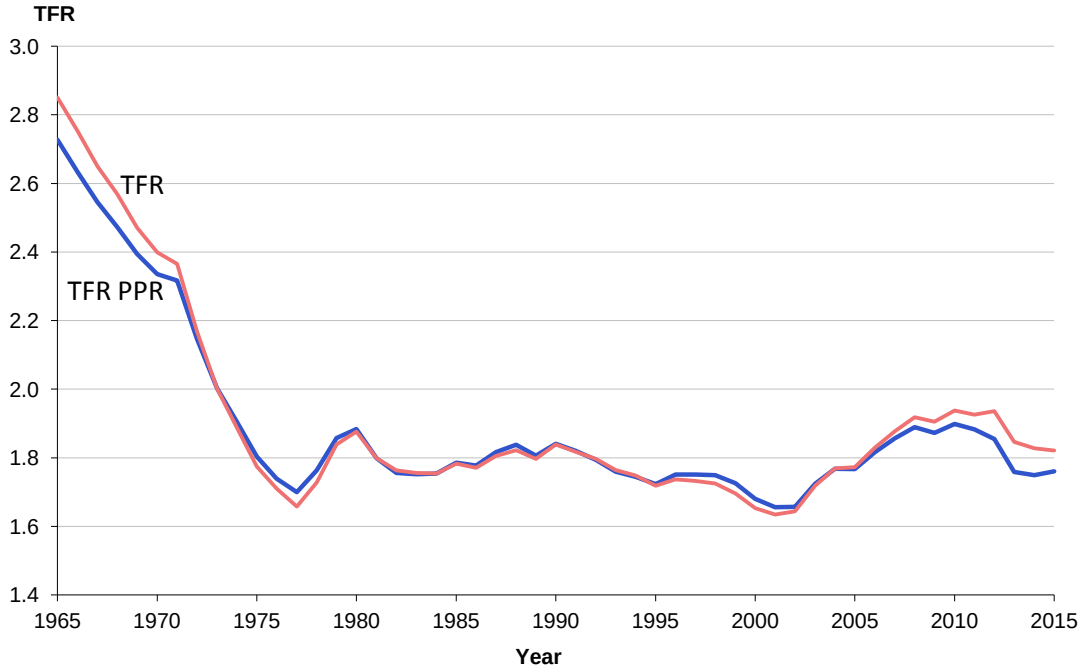
Figure 5: Period parity progression ratios (PPPR), England and Wales 1965-2015



Source: Office for National Statistics (ONS)

PPRs for progression to 3rd, 4th and 5th births showed declines in the 1960s and gradual recovery around 1981. Since then they have fluctuated slightly with small increases from 2001 – 2008. In 2015 PPRs for progression to 1st and 2nd births increased, whilst progression to 3rd, 4th and 5th births decreased slightly.

Figure 6: TFR estimated from parity progression ratios (PPRs) compared with usual TFR, England and Wales, 1965 to 2015



Source: Office for National Statistics (ONS)

The TFR is normally calculated from age-specific fertility rates, but can alternatively be calculated from PPRs. The TFR calculated using the parity approach has the advantage of being less prone to fluctuations due to changes in timing of births than the usual TFR, as well as reflecting better the decisions made by individuals about the number of children to have. Figure 6 shows how these two TFRs have differed since 1965. During the late 1990s, the parity-based TFR was consistently higher than the usual age-based TFR, while since 2006 it has been lower. The last period when the parity-based TFR was consistently lower was during the late 1960s-early 1970s.

Given that the parity-based TFR removes some of the timing effects, this suggests that the age-based TFR was under-estimating the level of fertility somewhat during the late 1990s, but is currently over-estimating the level of fertility slightly. This would support decreasing the assumption slightly.

4.7. Summary

In summary fertility rates climbed from 2001 onwards, and the UK experienced relatively high levels of fertility from 2008 – 2012, showing no discernible impact of the economic slowdown, except a small decline in 2009. However in 2013 the number of births decreased, and consequently the TFR decreased which has been sustained over the last two years. Provisional 2016 results appear to suggest that this decrease in births will be maintained at similar levels in 2016. This could have an impact on what both the short and long term pictures of fertility should look like.

5. Recent trends in cohort fertility

5.1. Completed family size, UK

A steady decline in completed family size (CFS) has been witnessed for cohorts born since the mid-1930s. Table 5 shows the average number of children achieved by each age for different cohorts of women. Among women who have completed their childbearing, average achieved fertility has fallen from 2.22 children for the 1945 (not shown in table) cohort to 1.90 for the 1970 cohort, the most recent cohort to complete childbearing.

Table 6: Achieved family size by exact age for selected UK cohorts

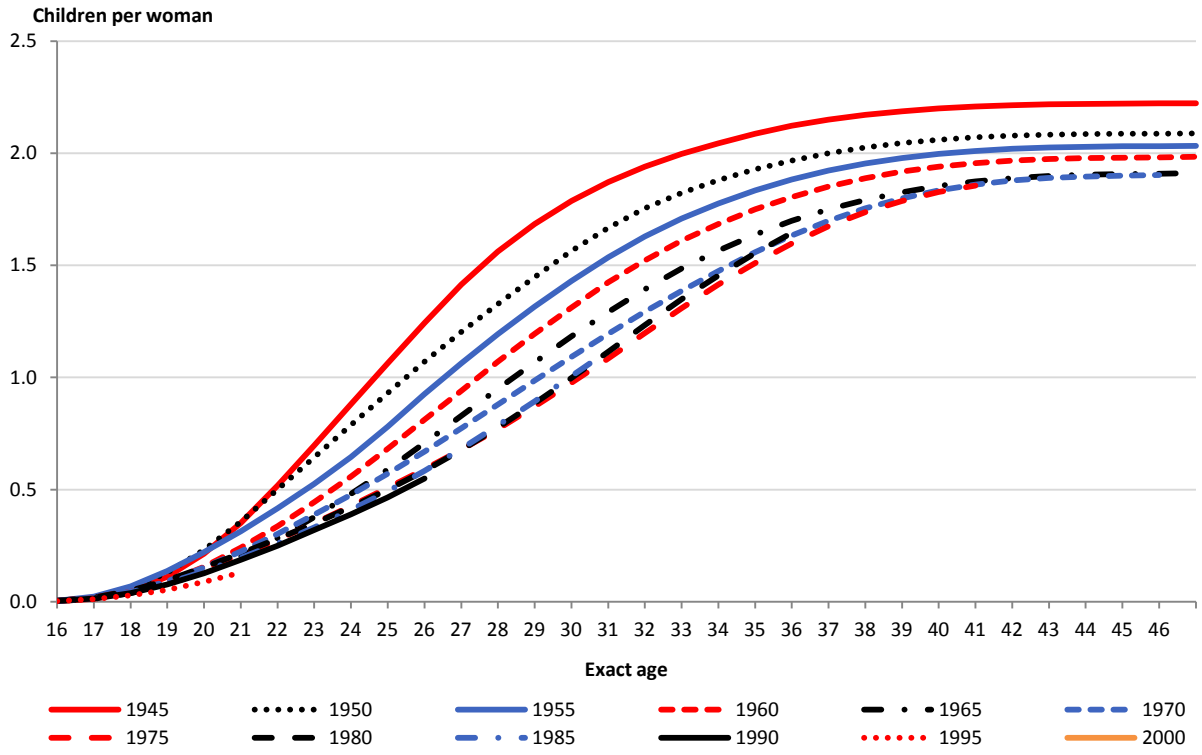
Year of birth	Exact age of woman						
	20	25	30	35	40	45	final
1950	0.23	0.93	1.56	1.93	2.06	2.09	2.09
1955	0.22	0.78	1.43	1.83	2.00	2.03	2.03
1960	0.16	0.68	1.31	1.75	1.94	1.98	1.98
1965	0.13	0.59	1.18	1.64	1.85	1.91	1.91
1970	0.15	0.57	1.09	1.56	1.83	1.90	1.90
1975	0.15	0.51	0.98	1.51	1.83		
1980	0.15	0.50	1.00	1.55			
1985	0.14	0.49	1.01				
1990	0.13	0.47					
1995	0.09						

Source: Office for National Statistics (ONS)
The ages of women are presented in 'exact years'. Therefore figures should be interpreted as the average number of children a woman has had up to that actual birthday. For the purposes of population projection, ‘final’ completed family size is that achieved by the end of age 46.

5.2. Achieved family size

Of more interest for projections is the achieved fertility of women who have not yet completed their childbearing. The 1965, 1970 and 1975 cohorts have had steadily fewer children by the ages of 20, 25 and 30 than earlier cohorts, and this trend continues with the data now available for the 1980, 1985 and 1990 cohorts. There is however an exception to this. As seen in figure 7, the achieved family size of the 1980 cohort at age 30, and beyond and the achieved family size of the 1985 cohort at age 30, is slightly higher than that of the 1975 cohort. This increase corresponds to the rising fertility rates for 25-29 year olds in the period 2002-2008.

Figure 7: Average achieved family size by exact age, UK 1945-2000 birth cohorts



Source: Office for National Statistics (ONS)

The latest data, shown in figure 8 indexes the achieved family size of recent cohorts against the 1970 cohort (the solid black line at 1.0). This allows us to see the changing pattern of fertility for cohorts who have not completed their childbearing, and make assumptions about how their completed fertility might look.

Compared to the 1970 cohort, the 1975 cohort had higher achieved family sizes up to age 20, but then lower family sizes through their 30s before recuperating in their early 40s. This suggests that despite experiencing the low fertility rates around 2006 in their peak childbearing years, this cohort will still have around the same CFS (completed family size) as the 1970 cohort.

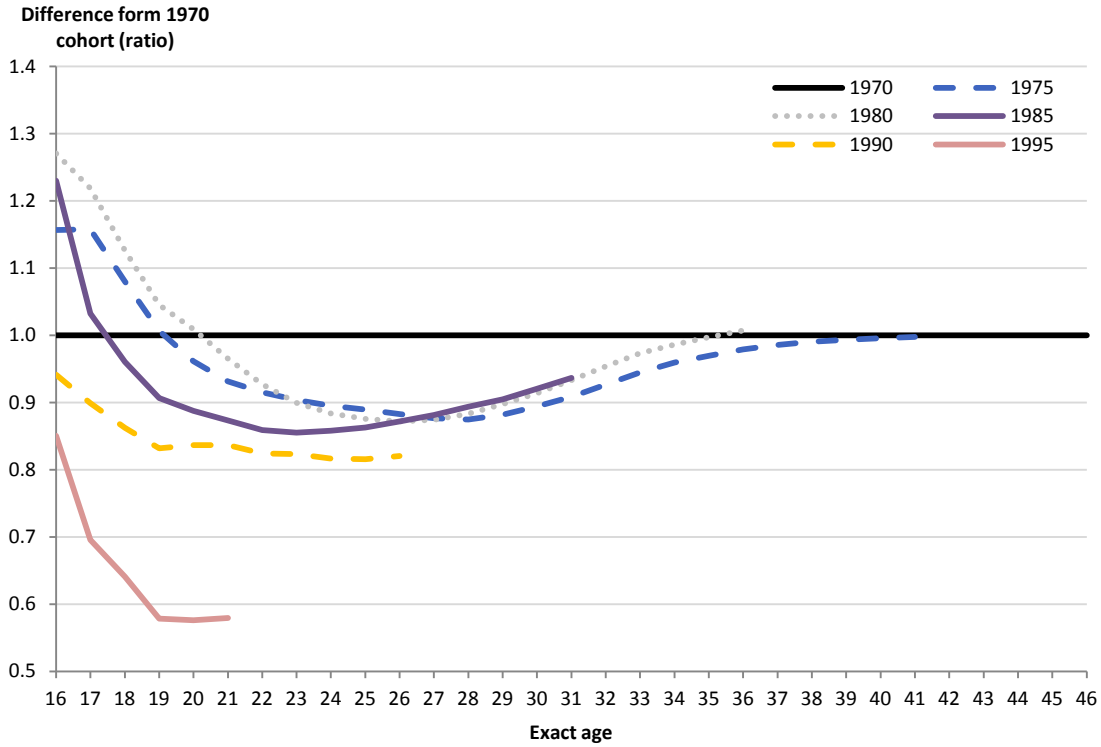
The 1985 cohort initially has lower achieved family sizes than the 1980 cohort, but by age 29 it has overtaken both the 1975 and 1980 cohorts. This suggests that it might recover more strongly and achieve higher CFS than these previous cohorts.

More recent cohorts have tended to have higher achieved family sizes in their teens, but then fall substantially behind the 1970 cohort in their 20s, with gradual recovery through their 30s. The most recent cohorts, represented in this chart by the 1990 and 1995 cohort have seen lower achieved family sizes in their teenage years, and steeper declines over time. Although only a few years of data are available for these cohorts, it does seem to have

substantially lower achieved family sizes so far, as a result of continuing falls in period teenage fertility rates.

The 2014 based projections for the 1990 and 1995 cohorts were CFS of 1.98 and 1.90 respectively. To achieve this CFS the 1990 cohort would have to increase its fertility to slightly above the 1970 cohort by the time they reached their CFS (about 4% higher than 1970 cohort), and for the 1995 cohort it would have to match CFS of the 1970 cohort. For the 1995 cohort to match the family size of the 1970 cohort it would have to have higher fertility rates at key childbearing ages over a sustained period, to catch up the "deficit" it currently shows (as illustrated by the large dip in family size by age 19).

Figure 8: Achieved family size by exact ages, indexed against 1970 cohort



Source: Office for National Statistics (ONS)

In summary the cohorts up to 1985 and possibly 1990 are expected to reach or even exceed the CFS of the 1970 cohort, but the picture for the 1995 and later cohorts is unclear, due to the much lower teenage fertility they have experienced.

5.3. Relationship between period and cohort fertility

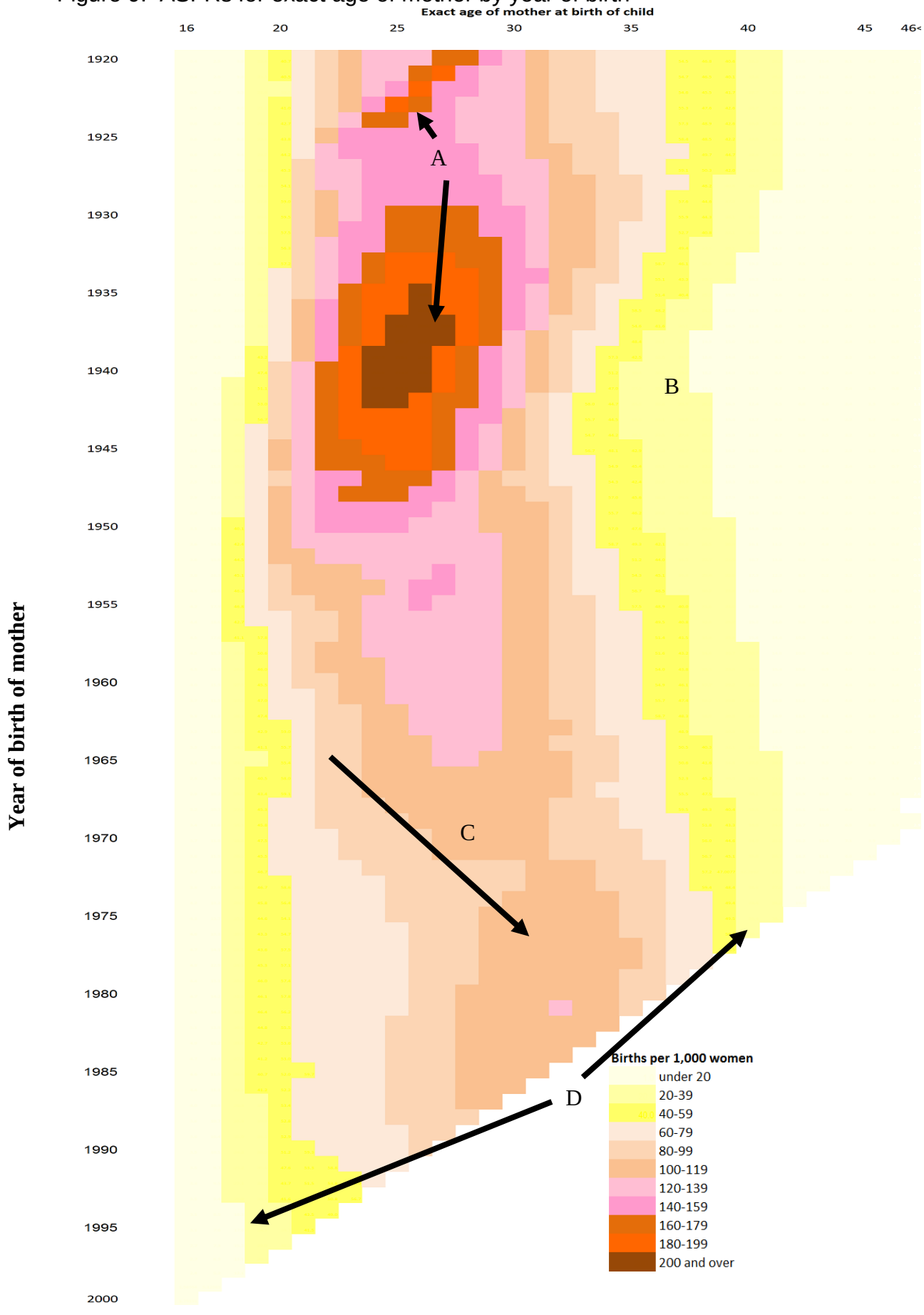
The heat chart (figure 9) brings together period and cohort trends in age-specific fertility in pictorial form for easier interpretation. The age of the woman at childbirth is represented on the horizontal axis, with each age represented by one column. Woman's year of birth is given on the vertical axis, with a row for each year. Therefore each calendar year is represented by a diagonal line of cells across the chart with 2015 being the bottom diagonal line. The highest

periods of fertility are coloured in orange and dark brown, with light yellow showing the lowest fertility.

The chart shows the following aspects of the relationship between period and cohort fertility:

- (A) The high fertility observed immediately after World War II occurred for a shorter time and at a slightly lower level than the high fertility in the 1960s and early 1970s. However both periods of high fertility mainly affected women in their twenties.
- (B) Recent rises in fertility levels are still much lower than those experienced in previous “baby booms”. In 2015, fertility rates of more than 100 children per 1,000 women are observed for women aged 29 to 34, one of the widest age ranges since 1990. In contrast the lowest number of age groups to reach this level of fertility was in 2001-2002, when fertility rates were particularly low for twenty-something women who were born in the 1970s.
- (C) The peak age for fertility has gradually risen over the decades from the mid-20s for those women born in the 1960s and early 1970s to around age 30 for those born in the late 1970s.
- (D) There is clear evidence on the chart of an increase in the fertility of older women, for women born from 1945 onwards and of a decrease in fertility for teenage women born since 1970.

Figure 9: ASFRs for exact age of mother by year of birth



6. Expert views on future fertility

6.1. Introduction

In February/March 2017, eight academic experts working in the field of demography were asked for their views on UK fertility trends over the next 25 years, via a questionnaire. This was followed by the NPP Expert Advisory Panel discussion in April 2017, which seven of the experts attended.

6.2. Expert assessment of long-term UK fertility level

The experts were asked for their views on the most likely level of the TFR in 2040. Their TFR predictions ranged from 1.60 to 1.90. The predictions fell into three groups, with two experts predicting between 1.60 and 1.65, three predicting 1.80 and three experts predicting between 1.86 and 1.90.

The average TFR predicted for 2040 was 1.79, which is substantially below the average predictions from the previous projection round (1.83 in the 2014 based projections). This is very similar though to the 2008-based expert prediction of a TFR of 1.79 in 2032. However it is worth noting that the membership of the panel between the 2014 and 2016 based projections was unchanged, so a lower predicition of long-term TFR is likely to be due to a change in the experts' views.

On average, experts believed that there was a 67% chance of the TFR in 2040 lying between 1.63 and 1.96, and a 95% chance of it lying between 1.52 and 2.09, a smaller confidence interval than in the 2014-based round of projections. (Figures 10 and 11).

Figure 10: Experts' estimates of the UK TFR in 2040 with 67% confidence intervals

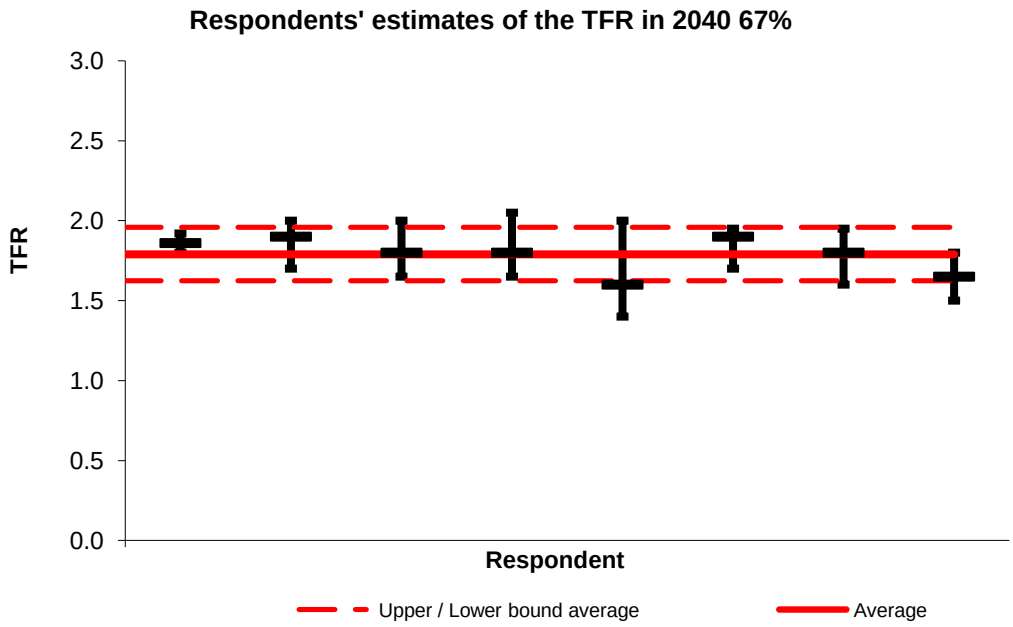
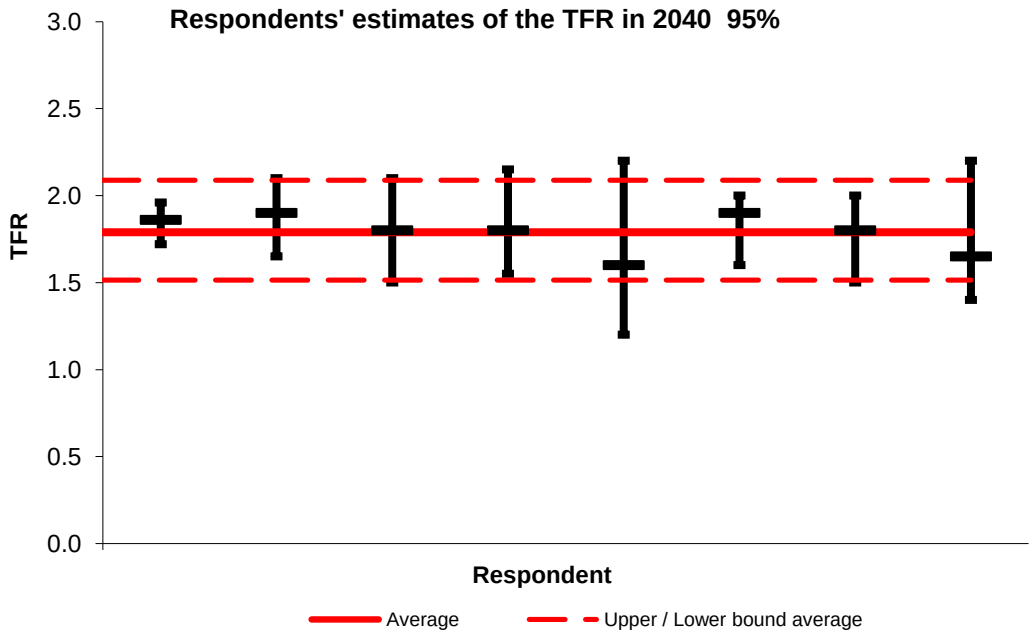


Figure 11: Experts' estimates of the UK TFR in 2040 with 95% confidence intervals



No discussion of likely sub-UK fertility rates in 2040 and the differentials between the UK countries took place.
There was no consensus among the experts around exactly what the TFR would be in 2040, and all commented on the difficulty of predicting TFR into the future, given the range of conflicting forces, and their uncertain impact.

There was a general consensus among the experts that the long term assumption of 1.89 in the 2014-based assumptions should be lowered.

Via the questionnaire and advisory panel discussion, experts also gave useful input on specific topics (migration, economic climate). This is incorporated in section 7 where appropriate.

6.3. Expert assessment of UK fertility trends in the short-term

The advisory panel was asked to assess the likely trend in fertility up to 2020 and their reasoning, and to estimate the likely TFR in 2020.

6.3.1. Likely short-term trends in fertility

The experts reached a broad consensus that the short-term trend was likely to be fairly stable or subject to a small decrease, with continued decreases in teenage fertility, accompanied by continued increases in fertility for women aged 40 and over.

There was consensus on the likely short term ASFR trend for women in their 20's with experts suggesting that there would continue to be small declines in fertility rates for this age group. There was broad agreement that fertility would continue to increase for women in their 30's.

All experts felt teenage fertility would continue to fall, though one expert did question whether these teenage births could simply be delayed rather than never occur.

A large amount of uncertainty was discussed or highlighted by the experts surrounding the UK vote to leave the European Union. Many experts cited job and economic security along with unknown levels of migration as factors which make understanding future levels of fertility difficult in both the long and short term. The experts also cited housing availability and stability as factors likely to affect fertility and completed family sizes in the future.

6.3.2. Quantitative estimates for 2020

The experts were asked to quantify the most likely level of the TFR in 2020, together with plausible ranges which would cover roughly 67 and 95 per cent of possible values. Figures 12 and 13 show the predictions for 2020, with a black bar representing each expert and the red lines representing the average level and range.

Forecasted TFRs for 2020 ranged from 1.70 to 1.82. The mean was 1.78, a lower prediction than in the 2010, 2012 and 2014-based projection rounds.

Figure 12: Experts' estimates of the UK TFR in 2020 with 67% confidence intervals

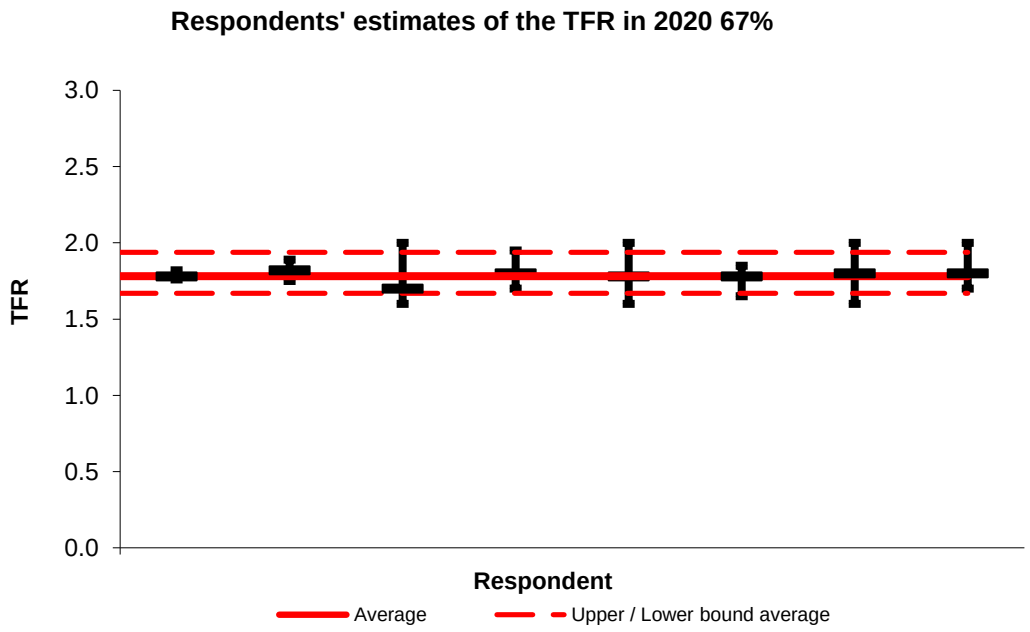
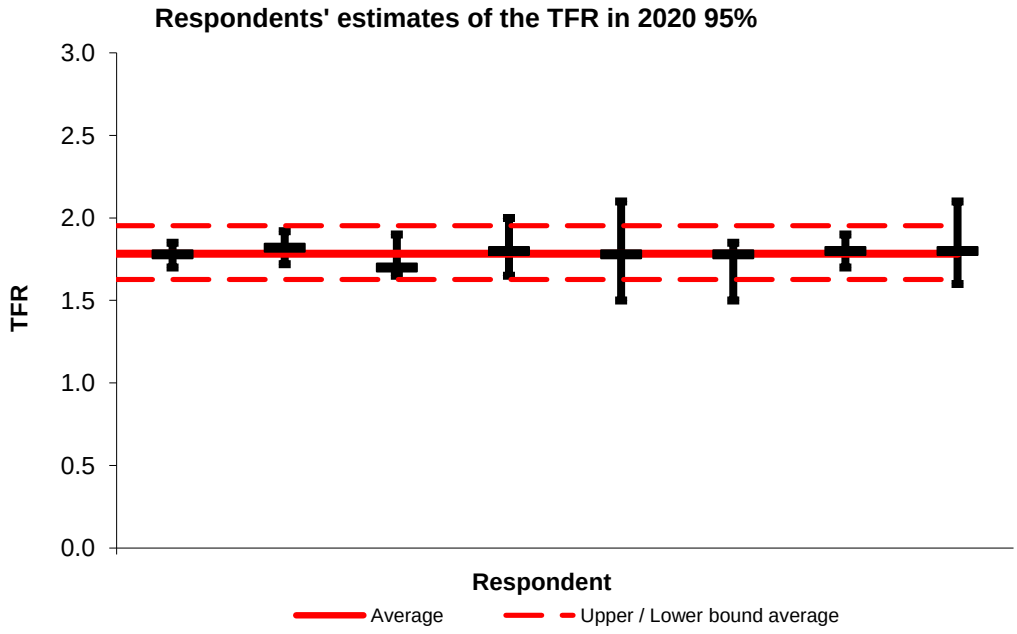


Figure 13: Experts' estimates of the UK TFR in 2020 with 95% confidence intervals



On average, experts believed that there was a 67% chance of the TFR lying between 1.67 and 1.94 in 2020, and a 95% chance of it lying between 1.63 and 1.95. This underlines the uncertainty inherent in estimating future fertility, even within a short timescale.

6.4. Underlying forces that may influence future fertility

The advisory panel was asked to consider six forces with the potential to affect fertility levels in the long-term (to 2040). By considering a range of arguments within each force they were asked to assess the overall likely impact on future family size. The experts emphasised that the effect of some forces were complex and sometimes conflicting.

The force ‘Changes in population composition and differential trends in population’ showed a good degree of consensus among the experts with the majority thinking that this factor would have a small upwards effect on fertility rates. The expectation was that advances in ‘assisted reproductive technologies’ would have a small upward effect on fertility rates in older women, and assist women in meeting their desired family size. The experts were uncertain about the long term effect.

The major driver of change for the population composition force was felt to be migration patterns and the fertility differentials between UK born and immigrant women. The experts noted that fertility among immigrant women still showed large differences, with some immigrant groups having fertility well below UK born women, while others had much higher fertility.

This led to discussion of the danger of projecting forward cohorts, given that more than 25% of births in the UK are to women born outside the UK. This suggests that cohorts of women in the UK may not be genuine cohorts, due to the violated assumption of a closed population.

Cohort fertility analysis assumes that women in a particular cohort experience the fertility rates of the country throughout their childbearing lives. International migration violates this assumption as a segment of the women will have experienced other fertility rates for parts of their reproductive lives. The effect of this will depend on the relative level of the “other” fertility rates compared to those of the UK.

The majority of experts felt that ‘Trends in patterns of education and work (including the proportion of time dedicated to the professional side of life)’ would have little effect or a small downward effect on fertility, but there was discussion about whether saturation level had been reached in the UK for further education, and whether ‘time since leaving education’ might be a better indication of women’s fertility behaviour than raw age.

There was discussion of the force ‘Trend in ideal family size and (the strength of) individual desires for children’, but the experts reached no consensus on how this would affect fertility patterns, other than to acknowledge that desired family size can differ from observed family size across a range of settings.

The final two forces:

- Trends in income (including indirect income such as free childcare hours),

- Changing nature and stability of partnerships, for example the rise of cohabiting parents;

had little agreement among the experts.

In addition to the forces we asked the experts about, they were invited to supply any other forces they felt would be important in shaping future fertility. Experts felt that housing shortages and costs, economic (including employment) uncertainties, political change, migration policy, the UK leaving the European Union, social media and interpersonal interaction and the gender division of domestic work were also factors that could affect UK fertility in the long term. They agreed that quantifying the impact of these factors would be challenging.

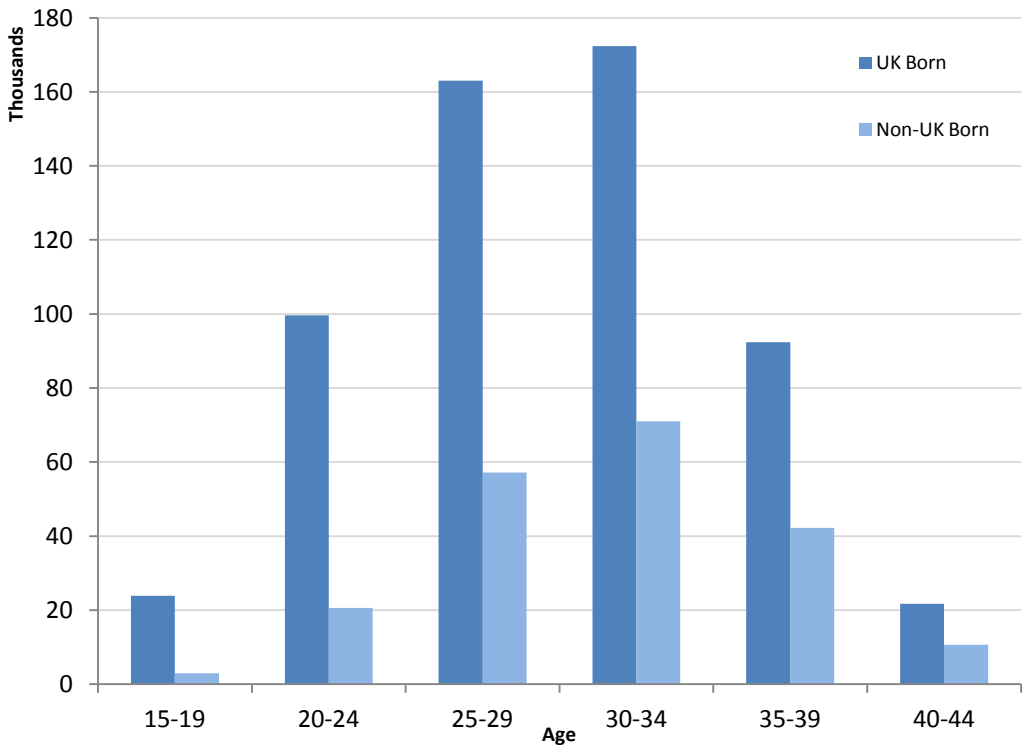
7. Underlying influences on fertility

7.1. International migration

7.1.1. Births to UK born and non-UK born mothers

Registration data can indicate the current impact of net international migration on births. In 2001, 15.3% of births in the UK were to mothers born outside the UK. By 2015 this had increased to 26.3%. Figure 14 shows that while the majority of births in the UK occur to women who were born in this country, births to non-UK born women make a substantial contribution to births in most age groups; over a quarter of births to women aged 25 and over being to women born overseas[iii].

Figure 14: Live births in the United Kingdom to UK born and non-UK born women, by age group, 2015



Source: Office for National Statistics (ONS), National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

Table 7 shows the top ten non-UK countries of birth of mothers who had a live birth in 2015. These 10 countries account for around half of all births to non-UK born mothers, with more than a quarter of the births to non-UK born women occurring to mothers born in Poland, Pakistan and India. Poland has been the most common non-UK country of maternal birth since 2009 overtaking Pakistan.

Table 7: Top ten countries of birth for non-UK born mothers of live births in the UK, 2015

Position	Country of maternal birth	Thousands
1	Poland	25.7
2	Pakistan	18.1
3	India	14.4
4	Romania	9.1
5	Bangladesh	7.8
6	Nigeria	7.2
7	Lithuania	5.3
8	Germany	5.1
9	Somalia	4.7
10	South Africa	3.8

Sources: Birth registration data from the Office for National Statistics (ONS), National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

Between 2004 and 2015 the number of births in the UK, to UK born women, has shown an overall fall of 2.1% to 573,000 (Table 8), the lowest number of births to UK born women for the years shown in the table. Before the fall between 2012 and 2015, with the exception of 2009 (which saw a small blip in birth numbers), the number of births to UK born women has been stable at around 613,000 births a year since 2008.
Births to non-UK born mothers increased every year between 2004 and 2012, with the number of births increasing by 50% over this time period. Births to non-UK born mothers decreased to 197,000 in 2013, from 201,000 in 2012, increasing again to 204,000 births in 2015.

Table 8: Number of live births to women living in the UK, for UK born and non-UK born mothers, 2004 to 2015

Thousands

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
UK born mothers	585	582	594	603	613	605	614	612	612	582	577	573
Non-UK born mothers[1]	131	141	154	169	182	185	193	196	201	197	200	204
All mothers	716	723	749	772	794	790	807	808	813	779	777	777

1. Non-UK born mothers include those whose country of birth is not stated.

Sources: Birth registration data from the Office for National Statistics (ONS), National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

Numbers of births are affected by both population factors (size and age structure) and fertility rates. These factors are discussed in turn below

7.1.2. Female population by country of birth

In terms of the population of women of childbearing age (15-44), the UK-born population has fallen slightly between 2004 and 2015, from 10.9 million in 2004 to 9.9 million in 2015 (due to relatively small birth cohorts reaching their teens and the larger 1960s cohorts passing childbearing age). Meanwhile the non-UK born population of childbearing age has increased substantially, from 1.5 million in 2004 to 2.6 million in 2015, because of net migration. The net migration flow of non-UK born females aged 15-44 to and from the UK was on average 112,000[iv] for each year from 2004 to 2013.

As a result, the estimated percentage of women of childbearing age in the UK who were born outside the UK has increased from 11.9% in 2004 to 21.0% in 2015 (estimates from the Annual Population Survey (APS)[v]). These percentages vary considerably between the UK countries as shown in Annexes A to D. The percentages of women born outside the UK are highest at ages 25-29, 30-34 and 35-39, the peak childbearing ages, where more than one-quarter of women are non-UK born.

Tables 9 and 10 show selected country of birth groupings[vi] and the top ten countries of birth for women aged 15 to 44 born outside the UK but resident here in 2015. Around one in five women of childbearing age were born outside the UK. Of the women born abroad, over one third were born in the EU (excluding the UK), nearly one fifth in the Indian subcontinent and close to half elsewhere in the world.

Not surprisingly, there is a similarity between the top ten individual countries of birth for women of childbearing age living in the UK (Table 10) and those identified earlier for women giving birth in 2015 (Table 7), with Poland topping both lists and Pakistan and India the other countries in the top three.

Table 9: Estimated population of females aged 15-44 by country of birth[vii], UK, 2015

Country of birth	Population (thousands)	Percentage
UK born	9,922	79.0
Non-UK born	2,617	21.0
Total	12,539	100.0
Non-UK born breakdown		
Republic of Ireland	46	1.8
EU15[1]	329	12.6
EU Accession countries[2]	657	25.1
Indian sub-continent	451	17.2
Rest of World	1123	42.9
Unknown	11	0.4
Total[3]	2,617	100.0

1. Excludes UK and ROI (see endnote vi)
2. EU Accession 8 + Malta, Cyprus, Bulgaria, Romania and Croatia (see endnote vi)
3. Totals may not sum due to rounding.

Source: APS January-December 2015, ONS.

Table 10: Estimated population of foreign born females aged 15-44 living in the UK, by country of birth, top ten countries, 2015

	Country of birth	Population (thousands)	Percentage of all females aged 15-44
1	Poland	340	2.7
2	India	200	1.6
3	Pakistan	143	1.1
4	Romania	87	0.7
5	Germany[1]	80	0.6
6	China	72	0.6
7	Bangladesh	72	0.6
8	Nigeria	64	0.5
9	Lithuania	63	0.5
10	South Africa	63	0.5

1. The figures for Germany include British women whose parents were serving in the armed forces in Germany when they were born.

Source: APS January-December 2015, ONS.

7.1.3. Fertility rates for UK born and non-UK born women

For setting fertility assumptions, fertility rates are of most interest. Quantifying the contribution of migrants to recent increases in fertility is far from straightforward, not least because a woman who was born outside the UK may not be a recent migrant. While the fertility of 'migrants' cannot be measured directly, the fertility of women born in the UK can be compared with the fertility of non-UK born women.

The estimated TFR[viii] for UK born women showed an increase from 1.67 children per woman in 2004, to 1.86 in 2012 before recording a considerable fall, to 1.76 children per woman in 2013 and falling further to 1.75 in 2015. (Table 11).

Table 11: Estimated TFRs by country of birth of mother, UK, 2004-2015

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
UK Born	1.67	1.67	1.73	1.76	1.81	1.8	1.83	1.85	1.86	1.76	1.76	1.75
Non-UK Born[1]	2.45	2.41	2.37	2.45	2.43	2.36	2.36	2.20	2.18	2.12	2.08	2.06
All Women[2]	1.77	1.77	1.82	1.87	1.92	1.9	1.93	1.92	1.93	1.84	1.83	1.82

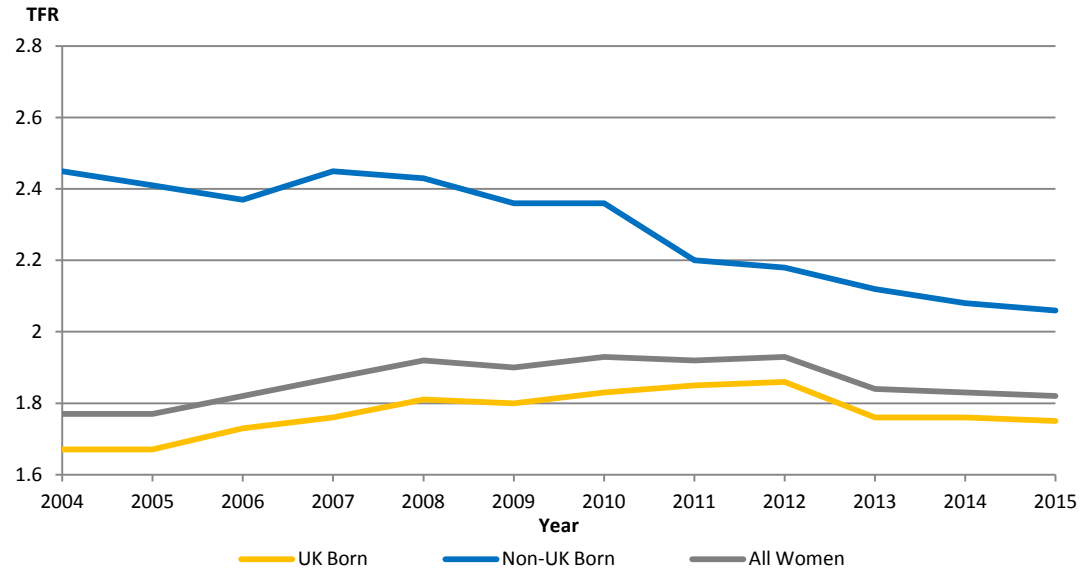
1. Non-UK born women include those whose country of birth is not stated.
2. These fertility rates use Annual Population Survey (APS) data in their calculations; therefore the rates for 'All women' may differ slightly from published national figures based on mid-year population estimates as denominators.

Sources: Total fertility rates (TFRs) calculated by the Office for National Statistics (ONS) using birth registration data from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

In contrast the non-UK born fertility rate rose to a peak of 2.45 in 2007, before dropping year on year to 2.12 in 2013 and further to 2.06 in 2015. However, between 2010 and 2015 the TFR showed a decrease from 2.36 to 2.06, a drop of 0.30 children per woman. This was because the estimated foreign born population of childbearing age increased while the number of births only increased by a smaller rate.

The difference between the TFR for UK born and the TFR for non-UK born has narrowed since 2004 because of an overall rise in the UK born TFR and a drop in the non-UK born TFR (Figure 15). Small increases (2008-2012) in the overall UK TFR were mainly due to increasing fertility among UK-born women, as evident in the parallel rise in the fertility rate for UK born and the overall fertility rate for the UK. Decreases in both the UK born and non-UK born TFR in the most recent years have contributed to declines in the overall fertility rate for the UK.

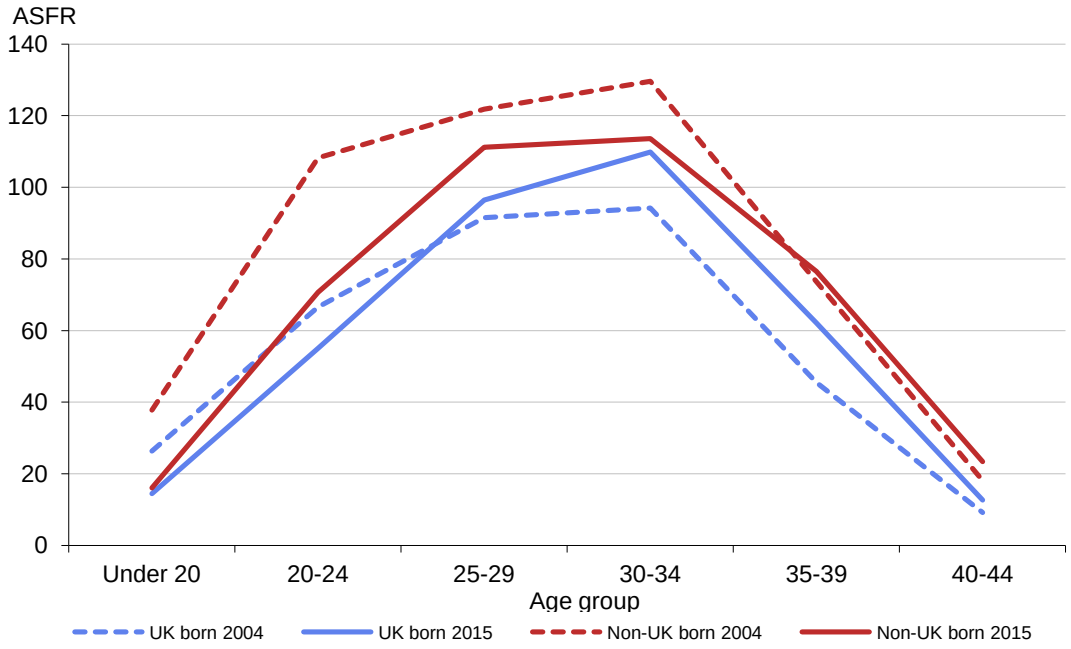
Figure 15: Total fertility rates (TFR) in the UK, for UK born and non-UK born women, 2004 to 2015



1. Non-UK born women include those whose country of birth is not stated.
2. These fertility rates use Annual Population Survey (APS) data in their calculations; therefore the rates for 'All women' may differ slightly from published national figures based on mid-year population estimates as denominators.
Sources: Total fertility rates (TFRs) calculated by the Office for National Statistics (ONS) using birth registration data from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).ONS, NRS and NISRA.

The impact of the fertility of non-UK mothers on overall UK fertility stayed almost the same between 2011 and 2015. Throughout this time period it can be inferred that average UK fertility was about 0.07 of a child per woman higher[ix] because of the presence of women born outside the UK. Although the TFR for non-UK born women decreased in 2013 and further again in 2015, the impact remained unchanged, at 0.07 children per woman. Therefore the contribution of non-UK born women to overall fertility is relatively small, despite their higher TFR, a finding consistent with that seen in other European countries[x].

Figure 16: Age-specific fertility rates for UK born and non-UK born women, UK, 2004 and 2015



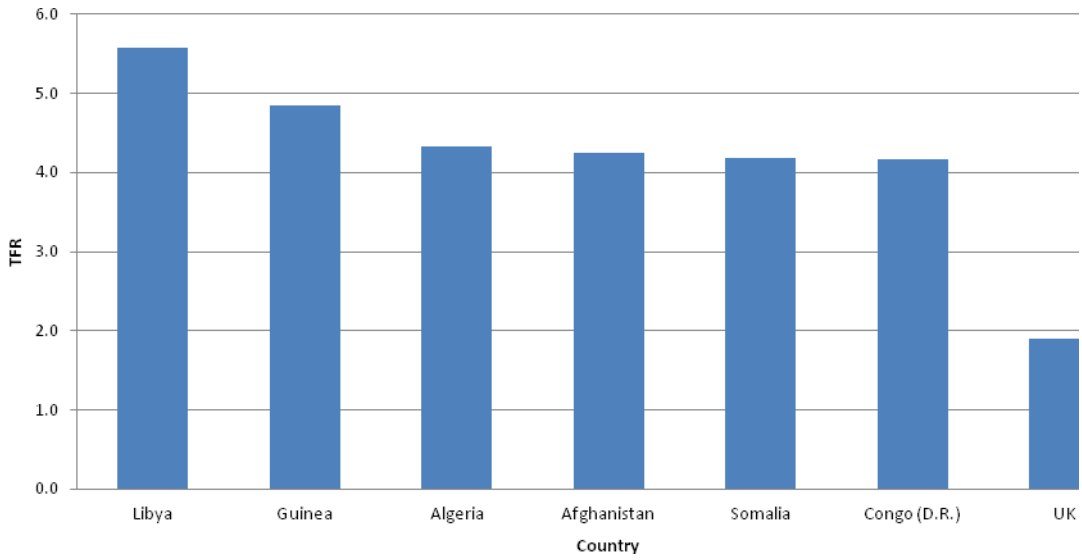
1. Non-UK born women include those whose country of birth is not stated.
2. The age-specific fertility rates (ASFR) are calculated by ONS. The 15-19 age group includes births to under 15 year olds and population estimates for women aged 15 to 19. The 40-44 age group uses births to women aged 40 over and population estimates for women aged 40 to 44 (from the Annual Population Survey (APS)).
Sources: Age-specific fertility rates (ASFRs) calculated by the Office for National Statistics (ONS) using birth registration data from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA).

In 2015, fertility rates for non-UK born women were above those of UK born women in all age groups (Figure 16). Both groups had similar age-patterns of fertility, with the peak age for having children being 30-34, followed by 25-29 years. Since 2004, the fertility rate has shown the greatest rise for UK born 30 to 34 year olds and the largest drop for non-UK born 20 to 24 year olds. As a result there is greater similarity between the age specific rates for the two groups in 2015 than in 2004.

Clearly women born outside the UK are not a homogenous group in terms of fertility. Total fertility rates (TFRs) for individual countries of birth are available for Census years. Total fertility rates for women born in specified country groups based on the 2011 Census in England and Wales showed that women born in Libya had a TFR of 5.6 and those born in Guinea had a TFR of 4.8, compared with the TFR of 1.9 for UK born women (Figure 17). Of those non-UK maternal countries of birth displaying the highest TFRs (4.0 or above), 5

out of 6 in 2011 were African including Algeria, Somalia and Democratic Republic of Congo.

Figure 17: Total fertility rates (TFRs) for the top six non-UK maternal countries of birth and for UK born women, E&W, 2011



Sources: Total fertility rates (TFRs) by mothers' country of birth calculated by the Office for National Statistics (ONS) using birth registration data and 2011 Census population data.

Total fertility rates for UK born and non-UK born women will be sensitive to changes in the timing of fertility within women's lives. International research has noted that immigrant women typically have low fertility prior to immigration, followed by high fertility immediately after immigration[xi]. If this were also the case in the UK, the estimated TFR for foreign born women could be inflated by this timing effect. In order to obtain a true picture of differences in completed family size between UK born and non-UK born women, it is more useful to look at the actual completed fertility of those aged 45; however this approach has other pitfalls and cannot tell us anything about the fertility of recent young migrants.

Research has shown that migrant women living in western, northern and southern Europe typically retain higher levels of fertility than the native populations, but this difference generally reduces with duration of stay[xii]. This adds complexity to interpreting the impact migrant women will have over time. The impact of international migration on past and current fertility rates is difficult to quantify precisely, due to data and methodological restrictions. However it is clear that even if net migration fell to zero immediately, international migration would continue to have an impact on fertility for many years to come. The impact of both past and future international migrants on future fertility will depend on several factors including:

1. Future changes in the numbers of in-migrants and their origin countries. (Effected by for example policies relating to migrant workers),
2. Changes in future fertility rates in origin countries
3. Differentials in fertility rates between future in-migrants, existing first and second generation in-migrants and the indigenous UK population. For example, if the number of women of childbearing age in the UK who were born in Poland continues to increase relative to other groups, this could act to decrease the overall fertility of non-UK born women living in the UK in future[xiii], given that the fertility of this group is lower than seen in some other non-UK born groups.
4. The extent and speed of convergence in these fertility rates[xiv]
5. Future emigration patterns among UK born and non-UK born women.

7.2 Higher education

7.2.1. Research

In post industrial societies it has traditionally been accepted that higher education (HE) for women may lead to postponement of partnership formation and parenthood, which in turn may lead to lower eventual completed family size (both for those participating in HE and for those cohorts on aggregate). Rising levels of female participation in HE may also influence the relative values attached to family life versus other individual aspirations, such as careers, and thus affect intended family size.

A study by Bhrolchain and Beaujouan[xv] (2012) has investigated the relationship between educational enrolment and the postponement of childbearing in Britain and in France in the 1980s and 1990s. In their conclusion they stated that a "sizeable part of the increase in the age at first birth" could be attributed to "changing educational enrolment"; that is an increase in the number of women lengthening their education into their late teens and early twenties. They also noted that the "best educated women postponed their first birth after completing their education, by more than the less well educated". Further work by Berrington et al[xvi] (2014) shows that "a rise in the median age at first birth has been most pronounced among highly educated women".

Previous ONS work[xvii] found that, among women born in England and Wales in the mid-1950s, those who obtained a higher education qualification started childbearing on average five years later than women who did not, and then accelerated their subsequent childbearing. In addition they were more likely to remain childless. The work by Berrington et al (2014) also found evidence to show that childlessness has increased faster for the most highly educated women than for less educated women, twice the pace in the 1960-1969 cohorts.[xviii]

Cohort studies[xix] have shown that 42 per cent of women with university qualifications, who were born in 1970, were still childless by age 34. This is a higher proportion than the 35 per cent of graduates born in 1958 who were

childless at that age. In both cohorts the proportion childless was much lower among women with intermediate or no qualifications. The Northern Ireland Longitudinal Study suggested that more highly educated women were having births at older ages and spacing them more closely than those with no or lower qualifications[xx]. Research from Australia also supports this, stating that the proportion of 25-29 year old women with higher qualifications who were childless increased from 71 per cent in 1981 to 84 per cent in 1996[xxi].

Conversely, analysis of the relationship between education levels and fertility in Norway suggests the opposite; that the "inverse relationship between women's education and completed fertility has become less pronounced over time"[xxii]. Considering all levels of education, for women born from the 1940s to the 1960s, the authors even reported a slight increase in childbearing for the most educated women in the country. The prime explanation for this is the reduced incompatibility between working and childrearing, through policies to support mothers in the work place and greater equality between partners at home. This particularly influenced the decision of parents to have a second or third child.

Recent work by Tropf and Mandemakers (2016) found that family background plays an important role both in fertility timing and educational attainment suggesting a rise in educational attainment alone cannot explain differences in fertility timing between cohorts[xxiii].

A comparative study of education and birth timing in seven countries has confirmed these differences in the fertility-education relationship between countries such as Britain and Norway that have different family policy regimes[xxiv]. However it is possible that for the more recent 1970s and 1980s cohorts in the UK the negative impact of HE on completed family size could be much less prominent than for previous cohorts due to various policy changes over the past 15 years.

7.2.2. Trends in Participation in Further and Higher Education (HE)

There is no question that participation in higher education has increased in recent decades. The 2003 DfES White Paper[xxv] noted that in the early 1960s only 6 per cent of under-21s went to university, compared with over 40 per cent of 18–30 year olds in England at the start of the 21st century.

Figures released by the Department for Business Innovation and Skills[xxvi] in September 2016 suggest a slow increase in the Higher Education Initial Participation Rate[xxvii] for females from 47% in 2006/07 to 53% in 2014/15.

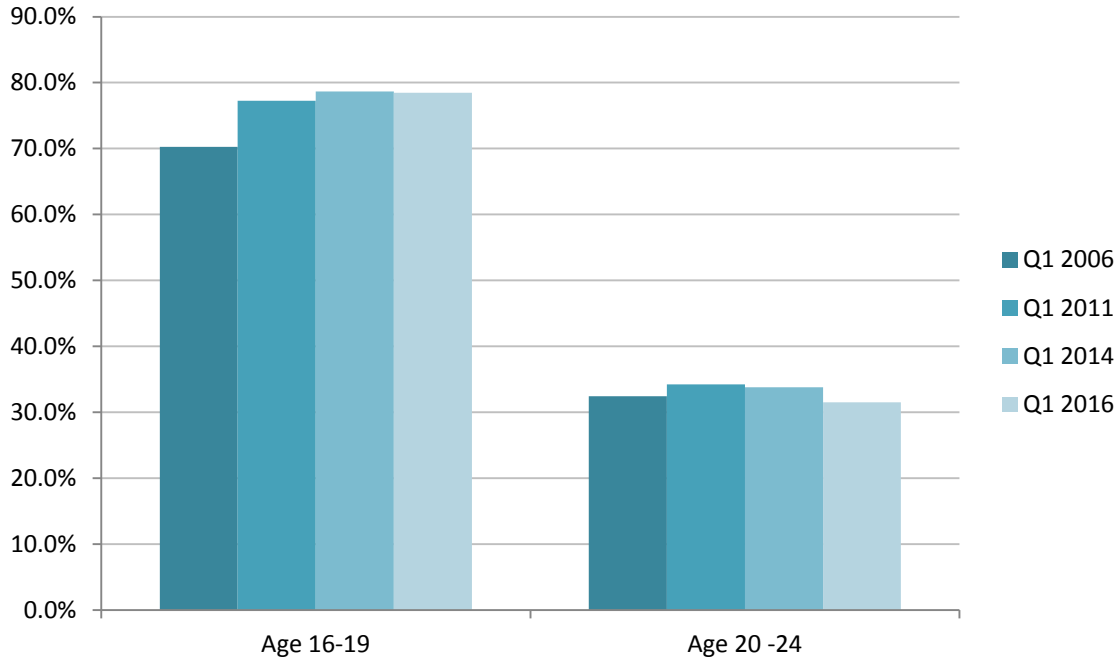
The HEIPR estimate for the 2012/13 academic year was 43%, down by six percentage points compared with the estimate for 2011/12 of 49%.The initial participation rate was estimated to be 46% for three consecutive years prior to 2011/12. The decrease in HEIPR was largely due to students choosing not to defer entry in 2011/12 resulting in reduced participation from 19 year olds in

2012/13, the year that tuition fee levels increased. HEIPR has seen a steady recovery from the low point in 2012/13.

In both 2006/7, 2010/11, 2013/14 and 2014/15 roughly three quarters of the female students aged 17-30 were under 20 years old at the start of their course[xxviii]. There does not appear to be any real shift in the age at which students are commencing study from this data.

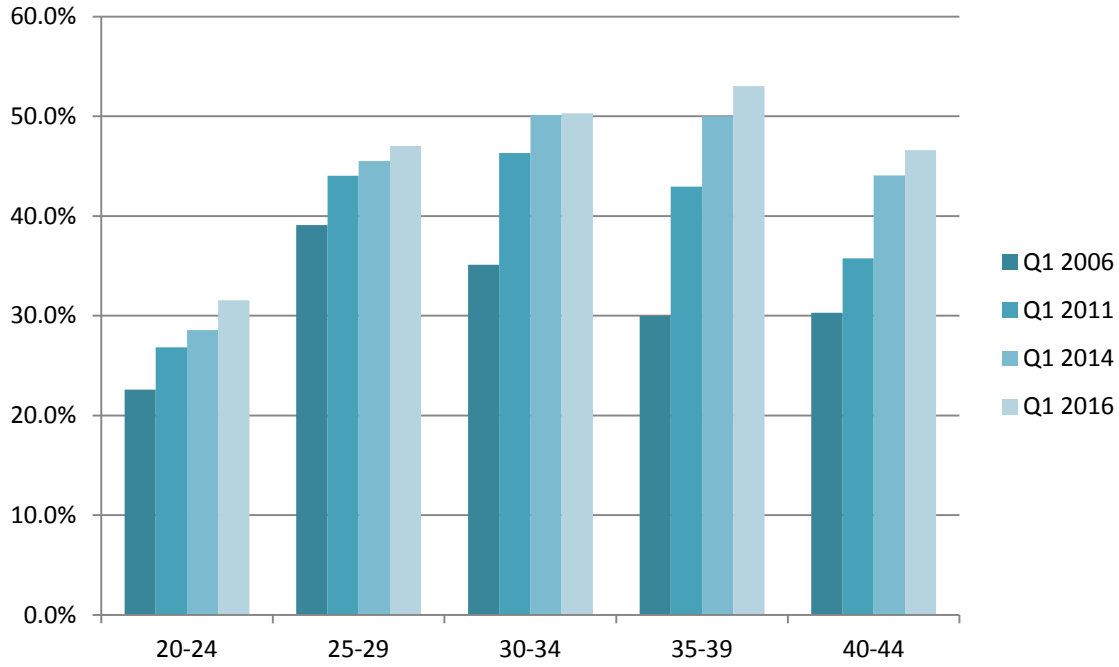
The gradual rise in study is supported by survey data from ONS. Figure 1 shows rising participation rates in education for women aged 16-19, and these rates are expected to continue to rise as further changes to school leaving age and participation age were introduced in 2014/15 school year[xxix], having risen to 17 in the 2013/2014 school year and then to 18 in 2014/15.

Figure 18: Proportion of women in UK currently studying



Source: Labour Force Survey (weighted data; Q1 wave shown), ONS
By Q1 2014 the school/participation leaving age had been raised to 17 but had not yet been raised to 18.
By Q1 2016 the school/participation leaving age had been raised to 18.

Figure 19: Proportion of women in UK with a degree or higher



Source: Labour Force Survey (weighted data; Q1 wave shown), ONS

Figure 18 illustrates the proportion of women undertaking study at the time of the survey interview. It is therefore not directly comparable to Figure 19 which shows the proportion of women who have actually achieved a higher educational qualification. Unlike the figures for 20-24 year old women who were studying, which are relatively stable at around 30%, the proportion of this age group who have achieved a HE qualification has continued to rise from 22.6% in 2006 to 31.5% in 2016.

Over time this change is gradually filtering its way through to the women in the older childbearing ages. This can be seen by the ageing on of the peak, as higher proportions of older women have a degree or higher qualification (e.g. for 2006 the peak is 25-29, for 2014 both 30-34 and 35-39 have roughly equal peaks and for 2016 the peak is seen for 35-39 year olds).

Similar trends are seen in all UK countries, but participation has been noticeably higher in Scotland for all cohorts. For example in Scotland 64.6 per cent of women aged 30-34 in 2016 had HE qualifications, compared with 50.1 per cent in the UK as a whole – this is likely to be having a dampening effect on Scottish period fertility due to postponement, but its impact on completed family size is less certain.

7.2.3. The future

For women currently aged 25 - 34, the proportion with higher qualifications is likely to stabilise in the next 10 years, in response to the broad levelling of participation in higher education from 2006 to 2013[xxx]. Therefore the impact of

HE participation on the fertility of 1980 - 1990 cohorts is likely to depend on to what extent well-educated women are able to combine employment and parenthood. It is possible that any negative impacts of higher education on competed family size have reached a plateau.

It is clearly harder to predict the level of future participation of young people in higher education and the impact this could have on the fertility of women born from 1995 onwards. The labour government was keen to widen participation in HE in particular to those from lower socio-economic groups by raising aspiration and achievements at younger ages[xxxi]. However when the Coalition government came to power, discussions around higher education focussed on tuition fees. It is possible that the rise in tuition fees from autumn 2012 will reduce the proportion of young people going into higher education in the long term; however the HEIPR estimates suggest that this might not be the case. The Labour Party manifesto[xxxii] for the 2017 General Election pledges the abolition of tuition fees in England. If this type of policy was put in place it could have impact on HEIPR increasing further.

The new legal requirement for young people in England to stay in education or training up to age 18 from 2015[xxxiii] does have scope to increase participation further as it is likely to lead to a larger pool of young people with qualifications to go into HE. The Higher Education Policy Institute mentions several groups where there could be latent demand for HE, such as disadvantaged social groups, but notes that there could be increased unmet demand for HE in future[xxxiv].

For women currently in their teens or younger who do enter higher education in the future, paying off higher tuition fees and maintenance loans after graduation could have the potential to delay starting a family. However Australian research by Yu et al (2007)[xxxv] suggests that having debt related to a higher education course did not have a significant effect on men's and women's expected lifetime fertility. More generally, the impact of HE on the fertility of the most recent birth cohorts, as for their predecessors, will depend to a large extent on their ability to combine employment and parenthood, itself dependent on policy and other factors.

7.3. The changing economic climate and changing policies affecting families

During the past nine years, the UK has experienced both a period of economic slowdown (starting in 2008) and two changes of government (in 2010 and 2015) with resulting changes to various policies. Both these factors could have impacts on fertility, so are discussed in turn below. However the two are clearly interlinked; while some policy changes following a change of government are ideological, others relate to the perceived need to cut government spending due to the economic climate.
It is likely that the results of a further General Election in 2017 and the UK voting, in 2016, to leave the European Union will have impact on future policies, international migration and stability of the economy. This in turn could

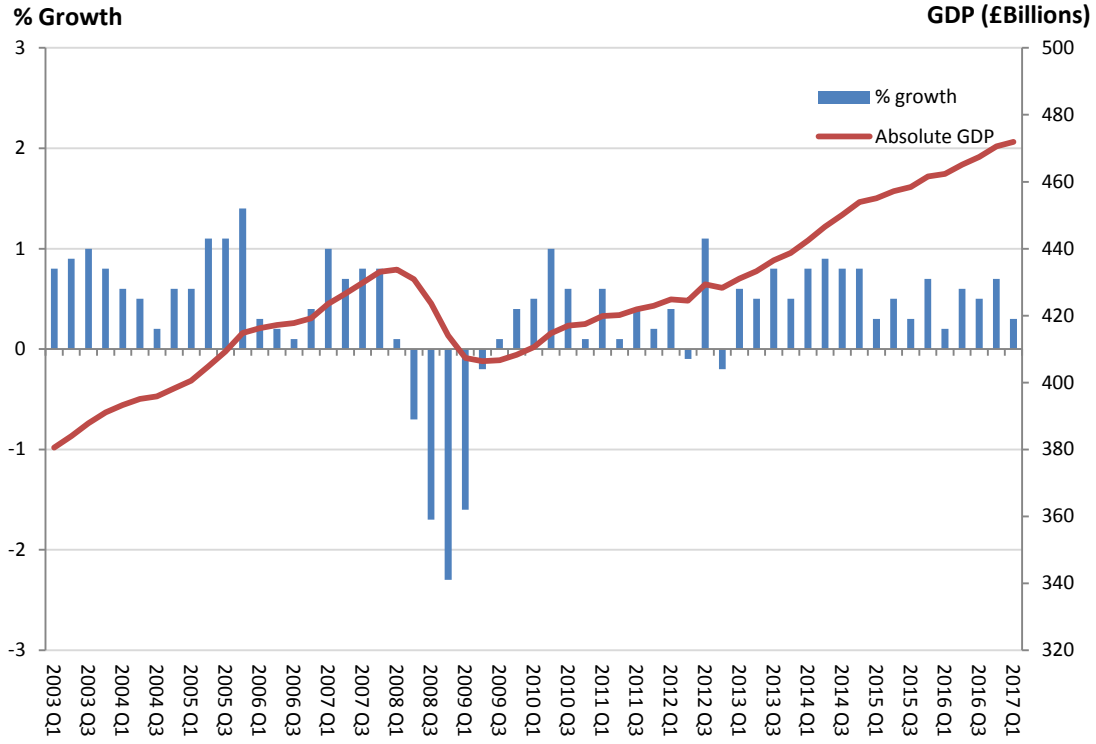
impact fertility levels in the UK. However it is too soon to say how this will manifest.

7.3.1. Economic climate

A detailed discussion of the relationship between the economy and fertility is outside the scope of this paper. A recent comprehensive review of the effects of recession on fertility in the developed world (Sobotka et al, 2011[xxxvi]) found some relationship between fertility and the economic cycle but noted that the effects tend to be small and temporary, and have more impact on the timing of childbearing than on the completed fertility of cohorts. The report also highlighted how changes in fertility behaviour during economic downturns vary by sex, age, social status, and number of children, with childless young adults often most affected.

Finally, the point was made that other country-specific factors such as policy can aggravate or mitigate the impact of recession on fertility. Looking at the most recent trends in TFRs, developed countries within the OECD have experienced the recent recession differently and no straightforward correlation or conclusion can be drawn. In particular Australia, which has a similar TFR trajectory to the UK throughout the period from 2004 -2013, experienced a very different economic situation to the UK since 2008. This shows that the link between economic and fertility trends can be complex and show unexpected associations.

Figure 20: % growth in GDP and absolute GDP for the UK 2003-2017



Source: Office for National Statistics (ONS)

Figure 20 shows the economic change over the past 14 years. GDP growth from 2000 to 2008 was fairly strong, as shown by the quarter on quarter growth bars. However, from in 2008, there was a sharp fall in GDP, and total GDP did not recover to pre 2008 levels until Q3 2013. From Q4 2013 onwards there was steady GDP growth.[xxxvii]

The UK TFR was rising from 2000 to 2008 and then was been broadly stable from 2008 to 2012. Although it is not possible to prove that the recession caused this change in trend, the 2011 expert panel agreed it was the most likely explanation, and cited the housing market as a plausible causal mechanism for this. The fact that fertility rates fell among women under 35 but continued to rise among those over 35 between 2008 and 2009 was consistent with the theory that a recession is more likely to have a downward effect on the fertility of younger women, who are more able to postpone their fertility until economic conditions improve. In contrast, older women may feel less able to put off having children due to their age and may be in a better financial position than their younger counterparts.

It is interesting to note that the 2013 fall in TFR coincides with the UK GDP surpassing its pre downturn peak. If a strengthening economy leads to rises in fertility then we would expect this to start showing from 2014 onwards in TFR figures. This has not been the case in the most recent TFR figures for 2014 and 2015. However it could be argued that GDP per capita is a better measure of how individuals feel the economic circumstances are for them. This has only recently started being reported for the UK. [xxxviii]

The 2013 downturn in fertility rates does not necessarily mean more recent cohorts will be affected significantly if they are postponing childbearing rather than deciding not to have children. If postponement is occurring then it is not unreasonable to expect period fertility to resume its rising trend once these cohorts have children at older ages.

7.3.2. Changes in policy that could have an impact on childbearing

Between 1997 and 2010, the Labour government introduced a wide range of policies with financial implications for pregnant women, parents and families. These ongoing commitments to supporting families were summarised in "Support for all: The Families and Relationships Green Paper"[xxxix] in January 2010. Policies included:

- Reforms to benefits for low-income families with children[xl], including the Working Families Tax Credit (WFTC) from 1999;
- Changes in financial support for all families with children, including the Child Tax Credit and increases in child benefit for first children. Adam and Brewer (2004)[xli] estimated that state financial support for children in the UK grew 52 per cent in real terms between 1999 and 2003;
- Policies that may have made it easier to combine employment with parenthood, including lengthening maternity leave, extending maternity pay, introducing paternity leave and the right to request flexible working[xlii];

- Changes to the provision of childcare, such as a legal duty on local authorities to provide childcare, and Sure Start Children's Centres[xliii];
- Introduction of the Child Trust Fund, Sure Start Maternity Grant and Health in Pregnancy grant.

The policies listed above were not put in place with the aim of influencing fertility; the drivers varied and included reducing child poverty, encouraging lone parents into employment and improving gender equality and social inclusion. However it is possible that they could indirectly have had an effect on childbearing decisions, for example creating an environment where women could more easily combine work with having a family may have had (and may still be having) a positive impact on fertility. This is consistent with the rising fertility rates seen over the last decade, but there is limited hard evidence of a causal relationship.

Brewer, Ratcliffe and Smith (2007)[xliv], for example, found that the Working Families Tax Credit had some positive impact on the fertility of women in couples, increasing the probability of a birth by 10 per cent, but it is not clear whether this also implies higher completed family sizes for these women or not - there is much debate over whether government policy can influence women's completed family sizes, rather than simply changing the timing of births[xlv].

A comparative study (Kalwij, 2010[xlvi]) on the impact of family policy expenditure on fertility in Western Europe found that subsidising the direct costs of children (e.g. via family allowances) had no impact, while reducing the opportunities costs of children (e.g. via childcare allowances) did have a small upward impact on completed family size. Specifically for the UK, a RAND review[xlvii] concluded that the investments in early childhood and changes to parental leave had only very small impacts on fertility, whereas the employment and tax credit policies of the Labour government may have had an unintended positive effect on fertility in the first decade of the 21st century. Recent increases in the cost of childcare may be having a braking effect on fertility growth, and may have contributed to the fall in TFR seen in 2013.[xlviii]

When the Coalition government came into power in May 2010, there were some significant changes in the policy realm. Perhaps the largest changes were the reforms introduced during 2013, with the aim of "simplifying the welfare system and making sure work pays"[xlix]. These included a range of changes such as:

- The introduction of Universal Credit – a single benefit for those looking for work or on a low income, replacing a variety of existing benefits including Child Tax Credit and Working Tax Credit. This is being phased in nationwide from 2015 to 2017 (pilot areas already have universal credit). Couples with children and lone parents are expected to benefit from the change.
- Changes to Housing Benefit – reduced Housing Benefit from April 2013 for those living in property deemed to be larger than they need.

Children under 10 are be expected to share a room, as are children under 16 of the same gender.

- A benefit cap –from April 2013 in England, Wales and Scotland, there has been a cap on the total amount of benefits that working age people can receive, so they cannot receive more than the average wage for working families. This cap is set at £500 per week for lone parents or couples with children. Lowering the level of this cap has been raised as a possibility following the Conservative win in the 2015 general election.[l]
- Benefit uprating – below-inflation (1%) increases in working age benefits and tax credits for three years from 2013-14. Includes maternity/paternity pay, and elements of child and working tax credits.
- Other changes to Disability Living Allowance and Council Tax Benefits.

Other changes introduced by the Coalition government that may be relevant to childbearing behaviour include:

- Child Benefit - a three-year freeze from April 2011; plus from January 2013 the removal (via the tax system) of Child Benefit from families where one adult earns over £50,000;
- Tax Credits – reducing/ withdrawing Tax Credits from higher-income households from 2011 and removing the 'baby element' from 2011, but increasing the 'child element' from 2012. These changes were then subsumed into the wider welfare reforms listed above;
- Parental leave - Additional Paternity Leave (up to 26 weeks) became available in April 2011 to fathers whose partner is returning to work[li], although take up of this has not been large[lii]. The Children and Families Act 2014[liii] introduced shared parental leave from April 2015, enabling new parents to choose how they share a year's worth of leave after the birth of their child.
- Flexible working – The Children and Families Act 2014 also extends the right to request flexible working to all employees. (Previously this only applied to employees who had or expected to have responsibility as a parent or carer.)
- Childcare - the government set out plans[liv] in January 2013 to increase the supply of high quality, affordable childcare and early education. Changes to childcare vouchers are also expected from late 2015[lv].
- Shared accommodation rate – from January 2012, housing benefits for single people without children who rent privately have been restricted for those aged under 35, rather than 25 previously[lvi].

Again, these policy changes by the Coalition government had a variety of drivers, including encouraging employment, reducing health inequalities and cutting government spending, rather than intending to influence fertility. There has been analysis of the impact of these policies on families' finances, [lvii] and this should be considered through the lens of the impact of finances on fertility.

It is difficult to say whether there has been any effect on fertility, but while the provisions in the Children and Families Act 2014 (principally rights around

flexible working) can be viewed as supportive of parenthood, other policies appear less family-friendly on the face of it than those in pre-austerity times. Potential impacts could affect two groups:

(a) those who have started their families and might be considering whether or not to have another child

(b) those who have not yet had children and whose childbearing choices may be affected by their current financial/housing situation or the perceived support available for families.

However, the impact of these changes on individuals' decisions to have first children or subsequent children is very difficult to infer and will vary between different groups of the population.

The Conservative government that came into power in 2015 pursued similar policies[lviii] to those of the Coalition government during their term in office. These included:

- Support for children through Tax Credits and Universal Credit being limited to 2 children from April 2017, with equivalent changes to Housing Benefit rules.
- Family element withdrawn in Tax Credit and Universal Credit- those starting a family after 2017 will no longer be eligible for the family element. In Housing Benefit, the family premium will be withdrawn for new claims from April 2016.
- Parents with a youngest child aged 3 including lone parents are expected to look for work in order to be eligible to claim Universal Credit.
- Tax-free childcare scheme launched in April 2017 (delayed from 2015) which will support parent's childcare costs and replace existing Employer Supported Childcare system.
- Universal Credit to benefit from additional £200m of support which is equivalent to covering 85% of childcare costs for households qualifying for Universal Credit childcare element.
- Universal Credit to be a qualifying benefit for Healthy Start Food Voucher Scheme to help teenage mothers, mothers in early pregnancy or with young children who are on low incomes.
- Free childcare entitlement will be doubled from 15 hours to 30 hours a week for working parents of 3+4 year olds from September 2017.

The impact of these policy changes are currently unknown. Maintenance of these policies will be dependent on the outcome of the 2017 General Election.

Initial work from Stone and Berrington (2017 submitted)[lix] shows that there is evidence 'that means-tested family allowances and provision of subsidised housing encourages larger families…' where the 'likelihood of having a third or fourth birth was significantly higher for low income women, those in receipt of means-tested family allowances, and women living in government-subsidized social housing'. These findings suggest that recent changes to Tax Credits and Universal Credit being limited to 2 children from April 2017 could have an

impact on the progression to higher order births and therefore completed family sizes for a particular group of women.

The discussion above has not covered teenage fertility, one area that UK governments have sometimes directly tried to influence. For example the 1997 – 2010 Labour government set out in 1999 an explicit aim to reduce teenage pregnancies in the Teenage Pregnancy Strategy[lx], which ended in 2010. The 2010 Coalition Government did not have a specific policy in this area, but changed the focus to health; the under 18 teenage conception rate was one of three sexual health indicators in its Public Health Outcomes Framework for 2013 to 2016[lxi] and remains one of the indicators in the revised framework for 2016 to 2019[lxii]. The under 18 conception rate in England and Wales continued to fall in 2012 and 2013 [lxiii] reaching, in 2015, its lowest level since comparable statistics began in 1969. Other policy changes such as raising the participation age (in education or training) to 17 in 2013 and 18 in 2015[lxiv] could also have some impact on teenage fertility, as mentioned in section 7.2.

8. International context

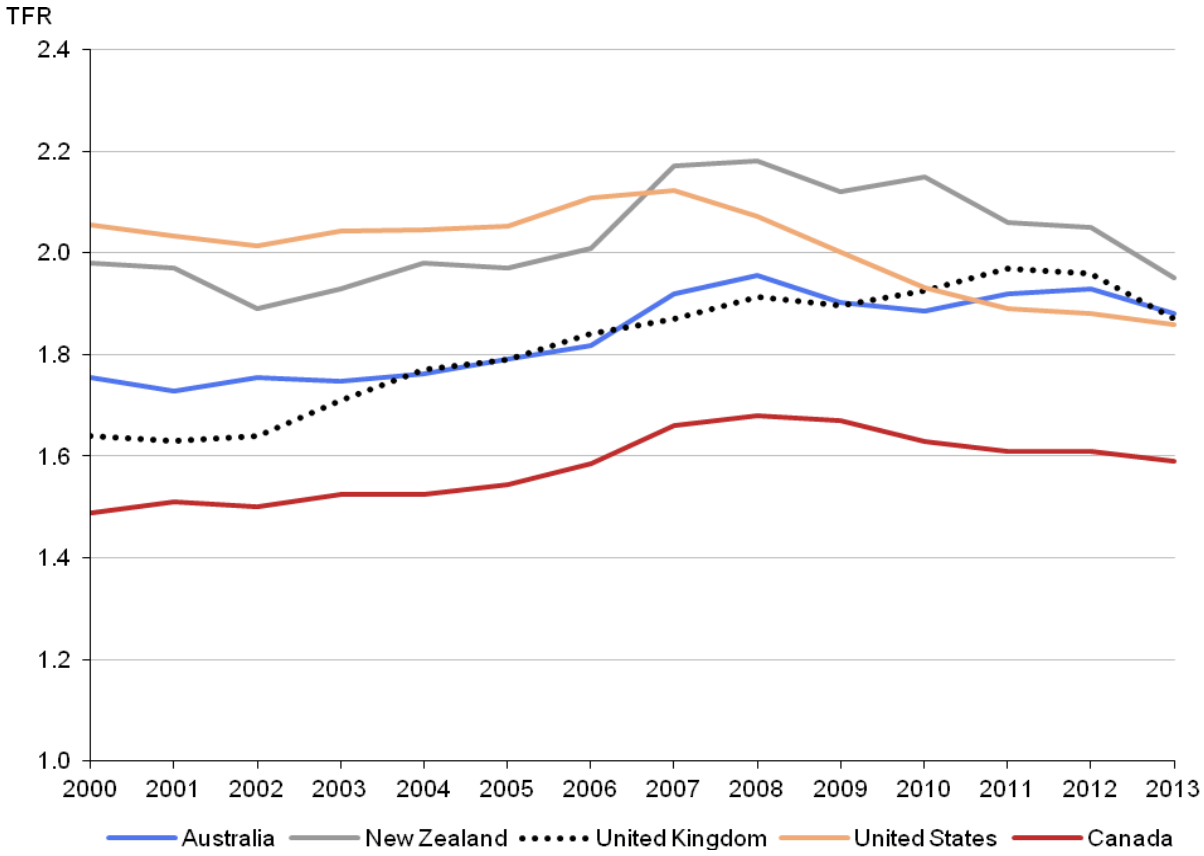
8.1. Trends in International total fertility rates

Figure 21 shows TFRs in a selection of English-speaking OCED countries over time from 2000 to 2013. A period of a modest recovery in total fertility rates which started in the early 2000s is clearly noticeable. Total fertility rates in all these selected OECD countries have increased from the early 2000s up to 2008 (or 2007 in the case of the USA).

The last few years (since 2008) have seen various trends emerge in fertility rates. A consistent fall in fertility rates has occurred in Canada, New Zealand and the United States, while rates have remained pretty stable in the UK as in Australia.
In all cases, total fertility rates in all the selected OECD countries have dropped dramatically in 2013 and are below the replacement level of 2.1. Persistent economic uncertainties can impact downward the number of children women may have over their reproductive life.

However, as countries within the OECD have experienced the recent recession differently, no straightforward correlation or conclusion should be drawn. In particular Australia, which has a similar TFR trajectory to the UK throughout this period, has experienced a very different economic situation to the UK since 2008.

Figure 21: TFRs in selected OECD countries, 2000 - 2013

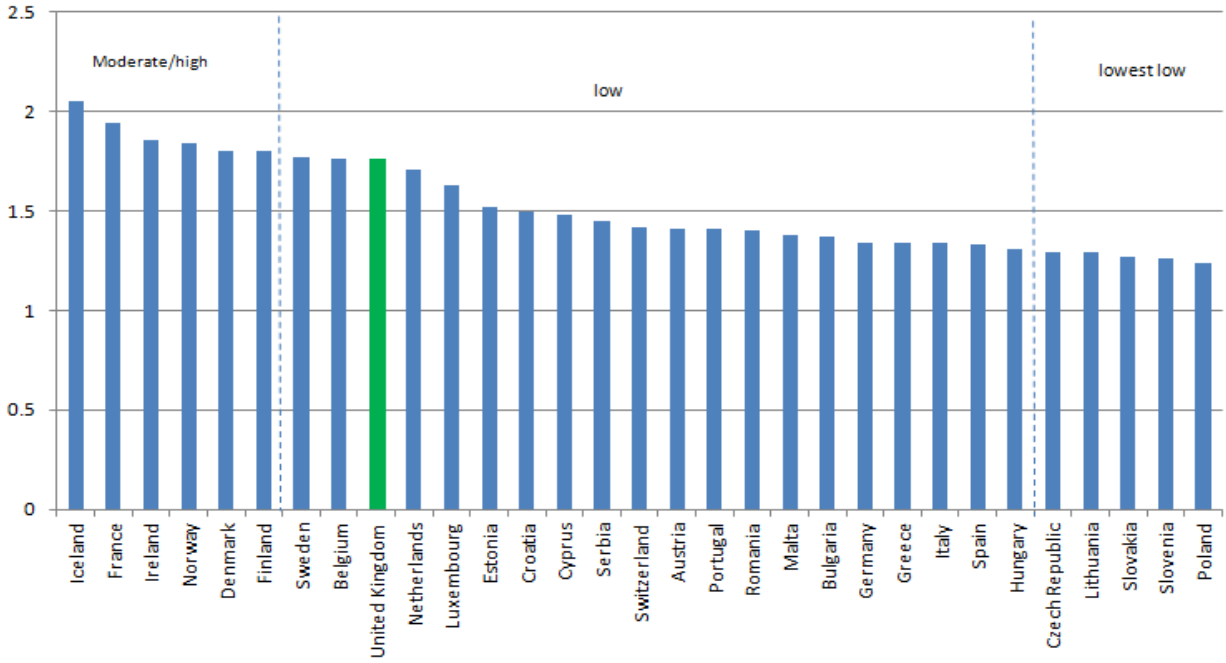


Source: OECD and ONS

Figure 22 shows TFRs in selected European countries in 2005. The spread of below-replacement fertility in Europe is striking, and most EU countries have become the leaders in the global trend towards low and very low fertility. Authors such as Kohler et al. (2002) have named these patterns of total fertility rate at or below 1.3 children per woman as 'lowest-low' fertility.

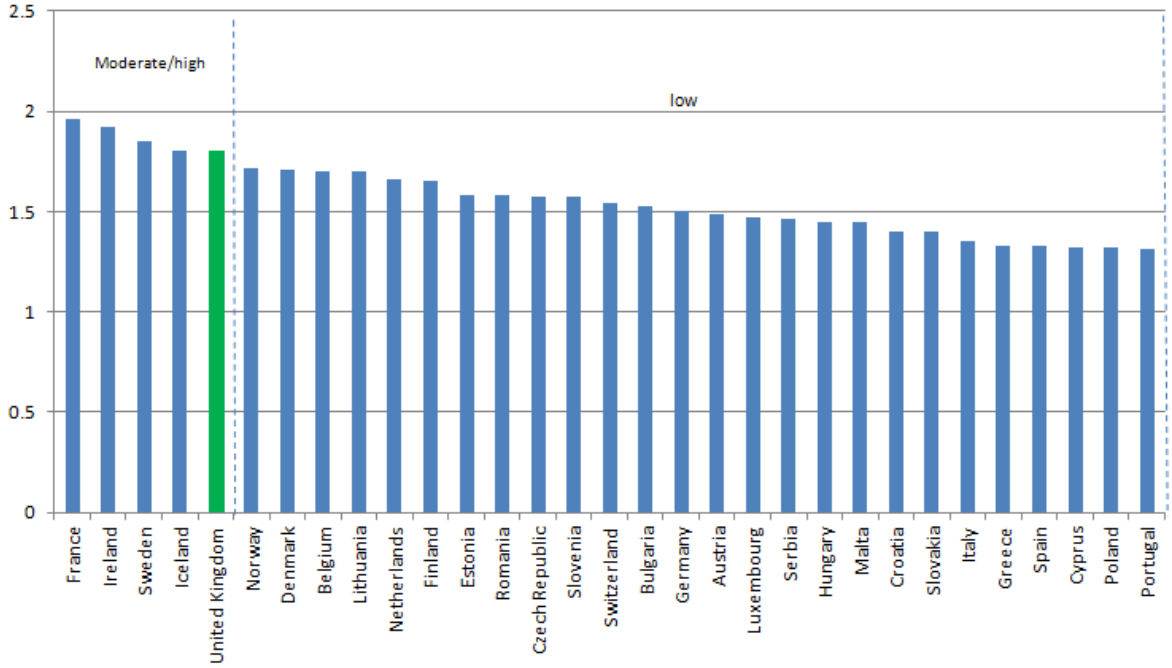
Figure 22 shows that in 2005 a sixth of the European countries shown, comprising of some of the EU Accession countries, were amongst the 'lowest-low' fertility countries (at or below 1.3). This provides a reminder that period fertility has the potential to be much lower than the UK has ever experienced. In 2005, the UK (highlighted in green) sat within the 'low fertility' group (TFR between 1.3 and 1.8), in 9th position overall, with a TFR of 1.76.

Figure 22: TFRs in selected European countries, 2005



Source: Eurostat and ONS

Figure 23: TFRs in selected European countries, 2015



Source: Eurostat and ONS

Several countries considered as the pioneers of the sustained below-replacement fertility in the past, including the United Kingdom (highlighted in green), France, Sweden and Norway, exhibited relatively high fertility in 2015, the most recent available year. The UK had moved up to joint 4th position with Iceland (Figure 23), with only Ireland, Sweden and France having higher period fertility of 1.85 children per woman or above. Fertility in Europe has shifted upwards slightly over the past decade with more convergence towards low fertility. Some of those countries in the 'low fertility' group in 2005, such as the UK and Sweden, have seen rises in recent years and moved into the 'moderate-high' (above 1.8) group. None of the countries in the 'lowest-low' fertility in 2005 have remained in this group 10 years later. All of the countries in this group in 2005 have moved to the 'low fertility' group in 2015. Italy and Spain, the first countries to attain and sustain lowest-low fertility levels in the early 1990s (Kohler et al. (2006)) remain in the 'low fertility' group but towards the bottom end with TFRs of 1.35 and 1.33 respectively.

This diversity in levels of period fertility between developed countries illustrates the wide range of possible levels that UK fertility could take in the future.

8.2. International projections

Population projections for the UK are also produced by international organisations. Eurostat's 2015-based projections use a long-term assumption of 1.56 children per woman for the UK (in 2060) increasing from 1.80 in 2015. This is based on the assumption that fertility levels in European countries will converge in the very long-term.

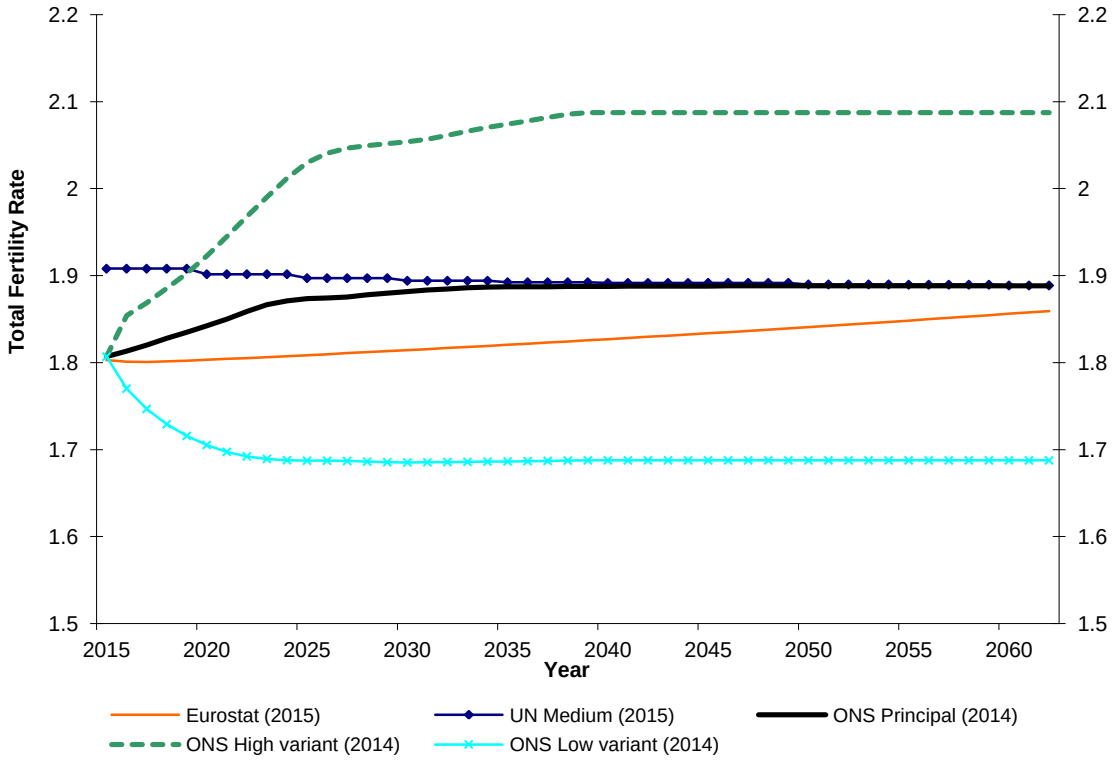
In the United Nations (UN) projections 2015 revision (World Population Prospects 2015[lxv]), fertility for the UK is assumed to reach 1.89, by 2030. This is based on the assumption that fertility for all countries converges to 1.89 in the very long-term (compared with 2.1 in the previous round).

Figure 24 illustrates the assumed path of the TFR in these two international projections for the UK, comparing them with the ONS 2014-based principal and variant assumptions. The chart shows that up to almost the first third of this century the United Nations (UN) long-term fertility assumption (dotted blue line) is higher than the ONS 2014-based principal projection (solid bold black line) of 1.89. For the rest of the century the two international projections (the UN and Eurostat) sit between the ONS 2014-based principal projection of 1.89 and the low variant of 1.69 (turquoise dashed line). If the ONS 2016-based principal projection was kept at the same level as in the previous round, it would be higher than the Eurostat and very similar to the UN assumptions and therefore result in higher population projections than from Eurostat and very similar population projections compared to the UN. (assuming mortality and migration assumptions were the same in all projections).

The central point of these various projections for the UK is that earlier notions that fertility levels may naturally stabilize close to replacement level—that is fertility levels with slightly more than two children per women—have not been maintained.

It is worth noting that Eurostat and UN projections use more recent data (2015) than the ONS 2014-based projections.

Figure 24: ONS' 2012-based Fertility projections compared to UN and Eurostat projections for the UK



Source: Eurostat, UN and ONS

9. Future UK Fertility – projection scenarios

9.1. Introduction

In order to assess plausible paths for future UK fertility, this section considers some alternative scenarios and their outcomes. By making different assumptions about future trends in period fertility rates for different age groups, the resulting completed family size (CFS) for different cohorts can be calculated. Equivalent scenarios for the four UK countries are presented in Annexes A to D.

The scenarios presented below all use UK data up to 2015 (except for historical projections, which are included for context).

9.2. 2014-based projections and simple trend based assumptions

Figure 25 shows the completed family size for cohorts from 1960 to 2000, under a range of simple trend based assumptions, compared to the 2014-based principal projection.

It is clear that simple trend based projections lead to a fairly wide range of potential completed family sizes. A constant trend from 2015 data uses just

the 2015 TFR to project forward the impact on completed family size, and by nature this converges to a value equivalent to the current TFR. While the end result is plausible, it is not plausible to expect the TFR to remain constant over time, and this ignores any possibility of rebalancing in age specific fertility rates within the TFR.

The 10 year trend, whether extrapolated for 5 or 10 years before stabilising, produces CFS that are judged too high currently, as they would be substantially above the completed family sizes achieved by any recent cohorts, or the likely sizes of any cohorts that will soon complete their childbearing.

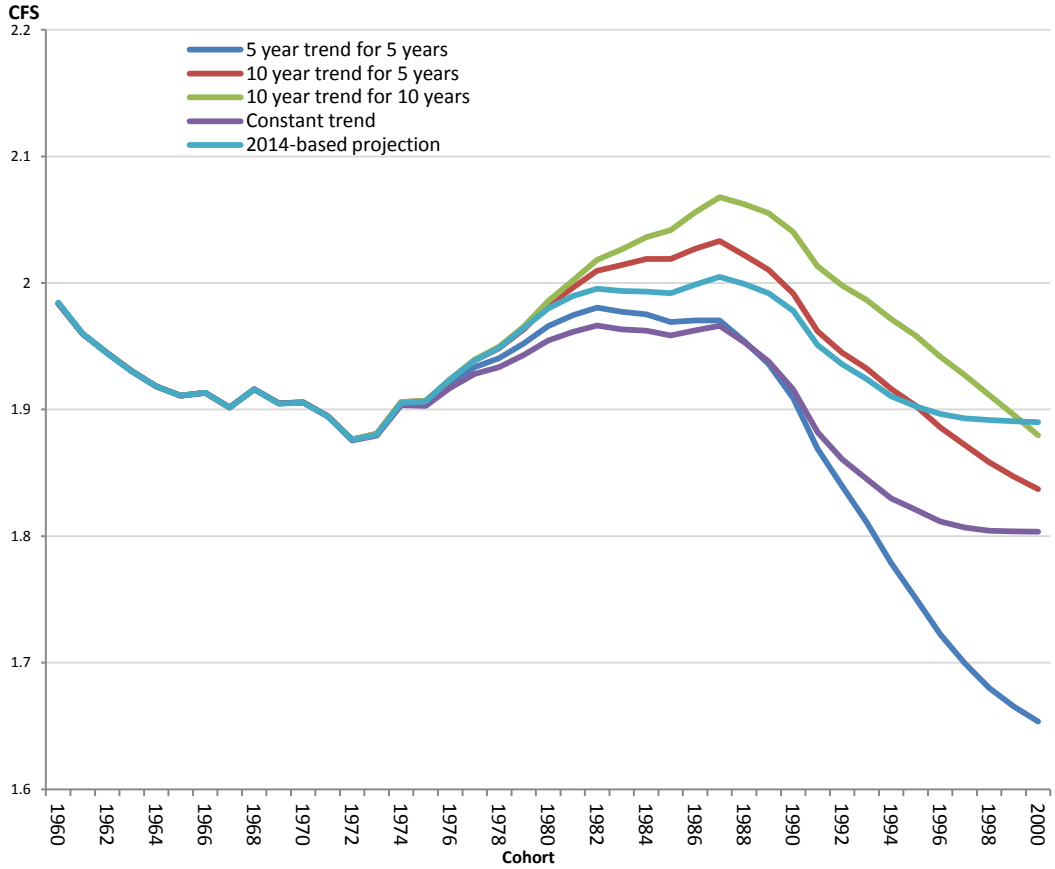
An excellent summary of why simple-trend assumptions are unlikely to produce realistic projections has recently been given by de Beer (2011)[lxvi]:

> "Due to random fluctuations in fertility rates over time, assumptions based on extrapolation from past changes in each age-specific fertility rate tend to result in erratic age patterns. Moreover such a procedure does not take into account the fact that changes in fertility rates which are caused by changes in the timing of fertility are temporary. Postponement of fertility will first lead to a decline in age-specific fertility rates at young ages, then some time later to an increase at older ages. After a certain period the decline at young ages will come to an end, then some time later the increase at older ages will stop. Thus past trends will not continue forever."

In addition recent research on UK fertility projections has shown that:[lxvii]

"Forecasts of the Total Fertility rate (from EWMA and random walk with noise model) and age specific fertility rates (Lee-Carter) were not found to provide more accurate forecasts than the official projections… and demographic expertise is still required when assessing the validity of model outcomes"

Figure 25: Trend based projections and 2014 based principal projection, UK



Source: Office for National Statistics (ONS)

9.3. Possible paths for future UK fertility

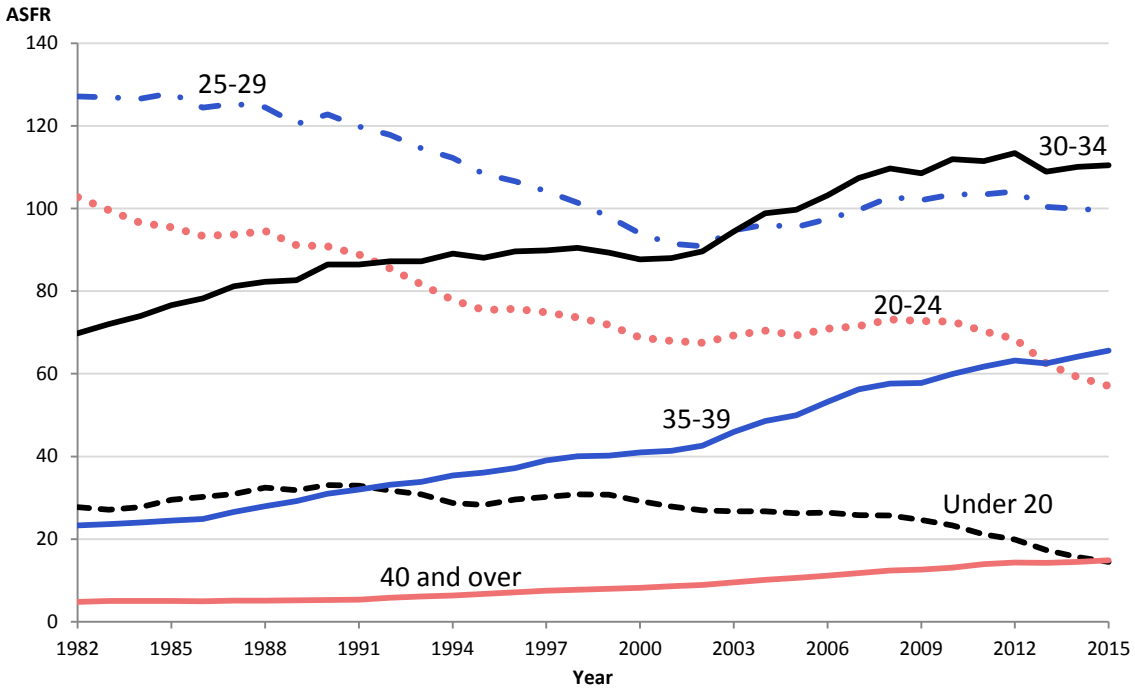
In order to assess the possible future path of UK fertility, it is important to consider fertility from both a period and a cohort perspective. In addition the mix of family sizes required to reach different average completed family sizes should be checked to ensure this is plausible.

9.3.1. Period trends

From an overall period perspective, there is uncertainty in the short-term course of the UK TFR, given the increased stability between 2008-2012, followed by the large drop in 2013 and continued declines to 2015. The provisional evidence suggests that fertility rates will be similar in 2016 when compared to 2015, and the expert panel felt there was no compelling reason to expect the short term trend to change. With 5 of the experts suggesting TFR in 2020 would remain similar to 2015 and the remaining 3 experts suggesting small declines in TFR by 2020.

Rather than making general assumptions about the TFR as a whole, a more useful approach is to make plausible assumptions about future age-specific fertility rates and examine the resulting TFRs.

Figure 26: Age Specific Fertility rates, UK, 1982 -2015



Source:Office for National Statistics (ONS)

Figure 26 (a repeat of figure 3 shown earlier) shows the trends in ASFR over the last 33 years.

From 1982 to 2002 the general trend in the UK and all constituent countries was a decline in fertility rates at lower ages, and rises at older ages. From 2002 to 2008 fertility rates for all age groups increased, with the exception of 20-24 year olds who had roughly stable fertility rates, and women aged under 20 who saw continued declines.

In 2004, the 30-34 age group overtook the 25-29 age group as the group with the highest age specific fertility rate. From 2009 onwards there were small decreases for younger women, and continued small increases for women aged over 30.

In 2013, all age groups except women aged over 40 saw decreases in fertility rates. Over the last two years decreases have continued for women aged under 20 and women aged 20-24. Women aged 25-29 have seen quite stable rates, with women aged over 30 seeing continued increases. In 2015 women aged over 40 had higher age specific fertility rates than those aged under 20.

Rates for women over 40 have been rising for the last 25 years and were the only group not to decline in 2013. Given biomedical advances and the

increasing social acceptability of childbearing at older ages they may be able to rise further. Socio-economic conditions might have the ability to slow this increase, but are likely to have less impact on older women who are unable and unwilling to postpone their childbearing much further. The NPP advisory panel thought that fertility rates among women over 30 would increase in the short-term and there was broad agreement that fertility for the over 40's would continue to increase too.

Future trends in the fertility of women in their twenties are the most difficult to predict – the advisory panel thought that rates would decline in the short term, with suggestions of only small decreases. Fertility in this age group is likely to be more sensitive to the socio-economic climate, as women have the option to postpone fertility to a later age, and are less likely to be as financially secure as older women. The expert panel felt that further declines in fertility to women aged under 20 were likely and that these declines might lead to small increases in fertility for women in their 20's due to births that have not occurred to teenagers.

9.3.2. Cohort perspective

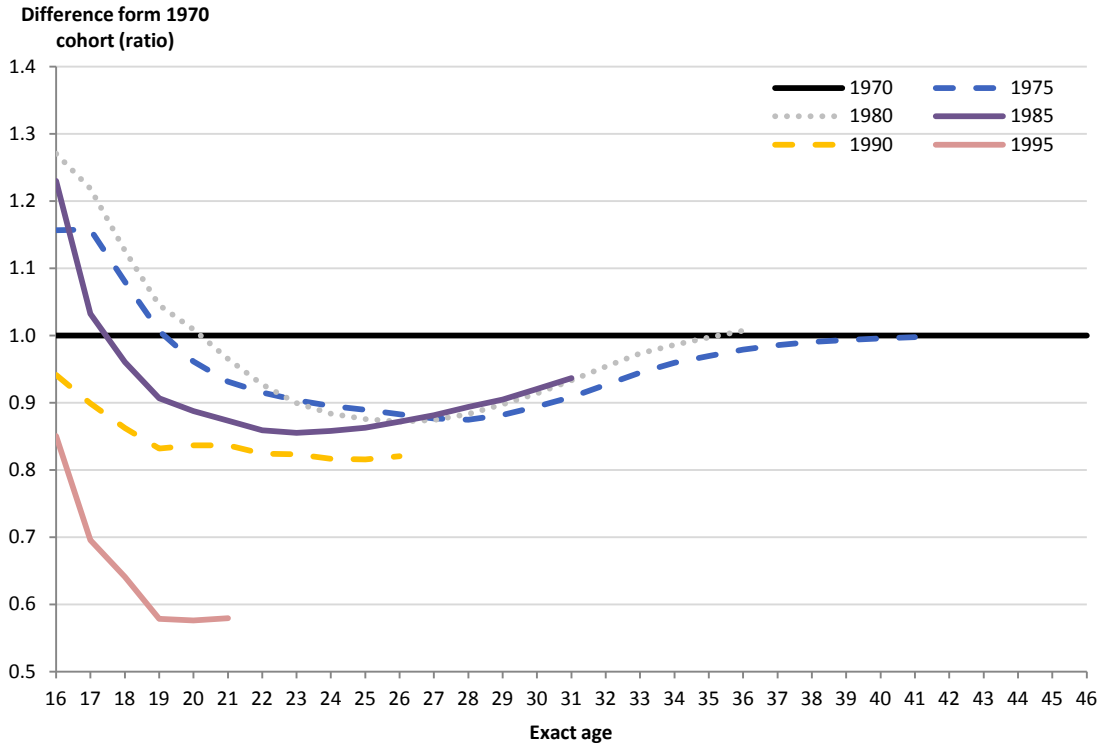
Taking purely a period approach effectively assumes that trends in age-specific fertility rates are independent from each other. In reality this is not the case because fertility rates at older ages for a given cohort will be influenced to some extent by the fertility rates they experienced at younger ages.

Women born during the 1970s were aged between 35 and 45 in 2015. Cohorts born in the early 1970s postponed their fertility, experiencing the falling fertility rates for women in their twenties during the 1990s, but then increasingly high fertility rates in their early thirties as they recuperated. Those born in the late 1970s experienced the low fertility around 2001 in their mid-twenties but have since been recuperating with high fertility after age 30.

This has meant that the completed family sizes of the 1970s cohorts are on track to catch up with those of women born in the late 1960s (1.91 for the 1968 cohort).

Figure 27 (a repeat of figure 8 shown earlier) shows the achieved family sizes of different cohorts by age indexed against the 1970 cohort.

Figure 27: Achieved family sizes, UK, 1970 to 1995 cohorts.



Source: Office for National Statistics (ONS)

Women born during the 1980s had only reached ages 25 to 35 by 2015, so were less affected by the 2001 'low' in fertility, not being in the peak childbearing ages at that time. The chart shows that they experienced higher levels of teenage fertility than the 1970 cohort, but then lower fertility in their 20s. The completed fertility for these cohorts is more sensitive to future changes in fertility rates as they are just entering / are in their peak childbearing years. As these cohorts have a higher proportion of women with HE qualifications than the 1970s cohorts, we might expect greater postponement and hence higher fertility at older ages among women born in the 1980s compared with the 1970s-born. As achieved fertility up to age 25 was substantially lower for the 1980 and 1985 cohorts than the 1970 cohort (as seen in figure 27), there is certainly scope for recuperation and thus higher rates at older ages. The 1980 cohort appears to be on track to achieve similar if not slightly higher CFS as the 1970 cohort, and there is no clear evidence that the 1985 cohort will not follow a similar trajectory.

For the 1990s cohorts, many of who were still teenagers in 2015, completed family sizes are almost entirely projected. These cohorts have had lower teenage fertility than their predecessors, strikingly so for the 1995 cohort, so have additional 'catching-up' to do to reach the completed family sizes of earlier cohorts. However it is reasonable to speculate that the pattern of recuperation via high fertility at older ages is unlikely to be reversed as older motherhood becomes increasingly the norm.

In the long-term, the advisory panel considered a combination of factors would be needed for completed family sizes to be considerably higher in future, including large-scale improvements in cost and availability of both housing

and childcare, increased employment flexibility, greater gender equality leading to better sharing of childcare burden and the continuing influence of past or future in-migration from high-fertility countries. For completed family sizes to be considerably lower among this cohort, a wide range of possible factors was mentioned including reduced in-migration associated with the UK leaving the European Union, welfare cuts, recession, increasingly high housing costs and postponement of partnership formation.

9.3.3. Family size distribution

In order to check whether completed family size outcomes are plausible, it is also worth considering the likely distribution of women by family size that would be needed to reach these outcomes. Among the 1970 cohort (in England and Wales), the most recent to have completed childbearing, 17 per cent of women remained childless, 18 per cent had one child, 37 per cent two children, 17 per cent three children and 10 per cent four or more children, with an average completed family size of 1.91.

A lower completed family size outcome of around 1.6 could be achieved, for example, if the percentage remaining childless was stable at around 20 per cent and other women all had exactly two children, or alternatively if childlessness increased to 25 per cent but the proportion having four or more children declined substantially. A higher completed family size outcome of 2.00 could be achieved if the level of childlessness fell, the proportion of one-child families fell and/or the proportion of women having three and/or four or more children increased substantially. Trends in parity progression ratios in the years up to 2008 (section 4.6) suggested that the increasing fertility had related to first births and third or higher order births. Since 2008 the parity progression ratios for all progressions except first births have declined slightly, suggesting that fewer women are progressing to larger family sizes. However the proportion of women having a first birth has continued to increase (except in 2013, where all progressions declined) so if this trend continues we might expect childlessness to fall.

This is consistent with recent experience in Sweden[lxviii], often regarded as a forerunner in demographic behaviour, which shows that a falling level of childlessness is not out of the question.

However future changes in the factors influencing fertility, such as the socio-economic climate, could alter these trends if their impacts vary by parity. Because the final projections for England and Wales are produced using a birth order model, it is possible to take parity into consideration when modelling future fertility trends.

9.4. Plausible assumptions

Table 12 shows five possible scenarios for future period fertility that are considered plausible. They have been produced by projecting forward possible trends in fertility for specific age groups. The scenarios are intended

to facilitate discussion about the most appropriate path for the UK principal projection to take (and not the path of the variants at this stage).

These scenarios represent a range of plausible trajectories of the UK fertility measures, both period (TFR) and cohort (Completed Family Size). As these scenarios represent a fairly narrow range of options they are not the only plausible options. These scenarios have been created based on expert opinions from both within the ONS and outside.

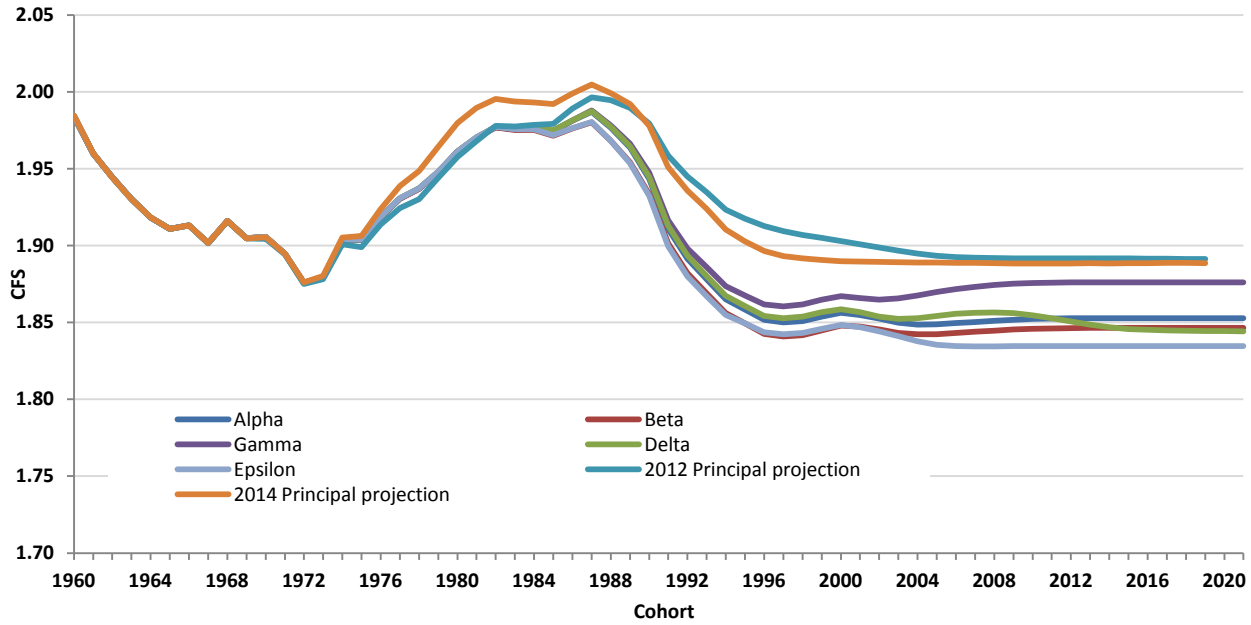
The following key goals helped inform these scenarios:

- Short term TFR to remain around 1.80 or fall slightly
- CFS for the 1970-1980 cohorts aimed at around 1.89
- ASFRs for over 40s continue to increase
- ASFRs for under 20s continue to decline
- 30-34 remains peak childbearing age group

Table 12: Plausible projection scenarios, UK level 2016 based projections

		Change in ASFRs from 2015 level (by 2040)									
Name	Description/ rationale	Under 20	20-24	25-29	30-34	35-39	40+	2016 TFR	2020 TFR	2040 TFR	Comments
Alpha	Based on 2014 based projection (Delta), but updated to incorporate 2015 data	-34%	0%	3%	5%	7%	14%	1.799	1.793	1.853	Plausible trajectory, 2020 TFR may be a little high, 2040 TFR is reasonable.
Beta	Adjusts Alpha to have a lower short term fertility, end goal of 1.85	-34%	-1%	2%	4%	8%	17%	1.799	1.779	1.850	Plausible trajectory, 2020 TFR inline with expert opinion and 2040 TFR at recommended level.
Gamma	Based on Alpha, aiming for 1.88 long term as more in line with 2014 based projection	-20%	0%	3%	6%	8%	16%	1.800	1.795	1.876	Lower reductions in under 20 fertility, 2040 TFR may be too high.
Delta	Based on Gamma, maintaining/slight increase in short term, end goal 1.85	-30%	0%	2%	5%	7%	13%	1.801	1.798	1.854	Short term and long term TFR may be too high based on expert opinion.
Epsilon	Adjusts Beta to have a lower end goal of 1.84/3	-41%	-1%	1%	3%	8%	13%	1.799	1.781	1.835	Large reductions in under 20 fertility which may not be plausible.

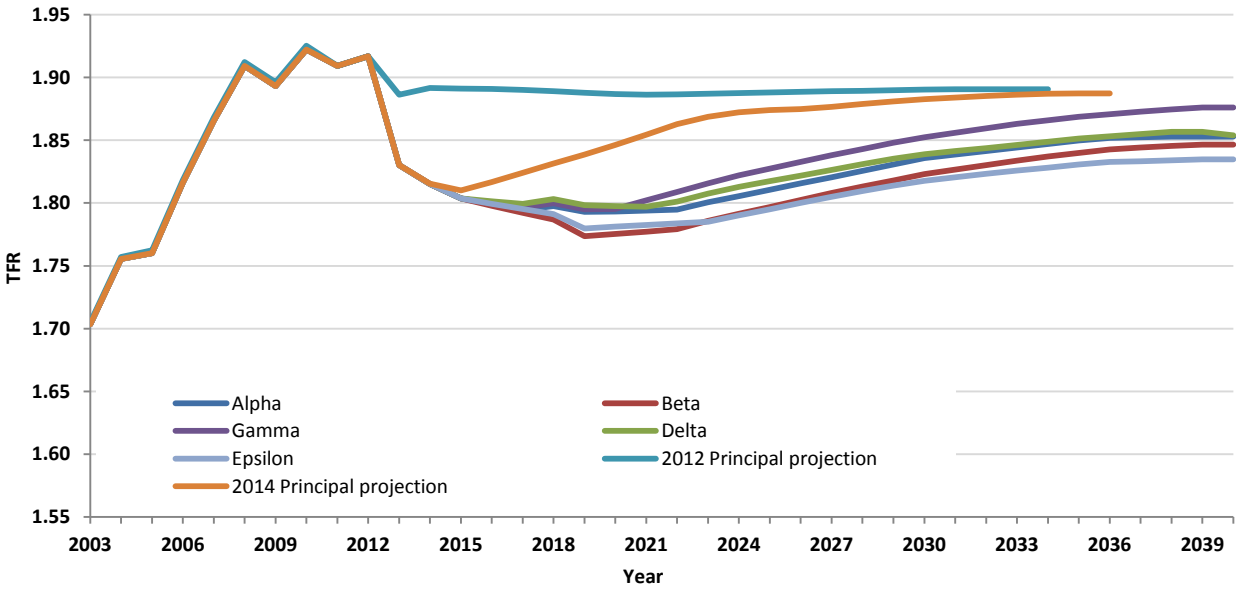
Figure 28: Plausible projection scenarios, CFS, UK level 2016 based projections



Source: Office for National Statistics (ONS)

While it would be possible to create a much wider range of scenarios, ONS sees little benefit in creating implausible scenarios here, or scenarios which we are unlikely to base our projection on**.** Figure 28 illustrates the completed family sizes these scenarios would result in, for cohorts born between 1960 and 2020. All cohorts after 1970 include some element of projection. Figure 29 shows the TFRs that are projected for each year in each scenario.

Figure 29: Plausible projection scenarios, TFR, UK level 2016 based projections



Source: Office for National Statistics (ONS)

It is clear when comparing these scenarios to the 2012-based principal projections what impact the post-census rebasing, and 2013 drop in TFR respectively, had on the short term accuracy of those projections. The continued decline of TFR in 2014 and 2015 has also highlighted issues with the 2014-based projecting higher levels of fertility in the short term. These provide ample evidence of the need for caution when making projection assumptions.

Scenario Alpha updates the 2014 based principal projection to incorporate the 2015 TFR; the resulting trajectory does seem plausible in the short term, taking into account the initial 2016 births numbers. Scenario Beta is also plausible with the TFR for 2016 at the same level as Alpha but results in a slightly lower short term (2020) and long term (2040) TFR than Alpha. The trajectory is in line with the average short term and long term TFR suggested by the expert panel.

The rationale behind each scenario is given in table 12, but the scenarios presented are broadly iterative, and ONS believes that scenario Beta is the most plausible with regard to our stated goals.

Scenarios Gamma and Delta present similar patterns of change, but with different end targets. The end target for Gamma is 1.88 which is not in-line with the opinions of the expert panel. ONS recommends that a long term TFR target of 1.85 is selected for the 2016 based projections round, and this is consistent with options Alpha, Beta and Delta.

Epsilon is similar to Beta in the short term but Epsilon has a low end target of 1.84. Epsilon projects a consistent TFR in 2016, followed by small further decreases to 2020. The expert panel predicted a similar or small decrease in TFR in 2020, compared to 2015, this small decrease in scenario Epsilon is considered plausible but the long term TFR of 1.84 may not be considered as plausible for the 2016-based assumptions.

ONS would like to propose scenario Beta as the basis of consultation, but the assumed changes to age specific fertility rates for all scenarios are given in table 13 to aid interpretation of the scenarios.

The key differences between scenario Alpha and Beta are:

- Different rate of change for 20-24 year olds
- Longer and larger initial decrease for 25-29 year olds in Beta
- Longer decreases initially for Beta, with stage increase for 30-34 year olds compared with Alpha’s long term year on year increases
- Lower initial increases for 40+ in Beta but longer overall increases compared with Alpha.

Table 13: ASFR changes for scenarios, UK, 2016-based projections

	Under 20s	20-24	25-29	30-34	35-39	40+
Alpha	0.5% decrease each year for 3 years, then 15 year trend for 4 years, then freeze at that rate (Downwards impact)	4 years of 0.5% year on year decrease, then 11 years of 0.2% year on year increase	2 years of 0.5% year on year decrease, followed by 3 of stability, then 10 years of 0.3% year on year increase, then 8 years 0.1% increase	2 years of 0.45% year on year decrease, then 3 years of 0.45%, and 16 years of 0.25% year on year increase	0.48% year on year increase for 8 years, then 12 years of 0.25% increase, then stable at those rates	0.85% year on year increase for 15 years, then stable at those rates
Beta	0.5% decrease each year for 3 years, then 15 year trend for 4 years, then freeze at that rate (Downwards impact)	4 years of 0.7% year on year decrease, then 11 years of 0.2% year on year increase then freeze	4 years of 0.6% year on year decrease, then 11 years of 0.3% year on year increase, then 8 years 0.1% increase then freeze	4 years of 0.3% year on year decrease, then 4 years of 0.45% year on year increase, then 4 years of 0.35% year on year increase and 9 years of 0.25% year on year increase then freeze	0.48% year on year increase for 8 years, then 16 years of 0.25% increase, then stable at those rates	4 years of 0.75% year on year increase, then 0.85% year on year increase for 15 years, then stable at those rates
Gamma	0.3% decrease each year for 3 years, then 15 year trend for 2 years, then freeze at that rate (Downwards impact)	4 years of 0.4% year on year decrease, then 8 years of 0.2% year on year increase	2 years of 0.4% year on year decrease, followed by 3 of stability, then 4 years of 0.4% year on year increase, then 6 years 0.3% year on year increase, then 8 years 0.1% increase	2 years of 0.45% year on year decrease, then 3 years of 0.45% year on year increase, then 4 years 0.35% year on year increase and 15 years of 0.25% year on year increase	0.48% year on year increase for 8 years, then 6 years of 0.35% increase, then 6 years of 0.25% increase then stable at those rates	0.85% year on year increase for 18 years, then stable at those rates
Delta	0.2% decrease each year for 3 years, then 15 year trend for 3 years, then freeze at that rate for 4 years, then 0.3% year on year decrease.	4 years of 0.2% year on year decrease, then 4 years of 0.1% year on year increase then hold at that rate	2 years of 0.3% year on year decrease, followed by 5 years of stability, then 2 years of 0.4% year on year increase, then 6 years 0.3% increase, then 8 years of 0.1% increase, then 4 years 0.25% decrease and then hold.	2 years of 0.40% year on year decrease, then 2 years of 0.40% increase, then 5 years 0.3% increase and 15 years of 0.25% year on year increase, then 6 years 0.25% decrease year on year, then hold	8 years 0.48% year on year increase, then 6 years 0.3% year on year increase, then 6 years 0.2% year on year increase then hold rates.	4 years 0.9% year on year increase, 10 years 0.85% increase, then hold.
Epsilon	0.5% decrease each year for 3 years, then 15 year trend for 5 years, then freeze at that rate (Downwards impact)	4 years of 0.2% year on year decrease, then 1 year of 0.1% increase then freeze	4 years of 0.6% year on year decrease, then 11 years of 0.3% year on year increase, then 5 years 0.1% increase then freeze	4 years of 0.45% year on year decrease, then 4 years of 0.45% year on year increase, then 4 years of 0.35% year on year increase and then 5 years of 0.25% year on year increase then 4 years 0.2% year on year increase then freeze	0.48% year on year increase for 8 years, then 12 years of 0.25% increase, then 4 years 0.2% increase then stable at those rates	4 years of 0.9% year on year increase, then 0.85% year on year increase for 10 years, then stable at those rates

The changes in ASFR shown here are indicative, rather than the actual changes that will be made in the final projection.

9.5. Short-term trend in fertility

The most plausible short-term trends for fertility (2016 to 2020) in the four UK countries will be discussed at the consultation meetings and informally with the devolved administrations during July. The average expert assumption was for a TFR of 1.78 in 2020, broadly in line with current TFR levels.

For this reason the ONS propose a broadly stable TFR profile for the short term, but the short-term path will to some extent be determined by the long-term level agreed. Within this stable TFR, it is likely there will be some changes in the ASFR balance, as fertility rates continue to fall in the youngest ages, and rise at the oldest.

It is not necessarily the case that if the long-term assumption is higher than current period fertility then projected fertility would start to rise immediately. For example, in the 2006-based round, the TFR was assumed to increase for four years before falling slowly to the assumed long-term level. Before taking a final decision on the short-term trend, the latest available data for 2016 (from birth registrations and notifications[lxix]) will be taken into consideration.

10. Next steps and fertility variants

10.1. Next steps

Consultation meetings and informal discussions to discuss the proposed principal fertility assumptions for each of the four countries are scheduled for June 2017. The intention is for the long-term assumptions to be agreed finally in early July. During June and July, ONS will also be discussing informally with WG, NRS and NISRA the most appropriate long-term and short-term paths for fertility rates in each country.

By July 2017, population estimates for 2016 will be available for all parts of the UK, and final births data will be published for England and Wales enabling updated 2016 age-specific fertility rates to be calculated for the projections base. As part of the projections process actual fertility rates for 2016 and previous years are smoothed to avoid anomalies present in one year being projected forward and producing odd results.

To produce the projected future fertility rates for England and Wales, ONS uses a birth order probability model. This model attempts to replicate the decision making process of having children, which depends both on a woman’s age and the number of children she has already had. It allows assumptions to be made about future trends in age and order specific birth probabilities. Data for this approach are not available for Scotland and Northern Ireland, because a long series of births by birth order is not available. Similar trends to England and Wales will be applied where appropriate, except where there are agreed reasons for differences.

Projected age-specific fertility rates for the four countries are then supplied to the NPP team to use in producing the national population projections.

10.2. High and low variant projections

The purpose of the fertility variants is to show the consequences of sustained levels of fertility above or below that assumed in the principal projection. The variants are designed to give plausible alternative scenarios, not upper or lower limits for future fertility. The impact of fertility on future population size is substantial - for example in the 2014-based round, the UK population in 2039 was projected to be around 1.5 million higher or 3.2 million lower according to the high or low fertility variants than in the principal projection.

In the 2014-based projections and previous rounds, the variant fertility projections for each individual country have assumed long-term family sizes of ±0.2 compared with the principal projection for that country. For example in the 2014-based round, the UK variants were 1.69 and 2.09 around the principal 1.89. Note that the paths of variant projections tend to diverge quite rapidly from the principal projection in the short-term, reflecting the swings that are often seen in actual fertility rates.

In 2009, ONS carried out an informal consultation with the devolved administrations and their users on the level of the fertility variants. An options paper was sent out suggesting alternatives to the consistent ±0.2 for each country, including wider variants, asymmetric variants and using the UK variants for all 4 countries or different width variants in different countries. Although the discussions confirmed that users would be prepared to accept asymmetric variants, there was not sufficient evidence or consensus to justify changing the existing method, particularly given the presentational issues that would arise for the UK if the four constituent countries had variants produced in different ways. The variants for population projections were also discussed at the wider ONS user consultation on Population Statistics in November 2010.

For this projections round, ONS' current intention is to produce fertility variants on a consistent basis for each of the four UK countries. At the expert panel there was some discussion about the current symmetrical variants, particularly surrounding the high variant which pushes fertility to above replacement level fertility for the UK. The experts felt this was not plausible and would prefer variants which produced plausible levels of fertility for the UK. Based on these discussions ONS has presented a set of symmetric variants ±0.2 higher or lower than the principal projection for each country and a set of asymmetric variants +0.1 higher and -0.2 lower than the principal projection for each country. ONS' preferred option would be asymmetric variants.

The long-term variants and the short-term paths of the variant projections will be discussed informally with the devolved administrations during July and August. Two possible options are presented in the table below, but these will

depend on the principal projection chosen, and be influenced by consultation meetings

Table 14: Potential variant trajectories, UK, 2016 based projections

		Change from 2015 level (by 2040)									
Name	Description / rationale	Under 20	20-24	25-29	30-34	35-39	40+	2016 TFR	2020 TFR	2040 TFR	Comments
Zeta Symmetric	Possible high variant if Beta is principal	0%	8%	12%	15%	18%	25%	1.816	1.865	2.046	May be considered too high as 2040 TFR is above replacement level.
Zeta Asymmetric	Possible high variant if Beta is principal	-1%	4%	6%	9%	11%	18%	1.811	1.839	1.946	Could be considered a more plausible TFR in 2040.
Eta	Possible low variant if Beta is principal	-34%	-13%	-9%	-7%	-5%	-2%	1.792	1.736	1.645	Plausible if fertility were to fall at all ages.

These trajectories are indicative only and do not show actual projected levels.

It is planned that these will be accompanied by a brief narrative explaining what factors might have to come into play to lead to the higher or lower fertility rates. These narratives will be indicative, rather than identify absolute contributions of different factors.

It is likely that some or all of the forces discussed with the experts will be included in any rationale for variants presented. This will likely take the form of descriptive information such as:

EXAMPLE ONLY-
High variant (TFR in 2040 of 2.05) - This variant assumes all of the below:

1. Assumes increased migration from high fertility countries, coupled with slower assimilation to UK born fertility patterns. – Small impact in long term
2. Assumes slowing of teenage fertility declines, coupled with better support for teenage mothers. – Very small impact, in short term
3. New legislation to further enhance maternity provision for working women – Medium sized impact in short term, small long term impact.

10.3. Replacement level fertility

10.3.1. Introduction

Replacement fertility is a well known demographic concept. But it has gained a higher profile since developed countries have started and continue to experience below replacement fertility.

In addition to high and low variants, ONS produce a replacement level fertility variant. Following user feedback, the appropriateness of the level of fertility selected for this variant was investigated.

This section explores the concept of replacement level fertility further and presents the analysis used to decide whether the replacement fertility rate used in the 2004-2012 based projections (2.075) should have been updated for the 2014-based round.

The focus will particularly be on the following points:

- Concept of replacement fertility
- What level is/has been the replacement fertility in E&W
- Conclusion

10.3.2. Concept definition

- Replacement level fertility is the average number of children a woman must have in order to replace herself with a daughter in the next generation. For example a replacement level fertility in a country of 2.11 means that 100 women will bear 211 children, 103 of which will be females (assuming sex ratio at birth of 105 males to females). About 3% of live born female infants are expected to die before they bear children, thus producing 100 women in the next generation.
- Replacement level fertility is the level of fertility at which a couple has only enough children to replace themselves, or about 2.1 children per couple.

10.3.3. The calculation of Replacement Level Fertility in England and Wales

This analysis updates the model presented in Smallwood & Chamberlain's 2005 article using 2011 data[lxx]. Both the period and cohort dimensions are considered. The difference between them is that on a period basis, replacement fertility is the level of fertility needed to exactly replace all the women in a population constructed using mortality and fertility at a particular point in time (i.e. the TFR). On a cohort basis, replacement fertility is the level of fertility needed to ensure that a generation born at a particular point in time is replaced (i.e. Cohort Fertility Rate (CFR)/ Completed Family Size (CFS))

10.3.4. The period approach

Period replacement fertility uses the fertility and mortality rates in a particular year- in this instance 2011 - to calculate a level of fertility that would produce sufficient births that a population age distribution constructed using current mortality would remain unchanged.

We consider a (fictional) generation of 100,000 women from birth through to the end of the childbearing period of their life: we will suppose that this generation is subject to the mortality observed during the year 2011, and that at each age (from 15 upwards) it has the fertility observed in the year 2011. This generation (the number of which will have been reduced by mortality to less than 100,000 by the end of their childbearing age) would give birth to a number of daughters which is, by definition, the net reproduction rate (for the year 2011).

The detailed calculations of period replacement fertility are available on request from: pop.info@ons.gsi.gov.uk

For the Census year, 2011, period replacement fertility for England and Wales was 2.07.

10.3.5. The cohort approach

The calculation of cohort replacement is identical in method to the calculation of period replacement; except that instead of using age-specific mortality rates and age-specific fertility rates from a particular period, rates that apply to a particular cohort are used, in this case the 1966 cohort who completed their childbearing in 2011.

In this calculation, the actual and projected mortality rates are applied to females, up to the end of their childbearing age.

The detailed calculations of cohort replacement fertility are available on request from: pop.info@ons.gsi.gov.uk

For the Census year, 2011, cohort replacement fertility for England and Wales was 2.06.

It is probable that no actual cohort will have the observed rates at each age. Reproduction rates therefore serve only to give an overview of the demographic situation over a given year, without being able to draw any certain conclusions from them as to the future of the population.

10.3.6. Conclusion

The period value is preferred as most demographic measurement is done in terms of a particular period of time, including the universally used replacement fertility level of 2.1. Although this is by its nature synthetic (as no group of individuals experience the fertility and mortality rates of a particular period through their life time) it is still useful in assessing the demographic situation. Note that the level of actual fertility in a particular year is directly related to the total number of births, which in turn largely determines the size of that birth generation.

Using the same period methodology to derive UK level estimates of replacement level fertility results in a UK level replacement fertility figure of 2.07, the same as E&W.

The UK estimate of replacement level fertility used previously (2.075) could be updated (to 2.070) but the impact on the replacement level variant projection would be minimal. It would be possible to use different replacement levels for the different UK countries, but the ONS does not intend to create divergent replacement levels for the individual countries.

Given that changing the replacement level fertility assumption would create a break in the series, for little gain, ONS recommends that the replacement level fertility assumption be left at 2.075 for the 2016 based projections assumptions.

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Population Statistics Division
May 2017

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[v] We are still using non-rebased APS figures in this report. Rebased APS figures will be available in time to inform the actual assumption setting process.
[vi] The country of birth groupings are stated below:

United Kingdom (UK)/British	The Channel Islands and the Isle of Man are included.
European Union 13 (EU15)	This includes the countries of the EU, other than the UK and Republic of Ireland, as constituted between 1 January 1995 and 1 May 2004 (i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden).
European Union Accession countries	These are the ten European countries that acceded to the EU on 1 May 2004 (Cyprus (excluding Northern Cyprus), Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia), plus the two countries that acceded in 2007, Bulgaria and Romania. On 1 July 2013 Croatia became the newest member state of the EU.
Indian Sub-continent	Bangladesh, India, Pakistan, Sri Lanka
Rest of the World	All other countries not included in the above groupings
Unknown	Does not apply, no answer or code missing

[v] See endnotes [iii].
[viii] Rates are calculated using denominators from the Annual Population Survey (APS). This requires estimates of the female population by five-year age group. These estimates are subject to sampling error and sampling error is likely to be higher among the non-UK born population where numbers are smaller. The APS data for 2011 used in this report has not yet been reweighted to take into account the 2011 Census results published in 2012 by ONS, NRS and NISRA. The APS data for 2004 to 2010 is weighted using 2010 population estimates. Rebased APS figures will be available in time to inform the actual assumption setting process.
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