Sustained period fertility decline in the Nordic countries: The end of the common high fertility regime?

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Abstract

The family-friendly Nordic countries with similar patterns of high and stable cohort fertility experience since 2010 a surprisingly strong period fertility decline. Yet, trends in period fertility do not automatically translate to trends in cohort fertility, so an important emerging question is whether cohort fertility will also decline. In this study, we compare current childbearing trends in Denmark, Finland, Iceland, Norway, and Sweden for women at reproductive age. By examining the development in fertility timing, we observe a new fertility postponement for women in their early 30s, but tempo-adjustments indicate that changes purely in timing fail to explain the recent period fertility decline in all Nordic countries. Parity-specific analyses show consistent patterns of strong declines in first birth intensities, but weaker declines in higher order childbearing. Declines particularly in third order childbearing are found mainly in Iceland, but to some extent also in Finland and Norway. The forecasts indicate that cohort fertility is likely to decline from the average of 2 children for the 1970 cohort to even below 1.8 children for the late 1980s cohort. Finland diverges on level, as cohort fertility below 1.6 is likely to be achieved. Denmark and Sweden diverge on trend, as their cohort fertility is expected to fall more slowly than in Finland, Iceland, and Norway. These findings do not only highlight Finland as an outlier, but also suggest that the high fertility regime of the Nordic countries is coming to an end. Our findings indicate that cohort fertility may decline also in societies with strong institutional support for parenthood and high levels of gender equality.

Keywords**:** Nordic fertility regime, period fertility, cohort fertility, fertility timing, forecasting

Introduction

The Nordic countries are known for their relatively high fertility levels compared to other high-income countries. This fertility regime is often attributed to the long tradition of public policies that promote work-family reconciliation and gender equality in those countries (Andersson 2004; Neyer et al. 2006; Andersson et al. 2009). However, all Nordic countries currently experience sustained decline in period fertility rates (Hellstrand, Nisén, and Myrskylä 2019; Comolli et al. 2019). The total fertility rate (TFR) reached 1.41 in Finland, 1.56 in Norway and 1.71 in Iceland in 2018, which constitutes a 20-25% decline since 2010 in each of the countries (Figure 1). The decrease was slower in Sweden and Denmark and their 2017 TFR levels, at 1.78 and 1.75 respectively, still placed among the highest in Europe (Eurostat 2019). The TFR in Finland and Norway is currently lower than the 2017 EU average of 1.59, and at least in Finland, there are currently no signs of the decreasing trend coming to an end (Official Statistics of Finland (OSF) 2019). These unexpected declines in period fertility may be questioning the high fertility regime of the Nordic countries. Declining birth rates have received great attention from policy makers, as they are one factor that can lead to more rapid population ageing (Reuters 2018). In Denmark, there have been public campaigns encouraging women to have (more) children at younger ages (Danish Broadcasting Corporation 2015a; Danish Broadcasting Corporation 2015b).

Yet, it is unclear how the strong decline in period fertility will affect the total number of children women currently of childbearing age will ultimately have over their lives. Period-based measures are sensitive to the timing of childbirth (Bongaarts and Feeney 1998) and tend to underestimate the fertility experience of cohorts when women postpone childbearing (Myrskylä, Goldstein, and Cheng 2013). Most of the variation previously seen in period fertility in the Nordic countries has indeed been attributed to tempo effects, as the completed cohort fertility level has been nearly constant close to replacement level since the cohorts born in the 1940s (Andersson et al. 2009; Jalovaara et al. 2019). A key example of a tempo effect is Sweden's "roller-coaster fertility" (Hoem 2005), where the TFR fell from its peak of 2.14 in 1990 to an all-time low rate of 1.51 in 1999, despite no change in fertility quantum. It remains therefore to be studied whether the decline in period fertility merely reflects fertility postponement, or also long-term changes at the cohort level. The existing cohort fertility forecasts for high income countries are soon outdated (Myrskylä, Goldstein, and Cheng 2013; Schmertmann et al. 2014).

Hellstrand, Nisén, and Myrskylä (2019) looked at tempo-adjusted measures and cohort fertility forecasts to show that long-term changes at the cohort level was the case in Finland. Cohort fertility is predicted to decline for Finnish women born around 1980, and to drop substantially for the late

1980s cohort. In this study, we expand the analysis to all five Nordic countries with up-to date data. The aim is to compare current and future childbearing trends for women of childbearing age in the Nordic countries. Using standard demographic decompositions, tempo adjustments and cohort forecasting methods, we display age and parity contributions to the decline in the TFR in 2010-2018, estimate tempo and parity compositional distorting impacts on the recent period fertility decline and forecast completed fertility for women aged 30 and older in the countries. As the main objective, we investigate whether the period fertility decline that started in 2010 in the Nordic countries reflects a decline in fertility quantum and, if so, how does the magnitude of such potential decline compare among the countries.

The strength of our study is our use of several different methods that independently and from different angles and by different assumptions investigates the recent period fertility decline. If all methods would consistently suggest a quantum decline in fertility in the Nordic countries, it would meant that the common Nordic fertility regime of high and stable cohort fertility is coming to an end. Furthermore, the Nordic countries are usually considered the prime example of the macro-level associations between high gender equality levels and fertility increases (Myrskylä, Billari, and Kohler 2011; Myrskylä, Goldstein, and Cheng 2012). Decreasing cohort fertility in the Nordic countries would challenge this conviction.

[FIGURE 1 ABOUT HERE]

The common Nordic fertility regime

While most developed countries have experienced a continuous decline in cohort fertility, the Nordic countries cohort fertility has since the 1940s cohort stabilized around the replacement level (Frejka 2017; Zeman et al. 2018). The long-term consequences of very low fertility that face many European countries (Morgan 2003) have not previously been a concern in the Nordic countries. Instead, the Nordic countries are often considered vanguard of family demographic developments in the Western world. Cohort fertility in the Nordic countries fell to some extent for the 1940s cohort, then recovered somewhat for the 1950 cohort and has since then, with the exception of Denmark with its positive trend, experienced only a weak downward trend (Zeman et al. 2018; Jalovaara et al. 2019). The main driver of the weak downward trend since the 1960 cohort is decreasing progression to third and higher order births rather than increasing childlessness (Zeman et al. 2018). Among women born in the early 1970s, cohort fertility is 1.9 in Finland, 2.0 in Denmark and Sweden, 2.1 in Norway and 2.3 in Iceland (HFD, 2019). Thus, the strongest period fertility declines in recent years are reported in the countries with the lowest (Finland) and the highest (Norway and Iceland) cohort fertility level respectively.

The consequences of these very similar declines in period fertility may lead to different cohort fertility levels in the three countries. Among other high-income countries, the US, Northern Ireland and France keep together with the Nordic countries the highest cohort fertility levels currently. In comparison, cohort fertility has dropped below 1.5 in some South European and East Asian countries (Frejka 2017).

When it comes to the parity distribution of Nordic women, childlessness is at average European level (Sobotka 2017) and the two-child norm is strong (Frejka 2008; Duvander et al. 2019). Ultimate childlessness rose slightly from the 1950 cohort in all countries, but plateaued for the 1960-1970 cohort on a level between 12 percent in Norway and 15 percent in Sweden (Andersson 2009; Jalovaara et al. 2019). In Finland, childbearing is somewhat more polarized. Ultimate childlessness increased in Finland to above 20 percent for the most recent cohorts, which by international standards is among the highest rates currently observed (Kreyenfeld and Konietzka 2017). However, Finland makes up for its high childlessness rate by also having a large proportion of people with many children: not only were about 15 percent of all births in 2017 third births, in addition 10.3 were of fourth or higher birth order, which is the highest share across all EU member states and twice as high as in the rest of the Nordic countries (Eurostat 2019). Iceland also stands out with high third birth rates and their share of third-order births is close to 20 percent compared to around 15 percent in the rest of the Nordic countries (Eurostat 2019).

Fertility postponement has been one of the main demographic trends during the last decades in developed countries (Nathan and Pardo 2019), but the Nordic countries' most striking feature is the strong fertility recuperation at older ages (Andersson et al. 2009; Lesthaeghe 2010). While the widespread fertility postponement seen in most developed countries results from rising educational enrolment and career building, fertility recuperation is thought to be a consequence of welfare provisions and organizational features that support dual-earner families with small children (Lesthaeghe 2010). The Nordic countries indeed rank highest globally in gender equality and have among the most developed family-friendly policies that aim to promote work-family reconciliation among couples (Neyer et al. 2006; Rindfuss, Choe, and Brauner-Otto 2016). Gender equality is even given as a condition for sustaining or returning to relatively high fertility among developed countries (Esping-Andersen 2009; McDonald 2000, 2013). The most recent theories state specifically that increases in fertility are conditional on men becoming more involved in family life, in order to ease of the double burden of balancing work and family women tend to carry (Esping-Andersen and Billari 2015; Goldscheider, Bernhardt, and Lappegård 2015; Anderson and Kohler 2015). Macro-level findings imply that the gender revolution has so far only hindered strong declines in cohort fertility rather than increased fertility (Frejka, Goldscheider, and Lappegård 2018).

Policy goals in the Nordic countries

Since it is a general assumption that the family policies of the Nordic countries have contributed to a favorable setting for relatively high fertility (Brewster and Rindfuss 2000; Adserà 2004), we provide a brief overview of the Nordic policy goals and their implementation. In the social demographic Nordic welfare states, social and gender equality is an explicit policy goal (Esping-Andersen 1990) and the Nordic countries rank as the most gender equal countries globally (World Bank 2012). They aim for a dual earner-dual caregiver model where men and women equally participate in both paid work and childrearing (Ellingsæter and Leira 2006; Gornick and Meyers 2009). However, the policy goals are still not fully achieved in practice. It is still relatively common for women to work part-time (less than 20 percent of all employed women in Finland, and about one-third in the four other countries) to accommodate caregiving responsibilities (Wennemo Lanninger and Sundström 2014). Additionally, high female employment rates in the Nordic countries are accompanied by occupational segregation, as women tend to work in the public sector more often than men and are less often employed in higher positions than men (Mandel and Semyonov 2006). Nordic men still continue to perform less unpaid work than women, even though they share domestic responsibilities more equally than men in most countries (Hook 2006; Prince Cooke and Baxter 2010).

The Nordic countries' family policies are in line with the general policy goals designed to promote gender equality rather than to promote childbearing (Rønsen 2004). Family policies include both child-related cash transfers (cash benefits) and public support for services for families (benefits in kind), such as childcare and early education. Among all OECD countries, the Nordic countries use the largest share of total social expenditure of GDP on benefits in kind (OECD 2019). The aim of the family policies in the Nordic countries is to (a) support parents in combing work and family life, (b) ensure a more equal sharing of paid and unpaid work among men and women, and (c) provide care solutions that reflect the best interest of the child (Rostgaard 2014). Family policies in the Nordic countries are thus not directed explicitly to families but rather to each parent individually. For instance, a non-transferable, earmarked part of paid parental leave, is reserved to each parent, and affordable day care for small children is guaranteed regardless of the parents' labor market status. To compensate for loss of income when having a child, parents are entitled to benefits based on prior earnings, with the longest and most flexible leave period in Sweden. Having a larger part of the non-transferable, earmarked paid parental leave reserved for the father is associated with a higher actual uptake of paid leave by fathers. The only exception from this pattern is Finland, where the actual uptake is as low as in Denmark with a shorter fathers' quota.

Data and methods

Data

Our analyses are based on aggregated data from the Human Fertility Database (HFD), a source of high-quality fertility data that is based on a collaboration between the Max Planck Institute for Demographic Research and the Vienna Institute of Demography. From the HFD, we use several types of age- and birth order specific fertility rates. First, we use incidence rates that relate births by women in a certain age group/cohort to all women in that age group/cohort regardless of parity. Second, we use two types of conditional rates: births of order i related to women of parity i-1, and births of order i related to all women who have not yet reached parity i. The age of the mother was recorded as age at time of birth for period-based rates and at the end of the year for cohort-based rates. Data from the most recent years from the Nordic countries are not yet available in the HFD, but were supplied by the respective national statistical agencies. Based on this data, fertility rates were calculated to match the format in the HFD[1]. Thus, we have complete time-series of rates up to 2018 for Finland, Iceland, Norway and Sweden, and until 2017 for Denmark. The incidence rates by age (but not by birth year) of mother could be obtained also in 2018 using Statistics Denmark's database.

A potential limitation regarding the use of administrative data to study parity progression is that it may underestimate the parity of foreign-born women, as children are only recorded in the population registers if they also immigrate to the host country with their mother. Nonetheless, the available evidence indicates this to be a minor issue that does not significantly affects fertility trends for the total population. Migrating during one's childbearing ages and leaving a child behind in the mother's home country is an extremely rare event, at least in the case of Sweden (see Mussino, Miranda, and Ma 2018, p. 6).

[1] Due to rules about identifiable data for Denmark and Norway, in the tables that were used to calculate the fertility rates, cells with less than 3 observations were set to 0 and cells with observations between 3 and 4 were set to 5. Only live births to individuals registered as living in Denmark when giving birth were included. Parity include previous out-country births for both expats and migrants, given these children reside in Denmark December 31 any year from 1986 and onwards.

Methods

Methodologically, our analysis follows the approach pioneered by Hellstrand, Nisén, and Myrskylä (2019). We describe trends in fertility rates by 5-year age groups in all Nordic countries using incidence rates. We use the stepwise replacement method (Andreev, Shkolnikov, and Begun 2002; Andreev and Shkolnikov 2012) and the first type of the conditional fertility rates to decompose the difference in the TFR computed from conditional age- and parity-specific fertility rates ($TFRp$) in 2010 and 2018. The $TFRp$ adjusts for both age and parity composition of the female population and might therefore differ from the conventional TFR, but it allows us to decompose the recent period fertility development into additive age and parity contributions.

In addition to the simple tempo-adjusted TFR (Bongaarts and Feeney 1998), denoted as BF adjTFR, we use in this study also the tempo- and parity-adjusted TFR (Bongaarts and Sobotka 2012), denoted as BS adjTFR. These adjustments both measure the distorting impact on the recent period fertility decline caused by changes in the timing of childbearing, but the BS adjTFR has been argued to be an improvement over the simpler BF adjTFR in some respects (Bongaarts and Sobotka 2012). Unlike the BF adjTFR, the BS adjTFR controls for the female parity distribution and removes the additional distorting parity composition effect influencing the conventional TFR. Further, it exhibits smaller year to year fluctuations and is a closer approximation of completed cohort fertility. The BS adjTFR is more data demanding: while the BF adjTFR can be calculated using incidence rates only, the BS adjTFR needs information on the female population by parity and is calculated using the second kind of the conditional rates (births of order i related to all women who have not yet reached parity i).

Further, we apply existing parametric and model-based approaches (Myrskylä, Goldstein, and Cheng 2013; Schmertmann et al. 2014) and a novel nonparametric approach (Hellstrand, Nisén, and Myrskylä 2019) to estimate the cohort fertility rates (CFR) for women currently aged 30 and older. For cohort fertility estimation, we use the age-specific incidence rates that relate births by women in a certain cohort to all women in that cohort. The forecasts estimate the final number of children women still at reproductive age will ultimately have. Using the simple freeze rate method that freezes the latest observed age-specific fertility rates into the future, we estimate what cohort fertility would be if there were no change in older age fertility in coming years. The five-year extrapolation method (Myrskylä, Goldstein, and Cheng 2013) extrapolates the past five year's trend into the future and then freezes the rates. Extrapolation of trends perform well when older age fertility is developing continuously without interruption during a period of time. In times of changing trends, the freeze rate method may be preferable. Using prior data on age-specific fertility rates, the Bayesian forecasting method (Schmertmann et al. 2014) produces a probabilistic forecast that automatically estimates uncertainty and extrapolates trends in fertility rates over both time and age. The five-year extrapolation method, the Bayesian method, and the freeze rate method, all applied in this study, are among the best preforming forecasting methods that exist (Bohk-Ewald, Li, and Myrskylä 2018).

Due to the strong model-based assumptions regarding trends and age schedules in the Bayesian forecasting method, developments in age specific fertility rates that would lead to cohort schedules with shapes not seen in historical data are considered unlikely and assigned low probability. Therefore, a nonparametric method that lack such conservative assumptions was developed (Hellstrand, Nisén, and Myrskylä 2019). This nonparametric approach instead estimates what cohort fertility would be if the past recuperation paths seen in fertility histories where applied to women with uncompleted age schedules, regardless of what the complete age schedule or time series in fertility rates eventually would look like. For a cohort with observed age-specific fertility rates up to age x, we calculate the universe of fertility changes for ages above x that have been observed in the past, the add these changes to the most recent year's fertility rates. For the fertility histories, we use high-income countries since 1975. During this period, the general pattern was increases in older age fertility. Consequently, the median forecast of the nonparametric approach estimates the completed cohort fertility, if older age fertility started to increase like the main pattern in historical data.

Importantly however, the forecasted cohort fertility for cohorts at later childbearing ages, at 35 and above, depend very little on the choice of forecasting method. First, fertility rates at ages above 35 contribute fairly little to the overall cohort fertility and second, they usually do not change substantially during a short period of time. For younger cohorts, those at ages 30-35, the forecasted cohort fertility can vary greatly among different methods and the uncertainty is therefore larger. Fertility rates at ages 30-35 give high weight to completed fertility and may exhibit large changes during rather short time periods. By using a variety of different methods, we produce alternative developments and do not relay on assumptions for one method only. For more detailed explanation of the methods, see appendix 1.

Results

Developments in age-specific fertility in 1990-2018

The Nordic countries show similar trends in fertility rates during the last three decades. Figure 2 illustrates these trends by 5-year age groups. Fertility postponement is reflected by the negative trend at ages below 30 and the overall positive trend at older ages. We observe the most similar development in fertility rates at ages 15-19 and 40-44. Teen births are becoming extinct, placing at

2-5 live births per 1 000 women in 2018, while births to mothers older than 40 are becoming increasingly frequent, placing currently at 11-14 births per 1 000 women in all countries. Since 2010, when the period fertility decline started, we observe a convergence in fertility rates between the countries in the age group 20-24 and to some extent also in the age group 25-29. In the early 2000s, women aged 20-24 gave births with the highest intensity in Iceland and with clearly higher intensity in Finland and Norway compared to Sweden and Denmark. These differences are now vanishing due to fast decreasing rates for age group 20-24 in Finland, Iceland and Norway. The fertility rate for age group 25-29 places currently at 81 live births in Finland while between 98 and 109 live births per 1 000 women in the rest of the Nordic countries. In age group 30-34, we instead observe a divergence between countries and the largest variation in fertility rates. In 2018, the fertility rate in this age group reached 95 live births in Finland and close to 130 live births per 1 000 women in Denmark. Finland stands out for the low fertility rates in the peak childbearing years 25-34. Most importantly, all countries, but Denmark to a lesser extent, are experiencing a considerable decrease in fertility rates at ages 30-34 but also at ages above 35. This implies that the fertility recuperation pattern typical of the Nordic countries is declining and moreover, it reflects weakened prospects of stable cohort fertility in the near future.

[FIGURE 2 ABOUT HERE]

Age and parity contributions to the decrease in period fertility in 2010-2018

To illustrate the changes in age-specific fertility by parity progression, we decompose the recent period fertility decline into additive age and parity contributions. The decomposition of the decrease in the $TFRp$ between 2010 and 2018, (2017 for Denmark), by age and parity is shown in Figure 3. The dominant pattern in all countries is decreasing first birth intensities, with the strongest of these decreases found in Finland and Norway. The decrease in first birth intensities is strongest at younger ages, at ages 21-26 in Norway, at ages 23-27 in Iceland, and at ages 26-29 in Finland. However, first birth intensities have also decreased at ages above 30. In Sweden, the largest decrease in first birth intensities comes in fact from ages 29-32. Thus, we notice a new postponement in family formation for Nordic women in their early 30s. Decreasing first birth intensities explains most of the total decrease in period fertility since 2010: between 57 percent in Iceland and 92 percent in Denmark. When it comes to subsequent childbearing, we observe a strong decrease in third birth intensities in Iceland and a notable decrease in Norway and Finland. While second birth intensities remained remarkably stable in the other countries, they have decreased in Finland. The decrease in higher order childbearing is concentrated mainly to ages above 30 in all countries but Finland, where second and third birth intensities have decreased at nearly all ages. Birth intensities of fourth and higher order births have, with the exception of Iceland, remained nearly unchanged during the recent period fertility decline in all countries. Except for the small increase in second order birth intensities at ages 37-42 in Denmark and in first order birth intensities at ages 36-41 in Iceland, we observe no signs of fertility recuperation for older women in the rest of the Nordic countries. The rapid decline in fecundity after age 35 and the new postponement for women in their early 30s, weakens the chances for a fertility recuperation in the upcoming years.

[FIGURE 3 ABOUT HERE]

Fertility timing and tempo adjustments

In 2003-2010, the fertility postponement slowed down and the TFR was increasing to relatively high levels in all countries. Therefore, our main interest is whether a speed up in fertility timing in 2010 occurred that can explain the recent period fertility decline thereafter. To analyze the distorting impact of changes in fertility timing on period fertility, we use the tempo-adjustment method (Bongaarts and Feeney 1998) and the tempo- and parity-adjustment method (Bongaarts and Sobotka 2012). Figure 4 sums up our findings and shows the development in fertility timing and in the adjusted TFRs in the Nordic countries in 1990-2018. In 2018, the mean age at first birth was close to 29.5 years in Denmark, Finland, Norway and Sweden, while only 28.3 in Iceland. All countries experienced an increase in the mean age of first birth during the last decades, but the speed of the increase varied between countries and time periods. Since 1990, Finland experienced the slowest total increase in the age of first birth (2.8 years) and Iceland the fastest (4.4 years). After the slowdown in fertility postponement in 2003-2010, we observe signs of accelerated fertility postponement mainly in Iceland, Norway, and Finland. Since 2010, the mean age at first birth has risen with 1.5 years in Iceland and Norway but with less than 0.5 years in Sweden. The adjusted TFRs are consistently more stable and at higher levels than the conventional TFR, and the distance between these two illustrates the distorting tempo effect. The increasing TFR in 2003-2010 was a result of changes in fertility timing rather than in fertility quantum, since the adjusted TFRs were stable during this time period. In recent years, we observe increasing tempo effects particularly in Norway, Iceland, and Finland. The TFR is currently more distorted due to fertility timing in Finland, Iceland and Norway compared to Denmark and Sweden. However, the Bongaarts-Feeney-adjusted TFR has not remained stable since 2010 in any of the countries, which indicate that the quantum of fertility is decreasing as well, and the accelerated fertility postponement cannot alone explain the period decline. A quantum decrease can be observed even if we adjust for both tempo and compositional effects, since also the Bongaart-Sobotka-adjusted TFR has decreased since 2010. Based on the latter adjustment method, the largest quantum decrease has also been observed in Iceland, Norway and Finland.

[FIGURE 4 ABOUT HERE]

Cohort fertility

To highlight the current cohort fertility differences in both timing and quantum in the Nordic countries, we continue by reporting the observed cohort age-specific fertility rates in Figure 5 and the cumulated cohort fertility rates and the parity distribution in Table 1 for selected cohorts still in childbearing age. For comparison, the completed age-specific fertility schedule for the 1970 cohort is added in Figure 5 and the parity distribution for the 1973 cohort in Table 1. The age schedules shift to the right along the x-axis reflects the general pattern of fertility postponement. This is observed for the younger cohorts in all countries, but less so in Sweden. The 1980-1988 Swedish cohorts had children with similar intensities up to age 29. In all countries, the reduced peak in the fertility schedules reflects the fertility decrease at ages around 30 in recent years. As Finland experienced the most pronounced decrease, we note that the peak in fertility rates for the 1988 cohort is much lower there, at 100 live births per 1,000 women, compared to the level between 120 and 140 live births per 1,000 women in the rest of the countries. This implies that catching up on all postponed births at older ages would imply very odd shapes in completed age schedules for the youngest Finnish cohorts.

The cumulated cohort fertility rate for cohorts still at childbearing age follows the same country patterns as the completed cohort fertility rate; the cumulated cohort fertility rate is lowest in Finland and highest in Iceland at all ages above 30. The 1988 cohort who reached age 30 in 2018 have had 0.86 children on average in Finland and 1.07 in Iceland. Sweden and Norway place in between, and Denmark slightly above Finland. The reason for this pattern is the outstanding high childlessness for Finnish women. Over 52 percent of the 1988 cohort were still childless at age 30 in Finland while this share was below 42 percent in Iceland. However, the Icelandic pattern of high childbearing in fourth and higher order childbearing as observed for the older cohorts is not observed for the youngest cohorts.

[FIGURE 5 ABOUT HERE]

[TABLE 1 ABOUT HERE]

What brings the future: A forecast of the cohort fertility

In Figure 6, we present the cohort fertility forecasts for Nordic women born in 1975-1988. In line with the results so far, these forecasts indicate that cohort fertility is likely to decline in all countries, but there is some variation in the speed of the decline. The weak downward trend that started from the 1960 cohort in Finland, Norway and Sweden is likely to continue with similar phase in Sweden.

In Finland in particular, but also in Norway is the weak downward trend accelerating substantially. The exceptional strong downward trend Iceland experienced since the 1950 cohort is likely to continue. Finland is expected to keep the position of having the lowest cohort fertility, reaching levels close to 1.5 (95% Bayesian CI 1.44;1.56) for the 1988 cohort. Most surprisingly, even Norway and Iceland with cohort fertility levels at or substantially above replacement level are also at risk of reaching levels at 1.75, the threshold between low and "very low" fertility (Zeman et al. 2018), as the 95% Bayesian confidence interval for the youngest cohort is [1.68:1.81] in Norway and [1.73:1.89] in Iceland. The corresponding confidence interval for Sweden is [1.72:1.85] and [1.79:1.92] for Denmark. Consequently, cohort fertility in Norway would still place significantly higher than in Finland, but potentially lower than in both Sweden and Denmark. Iceland is likely to lose its position of having substantially higher cohort fertility than the rest of the Nordic countries. Furthermore, Denmark's upward trend from the 1955 cohort is turning negative, despite being the only country with increasing fertility rates at older ages.

All forecasting methods produce consistent results. Denmark and Sweden show slow decreases and Finland, Iceland, and Norway show sharp declines. Finland diverges also in the level. However, some variation exists for the youngest cohorts. The nonparametric and the freeze rate method give for example values outside the Bayesian confidence interval in Finland. The Bayesian method produces estimates that results from the combination of the smoothest time series and the smoothest cohort schedules possible. Consequently, freezing the current rates would lead to unsmooth age schedules whereas further decreasing rates would give the smoothest age schedules, which explains the discrepancy. Further decreasing fertility rates are similarly the most likely scenario in Iceland and Sweden, while the smoothest age schedules in Norway are obtained if the current fertility rates would remain unchanged. For Denmark, the most likely scenario is a continuation of the recent 5-year trend, which is in contrast to other countries positive. The results of the nonparametric method indicate that even though older age fertility would start to increase in the rest of the Nordic countries, strong declines in cohort fertility cannot be avoided in Finland, Iceland, or Norway. If the current negative trend in older age fertility would turn positive in Sweden, the downward trend in cohort fertility would plateau at 1.9 for the youngest cohorts. Unlike the situation in Finland, Iceland and Norway, the development in cohort fertility (weather decline or stabilization among the youngest cohort) in Denmark and Sweden still depends largely on the short-term developments in older age (31-35) fertility.

[FIGURE 6 ABOUT HERE]

When comparing our results to the previous study on Finnish cohort fertility (Hellstrand, Nisén, and Myrskylä 2019), we see that using one additional year of data make a clear difference (Table 2). This is the case at least for the nonparametric method. Using data until 2017, the 1987 cohort still had from a 16 percent (considering all HFD countries) to 32 percent (considering only Nordic countries) chance of CFR staying at 1.75. When the analyses were updated with data until 2018, the corresponding chance fell to only a 4/16 percent. The updated point estimates fell with 0.03-0.06 children for all methods. These results highlight the demand of updated data when forecasting in a time period of rapid period fertility change.

[TABLE 2 ABOUT HERE]

Discussion

This study analyzed fertility dynamics in the Nordic countries as these countries are experiencing unprecedentedly low period fertility levels. Our study is the first to analyze the most recent trends by age and parity and to forecast cohort fertility with updated data and is therefore thoroughly up to date. Using aggregated data from the Human Fertility Database and a variety of forecasting methods, we showed that Nordic cohort fertility is likely to decline substantially for the first time in decades. The Nordic cohort fertility is forecasted to fall to an all-time low rate. The magnitudes of the expected cohort fertility declines in each country are comparable with the recent period fertility declines; the strongest declines in cohort fertility are expected in Finland, Iceland, and Norway and weaker declines in Denmark and Sweden. Consequently, a convergence in cohort fertility to levels at 1.75-1.85 for women born in the late 1980s is expected in Denmark, Iceland, Norway, and Sweden. Finland is deviating from the rest of the Nordic countries, as its cohort fertility is expected to fall to levels below 1.6. Thus, the results show divergence within the Nordic countries in two dimensions: 1) divergence in levels, where Finland is takin off on its own, and 2) divergence in trends, where Finland, Iceland and Norway are on one trajectory with strong cohort fertility declines, and Denmark and Sweden on another with slow cohort fertility declines. Tempo-adjustments show consistent results: the recent period fertility decline in the Nordic countries reflects a decline in fertility quantum, and the strongest declines are observed in Finland, Iceland, and Norway. Signs of accelerated fertility postponement were observed also in these countries and the tempo-and parity-adjusted TFR indicated increased tempo-effects, but changes in fertility timing failed to explain the recent period fertility decline in any of the Nordic countries.

Parity-specific analyses showed that declining first birth intensities explains most of the recent period fertility decline in all countries. First birth intensities declined the most in Finland, but Norway and

Iceland followed closely by. The declines in first birth intensities were heavily concentrated to ages younger than 30 in these countries, but more evenly distributed at all ages between 20 and 35 in Denmark and Sweden. We observed a notable decline in first birth intensities also at ages above 30 in all countries but Iceland. This indicates a new postponement in family formation. Taking into account all parities, increases in older age fertility were small in Denmark and Iceland (at ages close to 40, second birth intensities increased somewhat in Denmark and first and second birth intensities increased in Iceland) but nearly non-existent in the rest of the Nordic countries. In contrast with the findings that decreasing progression to third and higher order births has been driving the weak downward trend in cohort fertility since the 1960 cohort (Zeman et al. 2018), the current forecasted cohort fertility decline may now be driven also by increasing childlessness. Consequently, the plateau in the increasing childlessness trends in Denmark, Norway and Sweden (Jalovaara et al. 2019) may only be temporary. Declines in subsequent childbearing were observed particularly in Iceland, where declining third birth intensities explained 26 percent of the period fertility decline, but to some extent also in Finland and Norway.

Previously, cohort fertility in the Nordic countries has, despite the ongoing fertility postponement, remained stable due to strong fertility recuperation at older ages (Andersson et al. 2009; Lesthaeghe 2010). Yet, the new fertility postponement for women in their early 30s together with weak signs of increasing older age fertility indicates that fertility recuperation is ceasing. Consequently, cohort fertility is likely to decline in all countries. The expected declines are not however large in all countries: we note that Denmark and Sweden are on their own trajectory with weaker declines in cohort fertility, and also on similar levels. For these countries, there still exist a reasonable possibility that the weak declines could be counterbalanced by increases in older age fertility. The cohort fertility decline would be leveling off for the late 1980s cohort, if Swedish women in their early 30s would start to catch up on postponed births like the most typical recuperation pattern seen in historical data, but would accelerate if the current negative in older age fertility would continue. Strong declines in cohort fertility in Finland, Iceland, and Norway are unlikely to be avoided even though women in these countries would start to catch up on postponed births with a higher intensity than typically observed in the history. The trajectory of the strong cohort fertility decline in Finland, Iceland and Norway differs from Denmark and Sweden, but it also differs between the three countries. Cohort fertility is coming down from 2.3 in Iceland, from 2.1 in Norway, and from 1.9 in Finland. These differences have been attributed to the large proportion of women with three children in Iceland and the large proportion of women without children in Finland. Iceland differs from the other countries as its cohort fertility decline seems to be driven only by decreasing family sizes but not much by decreasing progression to first births.

Since the Nordic countries have exemplified the demographic theories suggesting that men's increasing participation in family life and stronger institutional support will increase fertility (Esping-Andersen and Billari 2015; Rindfuss, Choe, and Brauner-Otto 2016), our findings are interesting. Gender equality is predicted to be critical in preventing very low fertility in rich countries (McDonald 2000; Goldscheider, Bernhardt, and Lappegård 2015). It could be argued that Finland is taking off from the rest of the Nordic countries due to its less gender-equal aspects (Hellstrand, Nisén, and Myrskylä 2019), but the decline also in other Nordic countries may require alternative explanation. Sweden has the longest and most flexible parental leave scheme, Iceland the most gender equal parental leave scheme, and Norway the longest earmarked paid parental leave reserved for the father. Fathers' uptake of parental leave up to the quota is the norm (Duvander et al. 2019) and most children are enrolled in day-care already at an early age in the Nordic countries. In Finland on the other hand, having a child is often followed by the assumption of a long career break for the mother. Less children are enrolled in day care, childcare leave on home care allowance is a popular practice in Finland, and Finnish fathers make little use of their right to paid parental leave. The availability of part-time employment is also lower in Finland than in Denmark, Norway, and Sweden, suggesting a less favorable environment for work-family reconciliation.

The mechanisms behind the Nordic fertility decline are still unclear. The period fertility decline that started in 2010 in the Nordic countries is also observed in other relatively high fertility countries like France, Ireland, and the United Kingdom (Eurostat 2019). If the cohort fertility decline expected for the 70s and 80s Nordic cohorts turns out to be part of a global trend, the Nordics (except Finland) may still be in top relative to other countries but at lower levels than before. If the cohort fertility decline is part of a global phenomenon, it could still be argued that cohort fertility would be even lower in the absence of the family policies in the Nordic countries. Labor market status has become a central determinant of childbirth in many modern societies (Matysiak and Vignoli 2008) and fertility trends tend to correlate with economic cycles (Sobotka, Skirbekk, and Philipov 2011). Recent Nordic comparisons show that fertility levels during and after the recent recession in 2008-2014 did not correlate with the severity or duration of the economic crisis, but it has been suggested that the recent period fertility decline is attributed to broader experience of increasing labor market insecurity (Comolli et al. 2019). Finland may also be in a special position; the Finnish cohorts currently at childbearing age have survived the recession of the early 1990s that was particularly strong in Finland. Cultural factors are also considered essential to explain variability in fertility. Recent Finnish

Surveys suggest changes in family values (Berg 2018), but comparable research is still missing for the rest of the Nordic countries. It could be that acceptance for childlessness and fewer children is an upcoming value change in the Nordic countries.

This study has produced new insight in current and future childbearing developments in the Nordic countries. Our results confirmed that the common high fertility regime of the Nordic countries, if defined as maintaining stable cohort fertility close to replacement level, is coming to an end. Thus, cohort fertility may decline also in countries with strong institutional support and comparatively high levels of gender equality. Consequently, more nuanced studies on the relationship between gender equality and fertility are required, but also new approaches including other aspects, as possible value changes towards families and children in the Nordic countries. Future studies should concentrate particularly on the transition to first birth and increase in childlessness, as the further postponement and lack of first births is the main driver to the recent period fertility decline.

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FIGURES AND TABLES

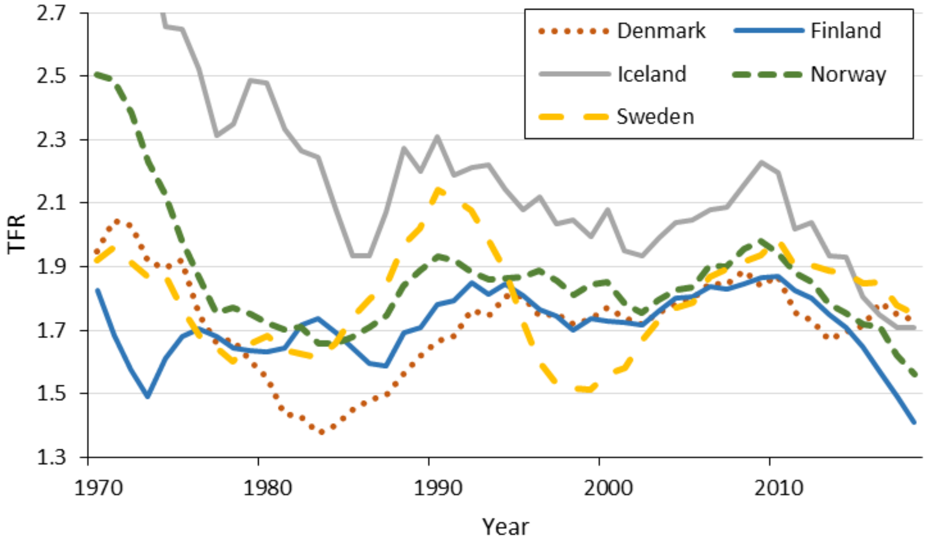


Figure 1: Total fertility (TFR) in 1970-2018 in the Nordic countries. *Source:* Nordic statistical bureaus (2019)

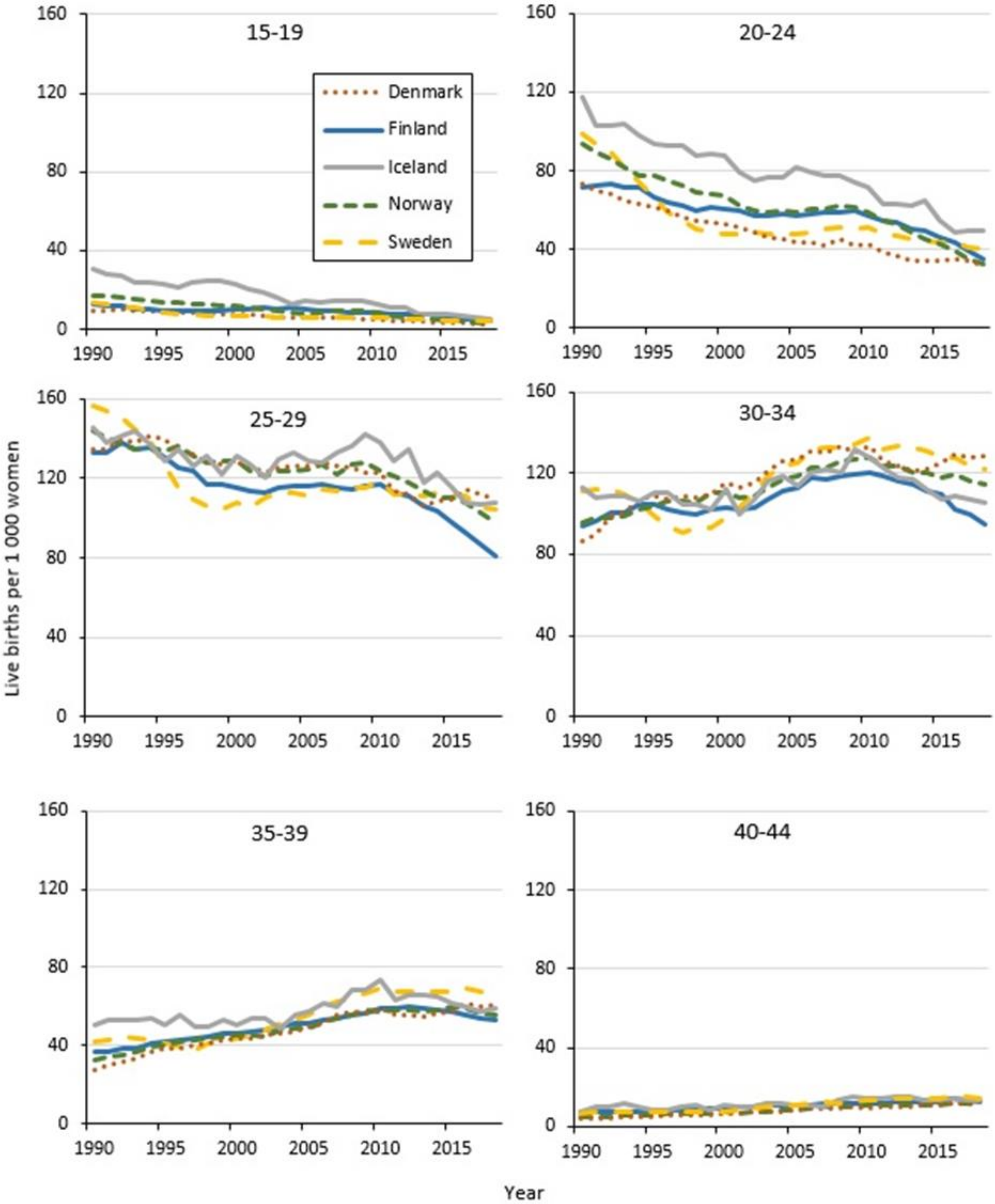


Figure 2: Age-specific fertility rates in the Nordic countries in 1990-2018.

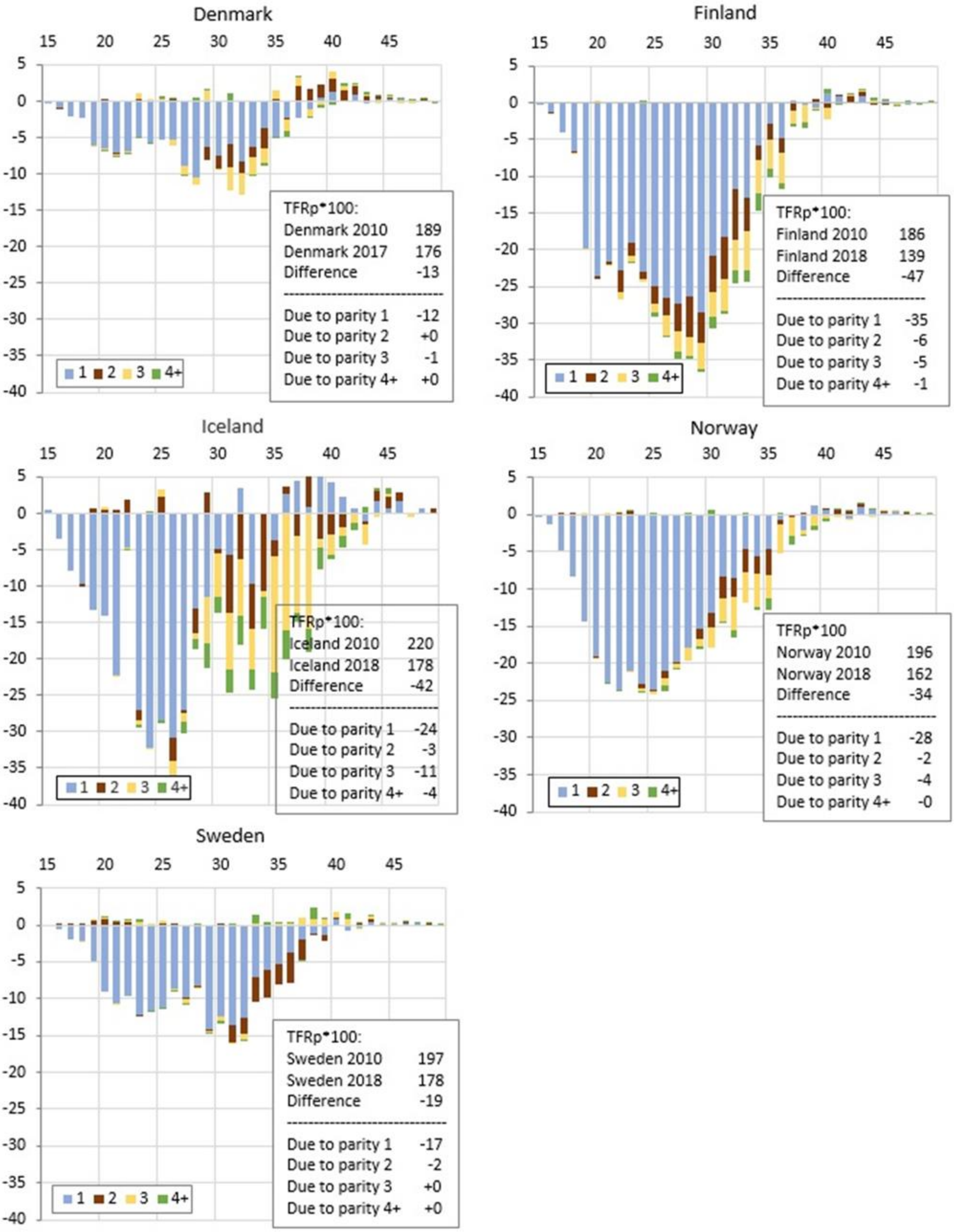


Figure 3: Decomposition of the decrease in the age- and parity-adjusted TFR (y-axis) in the Nordic countries in 2010-2018 by age (x-axis) and parity.

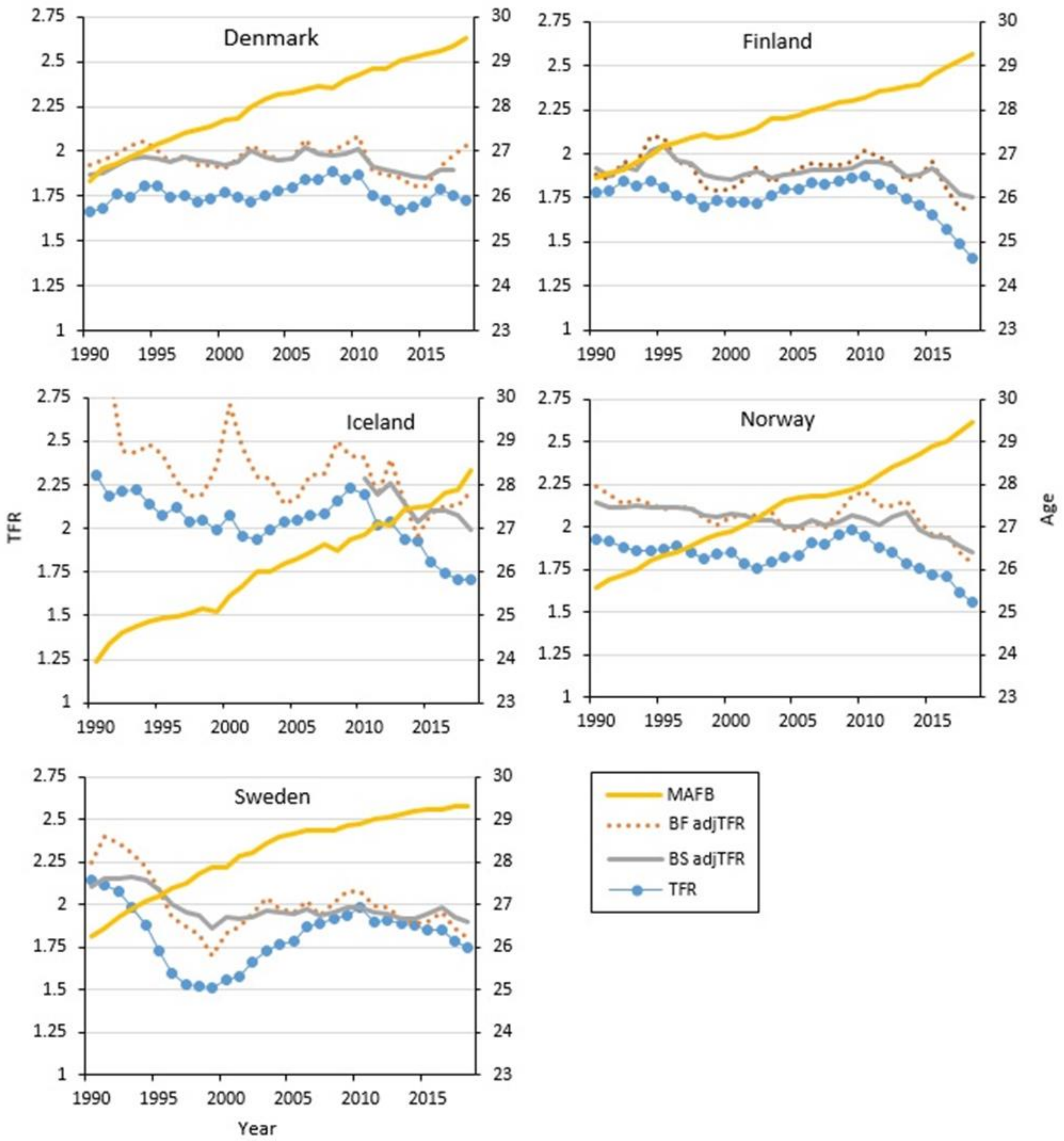


Figure 4: Observed and tempo-adjusted TFR and mean age at first birth in 1990-2018 in the Nordic countries.

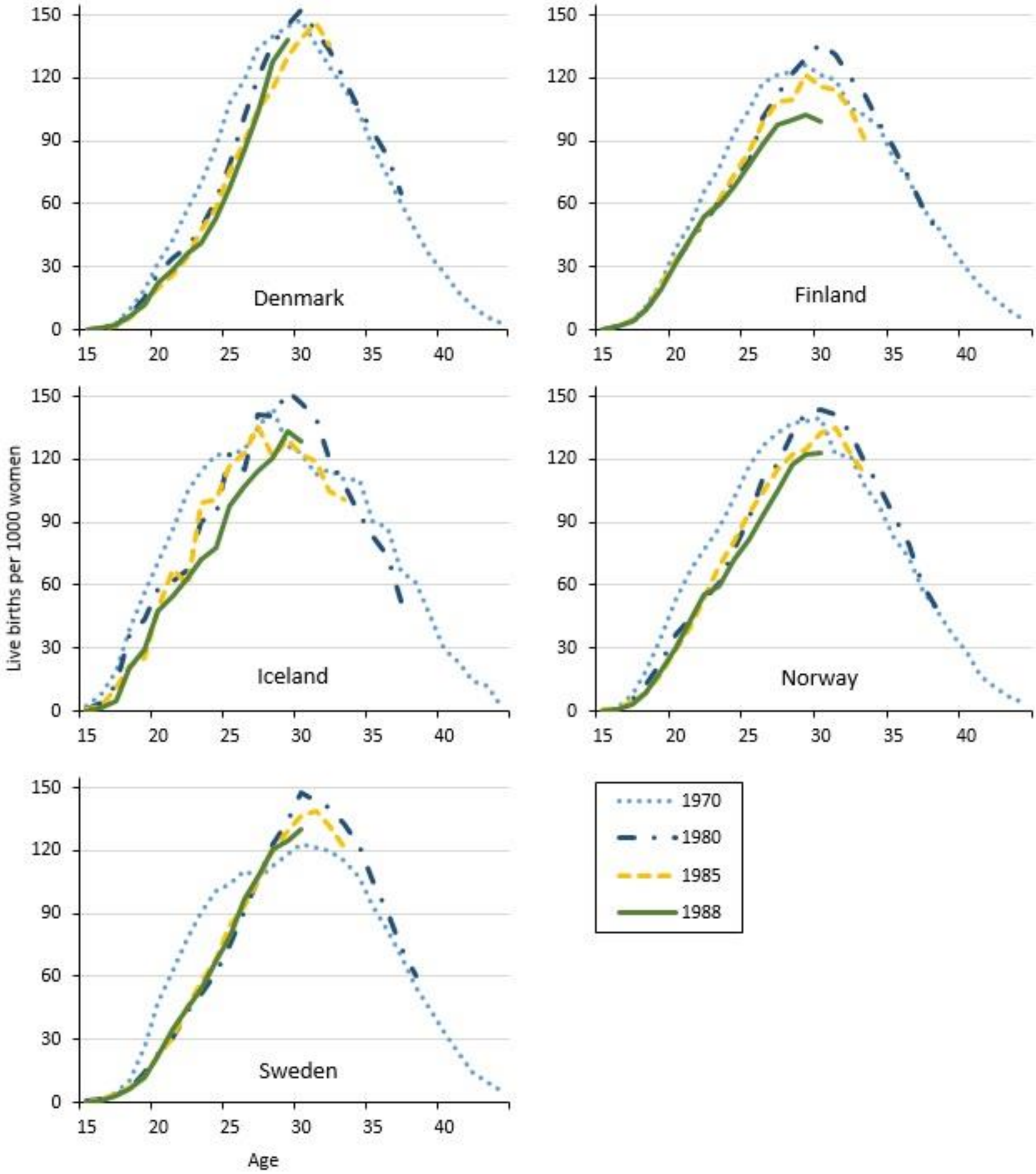
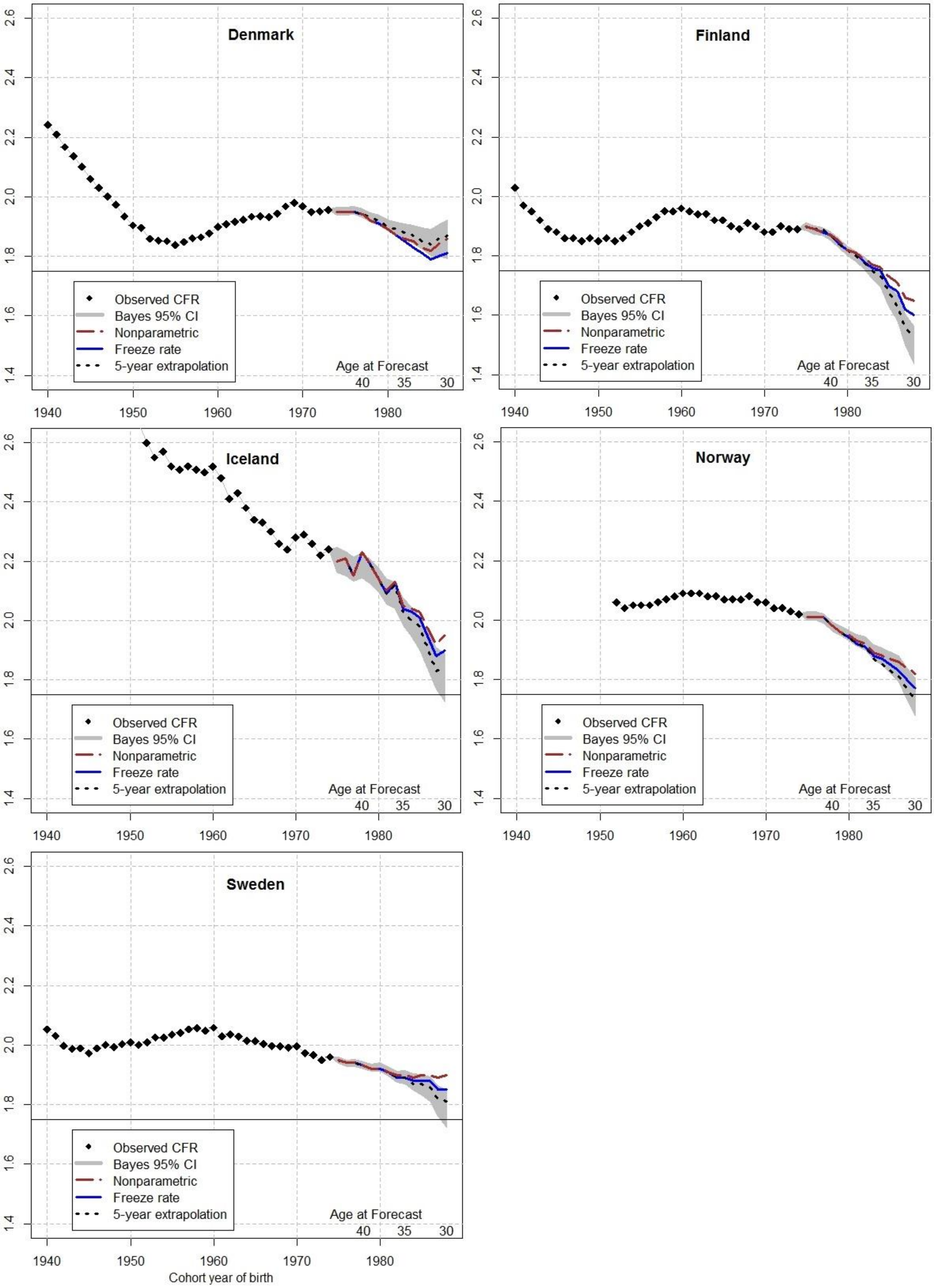


Figure 5: Age-specific fertility rates by cohort and country

Table 1: Cumulated fertility rates and the parity distribution by cohort (age reached in 2018) and country.

*) Note: Cohorts 1970, 1979, 1984 and 1987 for Denmark.

	Denmark*	Finland	Iceland	Norway	Sweden
Cohort 1970 (48)	1.97	1.88	2.28	2.06	1.99
0	17.0	19.5	12.5	13.4	13.8
1	14.2	16.9	12.2	14.8	15.0
2	43.4	35.3	32.9	41.1	44.1
3	19.1	18.9	30.4	23.0	19.2
4+	6.3	9.4	11.9	7.7	7.8
Cohort 1980 (38)	1.79	1.70	2.01	1.84	1.79
0	20.5	23.3	16.3	17.7	18.0
1	16.6	17.8	15.8	17.3	17.0
2	43.1	35.6	33.7	41.0	41.6
3	16.0	15.7	26.4	18.7	16.6
4+	3.8	7.6	7.7	5.2	6.8
Cohort 1985 (33)	1.29	1.25	1.51	1.37	1.31
0	33.0	36.6	27.4	29.8	31.4
1	23.4	21.1	22.8	23.5	22.6
2	33.7	27.5	33.2	33.6	32.3
3	8.3	10.4	14.1	10.5	10.0
4+	1.6	4.5	2.5	2.7	3.8
Cohort 1988 (30)	0.88	0.86	1.07	0.94	0.90
0	47.5	52.2	41.9	46.4	47.8
1	26.4	20.9	27.4	24.3	22.7
2	20.9	18.4	23.3	22.3	21.7
3	4.3	6.0	6.7	5.7	5.9
4+	0.8	2.6	0.8	1.3	2.0



Denmark
Finland
Iceland
Norway
Sweden
Observed CFR
Bayes 95% CI
Nonparametric
Freeze rate
5-year extrapolation
Age at Forecast
40 35 30
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1940 1950 1960 1970 1980
Cohort year of birth

Figure 6: Observed completed cohort fertility (CFR) for the 1940-1974 cohorts and forecasted CFR for the 1975-1988 cohorts in the Nordic countries.
Note: Observed for the 1940-1973 cohorts and forecasted for the 1974-1987 cohorts in Denmark.

Table 2: Forecasted CFR for the 1987 Finnish cohort using data until 2017 and 2018 respectively, by method

	2017	2018
Freeze rate method	1.65	1.62
5-year extrapolation method	1.59	1.56
95% Bayesian CI	[1.54:1.66]	[1.50:1.60]
Nonparametric method	1.70	1.66
Likelihood of staying at 1.75	16/32	4/16

Online Appendices (Electronic Supplementary Material)

Appendix 1 Methods

Tempo-adjusted TFR

The tempo-adjusted total fertility rate BF adjTFR (Bongaarts and Feeney 1998) is the sum of order-specific adjusted fertility rates

$$adjTFR_i(t) = \frac{TFR_i(t)}{1 - r_i(\mathrm{t})}$$

which adjust for the order-specific changes in the mean age of childbearing. The adjustment factor $r_i(t)$ is estimated by

$$r_i(t) = \frac{MAC_i(t+1) - MAC_i(t-1)}{2}$$

where $MAC_i(t)$ is the mean age of childbearing by birth order i at year t.

Tempo- and parity-adjusted TFR

The tempo- and parity-adjusted total fertility rate BS adjTFR (Bongaarts and Sobotka 2012) is defined as

$$adjTFR(t) = \sum_i \left\{1 - exp\left[-\sum_a \frac{p_{(a,t,i)}}{1 - r_i(t)}\right]\right\}$$

where $p_{(a,t,i)}$ is the conditional rate: births of order *i* are related to all women who have not yet reached parity *i* at age *a* during year *t*. The adjustment factor $r_i(t)$ is the same as in the BF adjTFR: it is the average annual change in the mean age of childbearing. We consider the birth orders 1,2,3,4, and 5+ for both tempo-adjusted methods

Since the last year's observation is lost in the adjustments, a crude estimate is calculated to replace the lost value. We use the adjustment factor

$$r_i(t)' = MAC_i(t) - MAC_i(t-1)$$

for the last year's observation, following Goldstein, Sobotka, and Jasilioniene (2009); but emphasize that the crude estimate should be read with caution. The crude estimate assumes that the development in the mean age of childbearing will follow roughly the same trend this year as the trend that was observed in the previous year – which is, however, not necessarily true.