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# Ways to project fertility in Europe:

## Perceptions of current practices and outcomes

TALL SOM FORTELLER

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**Abstract:**
National statistical offices responsible for population projections should regularly evaluate their work. Norway is currently considering changing the way fertility is projected. To establish a solid basis for deciding the way forward, this paper describes the different ways various European countries project fertility in their national population projections. Data were collected in two steps: First, statistical offices in Europe were asked to respond to a questionnaire regarding their current practices. The results were summarized qualitatively and quantitatively. The different methods used by the participating countries were categorized into four broad groups: 1) Model-based deterministic projections; 2) Model-based stochastic projections (frequentist and/or Bayesian); 3) Expert-based projections; 4) Other. A descriptive analysis of similarities and differences was performed to assess which methods were most common, how satisfied the statistical offices were with their method, the public availability of documentation, and the extent to which the accuracy of the projections was regularly assessed. Second, eight countries were selected for a more in-depth analysis. These countries take different approaches to projecting fertility, illustrating the range of options available and in use across Europe. We examined readily available information and documentation online, as well as reports and journal articles. For comparison purposes, this study also includes the fertility projection methods utilized by Eurostat and the UN. Some strengths and weaknesses associated with the different methods are presented, discussing both comments and feedback from statistical offices as well as those which emerge as part of the comparisons made in this study. In summary, a wide variety of methods are currently used. Whereas some countries are satisfied with their methods, documentation and results, others are actively working to improve their projections and outputs. It is hoped this study will act as a useful resource for individuals and agencies considering changing the way they project fertility, while perhaps also facilitating cross-national learning and knowledge exchange.

**Keywords:** Demographic Trends; Fertility; Europe; Methods; Projections.

**JEL classification:** E17; J11; J13

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## Sammendrag

Statistisk sentralbyrå (SSB) vurderer for tiden å endre måten fruktbarhet blir framskrevet på i de offisielle befolkningsframskrivingene. Denne artikkelen tar sikte på å beskrive de ulike måtene forskjellige europeiske land benytter for å framskrive fruktbarhet i sine nasjonale befolkningsframskrivninger. Dette gjør vi for å etablere et solid grunnlag for å bestemme veien videre. Data ble samlet inn i to trinn: For det første ble samtlige europeiske statistikkbyråer (ONS) bedt om å svare på et web-basert spørreskjema angående deres nåværende praksis. Disse resultatene ble oppsummert kvalitativt og kvantitativt. De forskjellige metodene som ble brukt av de deltakende landene ble kategorisert i fire grove grupper: 1) Modellbaserte, deterministiske forutsetninger; 2) Modellbaserte stokastiske forutsetninger (frekvensistiske og/eller Bayesiske tilnærminger); 3) Ekspertbaserte forutsetninger; 4) Andre metoder. Det ble utført en beskrivende analyse av likheter og forskjeller for å vurdere hvilke metoder som var de mest vanlige, hvor fornøyde de respektive statistikkbyråene var med egen metode, offentlig tilgjengelighet av dokumentasjon og i hvilken grad ulike forutsetninger ble laget på kort og lang sikt, samt hvor treffsikre de kortsiktige forutsetningene har vært. Dernest ble åtte land valgt ut for en mer dyptgående analyse. Landene representerer forskjellige måter å framskrive fruktbarhet på, og illustrerer spekteret av tilgjengelige alternativer som er i bruk over hele Europa. Vi undersøkte lett tilgjengelig informasjon og dokumentasjon på nettet, samt rapporter og journalartikler. For sammenligningsformål inkluderer denne studien også fruktbarhetsprojeksjonsmetodene brukt av Eurostat og FN.

Både styrker og svakheter knyttet til de forskjellige metodene beskrives i artikkelen. Videre inkluderer vi både kommentarer og tilbakemeldinger fra de ulike statistikkbyråene, samt de som framkommer i et bredere perspektiv. Disse blir diskutert inngående, basert på sammenligningene gjort i denne studien.

Oppsummert brukes for tiden et bredt utvalg av metoder. Mens noen land er fornøyde med metodene de benytter, dokumentasjonen og resultatene sine, rapporterer andre at de jobber for å forbedre måten de lager fruktbarhetsforutsetninger på og resultatene av disse. Resultatenene fra denne studien kan brukes som en ressurs for land som vurderer å endre måten de framskriver fruktbarhet på. Videre håper vi at studien vår kan muliggjøre læring og videreutveksling av ideer på tvers av europeiske land.

# 1. Introduction

Population projections are widely used by governments, policy makers, planners, and organizations around the world because they provide a "…picture of what the future size and structure of the population by sex and age might look like" (INSEE, 2019). Population projections are made by national governments in many countries around the world, as well as by international agencies like Eurostat and the United Nations (UN) that project population at both continental and national levels.

Three components are important when projecting the population of a specific geographic area; fertility, mortality, and migration, and the interplay between these three components results in population growth or decline. Thus, assumptions about fertility, mortality, and migration, in combination with past trends, comprise a basis for projecting population trends in the future (INSEE, 2019). Historically, methodological projection and/or forecasting studies of individal countries have largely centred around mortality, but recently also methodological advances in projection of international migration have attracted more attention (e.g. Bijak, 2011; Cappelen, Skjerpen & Tønnessen, 2015; Disney et al., 2015; Raymer & Wiśniowski, 2018). Fertility is, however, largely understudied in a projection perspective, although notable exceptions exist (see for instance Hyndman & Ullah, 2007; Bohk-Ewald, Li, & Myrskylä, 2018). Fertility nevertheless continues to be a much-debated topic as "close to half of all people globally live in a country or area where fertility is below 2.1 births per woman over a lifetime" (UN DESA, 2019a, p. 6). At the same time, according to the same source, fertility remains close to five births per woman in sub-Saharan Africa. Moreover, the impact of fertility projections is substantial, as the cumulative effect over generations can have pronounced consequences for a country as "…slightly higher fertility will play out over several decades" (UN DESA, 2013, p. 2) and vice versa when projected fertility levels are set slightly lower. Thus, it is of great importance to utilize well-tested and well-assessed methods for projecting future fertility.

Total fertility rate (TFR) can be defined as "the average number of children a woman would bear if she survived through the end of the reproductive age span, experiencing at each age the age-specific fertility rates of that period" (Alkema et al., 2011, p. 816). As such, the TFR provides an estimate of period fertility. When explaining and comparing fertility, one can look at either period or cohort fertility (Rowland, 2003). As the period fertility is utilized in most national projections, this study primarily focuses on methods used to project period fertility. Throughout this article, the terms fertility, total fertility and TFR are used interchangeably in a period perspective, unless otherwise specified. Appendix A5 provides an overview of commonly used terminology.

In general, population projections tend to become less accurate the further away they are from the date of the projection. Thus, when projecting fertility for the next 50 years, the likelihood is that the projected numbers for 2050 will be less accurate than the projected numbers for 2025. Different methods can be chosen to increase the likelihood of projecting population development as accurately as possible. However, because of the great variation in methods that exists for population projections, the accuracy and margin of errors varies. Past research highlights challenges when trying to choose a method for projecting fertility as little information exists on how to choose among the methods available (Bohk-Ewald, Li, & Myrskylä, 2018). The ever-present discussion of whether projections a priori are better or more valuable when framed in a stochastic framework, with formal measures of uncertainty explicitly formulated, is not a topic of this paper. Interested readers are referred to de Beer (2011) for more thorough discussions in this area.

Regardless of methods employed to make projections, it is important to emphasize that there will always be uncertainty when projecting fertility for future years. Fertility projections and projections in general assume that the observed long-term trends will continue in the future and do not aim to predict marked shifts in trends. As an example, changing fertility patterns because of the current Corona pandemic were not included explicitly in fertility assumptions made one to three years back – although certain alternatives or scenarios may be designed to describe the potential effects of such events. Moreover, fertility is likely to vary from year to year even in the future, but in the long-term few agencies attempt to predict such short-term fluctuations more than 10-15 years ahead. As such, long-term assumptions could be interpreted as an average future level and not as an assumption of the most probable level for a single year.

# 2. Aims and ouline of the current study

Statistics Norway is currently considering changing the way fertility is projected in the national population projections. Currently, future TFR is set after discussions with experts, and the current age schedule is assumed to remain constant, also in the future. This might result in inaccurate assumptions of future ASFRs (age specific fertility rates) and TFRs, and one reason for this study was to grasp how this may be accounted for in later projections by studying how other countries take changing age-patterns into account. This summary will enable Statistics Norway to compare their current practices with other methods that might be a better option for projecting fertility. In addition, there are other countries that have indicated a need to improve their fertility projections, such as Luxembourg (Peltier, 2018). Thus, our hope is that this examination will be useful not only for Norway, but also for other countries who are considering changing their methods or who are interested in a broader comparison of the different methods already in use for making fertility assumptions and projecting fertility at the national level.

To establish a solid basis for deciding the way forward, this paper describes the different ways various European countries project fertility in their national population projections. The overall aim is to explore the different methods currently being used to make assumptions about future fertility as well as the ways to project it, to assess the relative strengths and weaknesses, and to understand how countries view their ease of use, transparency and accuracy. To achieve this goal, a mixed-method study consisting of a survey and a document review was undertaken. Data were first collected through a survey, before eight countries were selected for a more in-depth document review. The data collection and methodes are described in detail below (Section 3).

The document review provides the basis for insights into the differences of the various methods and approaches used. As such, these results are presented first (Section 5.1). This review is based on the available information on current practices across national statisitical offices in Europe, as well as Eurostat and the United Nations. The second part of the study comprises a survey regarding current practices, benefits, and potential suggestions for changes in how fertility ought to be projected (Section 5.2). The survey was first piloted in the Nordic countries and their feedback was used to make edits to the survey before distributing it to the rest of the European countries on November 5th, 2019. Altogether 44 statistical agencies, including Eurostat and the United Nations, received the survey.

Taken together, this study provides a comprehensive overview, which enables both Norway and other countries to evaluate the extent to which their current methods for fertility projections are adequate and/or decide whether alternative approaches might be worth considering.

First, we present the data and method (Section 3). Next, we introduce the Norwegian setting (Section 4), followed by the results (Section 5). In the discussion and conclusion (Section 6), the two analyses are viewed in context.

# 3. Data and Method

This study takes a mixed-method approach, utilizing both qualitative and quantitative data and analytic techniques. Data were collected in two steps: First, statistical offices in Europe were asked to respond to a questionnaire regarding their current practices. These results were summarized qualitatively and quantitatively. The different methods used by the participating countries were categorized into four broad groups: 1) Model-based deterministic projections; 2) Model-based stochastic projections (frequentist and/or Bayesian); 3) Expert-opinion elicited projections; 4) Historical developments/other methods. A descriptive analysis of similarities and differences was performed to assess which methods were most common, how satisfied the statistical agencies were with their method, the public availability of documentation, and the extent to which the accuracy of the projections was assessed in the short- and the long-term.

More specifically, a pilot survey was distributed to the Nordic countries, prior to a joint Nordic population projection meeting in Copenhagen, Denmark, in late Autumn 2019. Altogether, a total of six questionnaires were sent to Denmark, Faroe Islands, Finland, Greenland, Iceland, and Sweden. A total of four questionnaires were completed and returned in this first round.

Based on the responses and feedback from the pilot-countries, an adjusted questionnaire was distributed to all Eurostat associated member countries on November 5$^{th}$, 2019. The survey was set up as an online questionnaire, distributed via a link in an email with additional information in a survey letter (Appendix A1). The email also contained an attached pdf of the questionnaire, making it possible for respondents to opt to complete a “hard copy” version. The questionnaire is shown in Appendix A2. In summary, the survey asks about the use of methods for projecting fertility in the most recent population projection, as well as discrepancies between projected and observed fertility. Some examples of questions asked were “Do you currently use a formal statistical model to project fertility?”; “In the data you use, what type of information is available?”, and; “If you could choose freely, do you have any suggestions of changes to the way your country projects fertility?”.

The survey was distributed to a total of 42 European countries, Eurostat and the United Nations (see Appendix A3 for an overview). Among these, 32 are currently producing fertility projections. They all responded to the survey and are included in this analysis. The remaining 12 countries that received the survey responded by stating that they do not produce fertility projections (Belarus, Bosnia and Herzegovina, Croatia, Cyprus, Greece, Latvia, Liechtenstein, Lithuania, Malta, Montenegro, North Macedonia, and Slovenia). Among these 12, six countries (Croatia, Cyprus, Greece, Lithuania, Malta, and Slovenia) answered that they use the population projections produced by Eurostat. A total of three reminders were sent, and a preliminary presentation of the aims and current status was presented in a Eurostat-UNECE Work session on demographic projections in Belgrade, Serbia, in November 2019.

Based on the survey responses, eight countries (Belgium, Denmark, Finland, France, Germany, Italy, Poland and Sweden) were selected for a more in-depth analysis. These countries were selected to illustrate the variation that exists in the methods used by European countries to project fertility, and to provide an overview of the range of options available and in use across Europe. The survey responses were compared and complemented with an examination of readily available online information and documentation, as well as published reports and journal articles. In addition, all countries were given an opportunity to assess and amend the summarized information, which helped to quality assure the analysis. Altogether 27 of the 32 agencies (84 per cent) took advantage of this opportunity. For comparison purposes, both the survey and the document review also include the fertility projection methods utilized by Eurostat and the United Nations.

# 4. The Norwegian setting

The total fertility rate (TFR) in Norway is currently at the lowest level ever recorded. It has decreased every year since 2009 (1.98), reaching 1.53 in 2019. At the same time, the mean age of childbirth (MAC) has risen steadily, and fewer women opt to have three or more children. The share of childless women has increased slightly (Andersen, 2020).

## 4.1 Norway's population projections

Future population development in Norway is projected by Statistics Norway using a cohort-component model. The projections are deterministic and a total of 15 alternatives are produced, differing in terms of their combinations of assumptions for the components of fertility, life expectancy, internal migration and international migration. The main alternative (MMMM) uses a medium level for all four components, throughout the projection period. For the national projections, fertility is projected for 16 different groups of women, depending on country group of origin (four groups), and for immigrants by length of stay in Norway (five groups) (Syse et al., 2018). The country groups are determined by country of birth and comprise i) Norway; ii) Western Europe, USA, Canada, Australia and New Zealand; iii) Eastern European EU countries; and iv) All other countries.

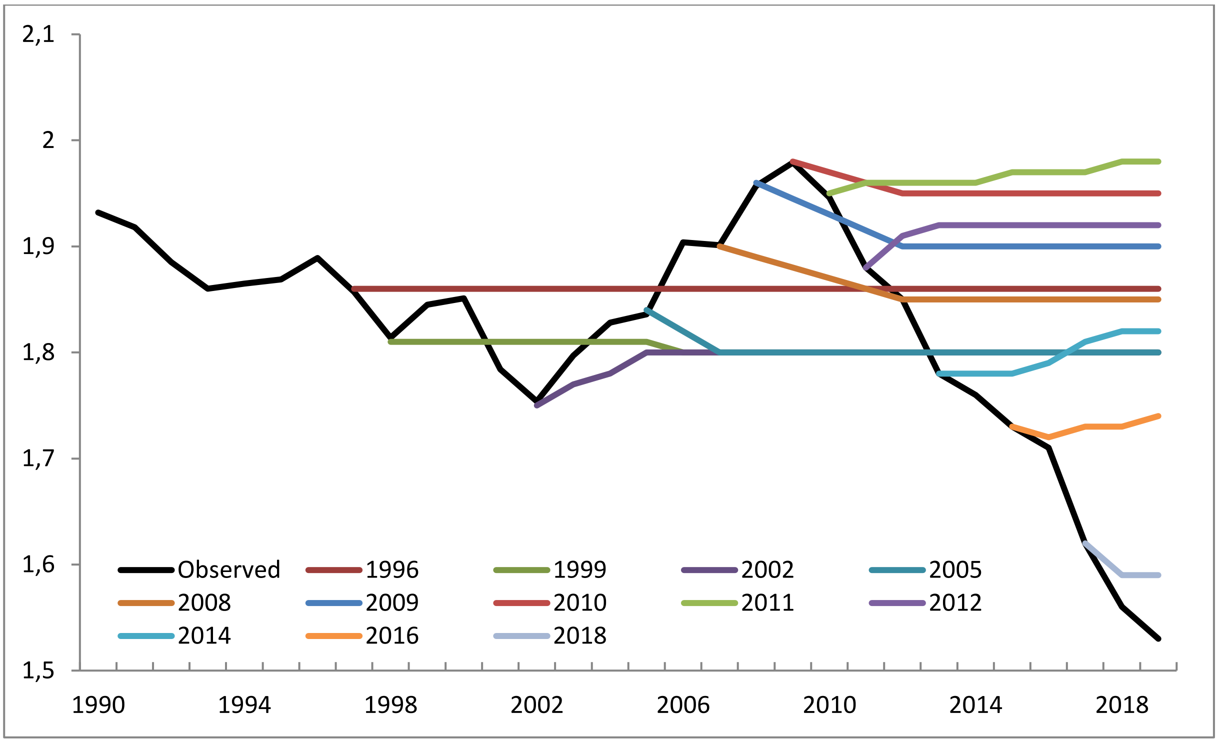
Three different scenarios are calculated for the fertility assumptions: Low, medium, and high. In practice, three annual factors are determined, one for each alternative. This factor raises or lowers the fertility of native women to a level determined after analyses of historical developments and expert consultations with a multidisciplinary advisory group consisting of fertility researchers (Syse et al., 2018, p. 41). The respective annual factor is applied to produce assumptions of future fertility for native women by multiplying it with the current age-specific fertility rates (ASFRs). The same factor is used also for the 15 other groups of immigrant women, but because their ASFRs vary, the total TFR differs between all groups. Since the distribution of native and immigrant women varies across the projection period, the total TFR for Norway is a result, rather than an assumption, in this set-up. The long-term medium alternative TFR from the 2018-projection is around 1.76. The fertility assumptions and projections are published biennially and provide projections up to the year 2100.

## 4.2 Why a different methodological approach might be warranted

***Accuracy***

When examining past fertility projections in Norway, there has been great variation in the preciseness of the projected fertility. Certain years, especially following World War II, the projected TFR was too low, while the projected fertility for the 1970s and 1980s was too high (Rogne, 2016). Research indicates that fertility projections in developed countries often have been too optimistic in the past (Keilman, 2008; 2018). In a study examining projected and observed population changes in Norway between 1996 and 2005, Rogne (2016) found that the deviations between the medium projected alternative and observed TFR did not follow a clear pattern (p. 67). However, there seems to have been a tendency of projecting fertility at a similar level as that observed the year prior to the production of the population projections, i.e. the baseline year (see Figure 1). Thus, the medium fertility has been projected too low during years with periods of high or increasing fertility, while projected fertility during years with lower or declining fertility rates have been too high.

Figure 1. Observed and projected (medium alternative) TFR (1990-2019)




Source: Statistics Norway.

Assumptions about future changes in fertility are based solely on assumptions about the future level of the TFR. However, changes in the level of the TFR are affected by changes in the age pattern of fertility. In Norway, the mean age at birth has risen steadily in Norway and changing age-patterns of fertility should be accounted for. This is currently not done in Norway. As stated above, Statistics Norway merely adjusts all the ASFRs up or down by the same factor, depending on what the future TFR has been set to. As such, we assume that the age schedule remains constant in future. This might result in inaccurate assumptions of future ASFRs and TFRs, and one reason for this study was to grasp how this may be accounted for in later projections by studying how other countries take changing age-patterns into account.

***Transparancy***

Statistics Norway documents that the level of TFR is set based on analyses of the development of fertility, in consultation with a reference group: “For each year in the projection period, we use a factor that adjusts the age-specific fertility rates up or down. To illustrate the uncertainty attached to future fertility levels in Norway, we create three different alternatives for the fertility assumptions: Low, medium (main alternative) and high. In combination, this constitutes three different sets of annual factors. The factors are determined by Statistics Norway after discussions with an advisory reference group consisting of fertility researchers." (Syse et al., 2018). All experts are explicitly named in the Norwegian documentation (Leknes et al., 2018, p. 43), and more details about the process and underlying analyses are included in the Norwegian documentation. The English version of the report summarizes the process and assumptions as follows:

> "Based on a summary of empirical knowledge of fertility trends and figures on births in the first quarter of 2018, we believe that the decline in fertility that we have seen since 2009 is about to come to an end. In the main alternative, we assume therefore that the drop in the fertility rate will level off in 2018 with a TFR of 1.60, before gradually increasing to a long-term level of 1.76 in 2031. In the low alternative, the TFR will reach a low point of 1.48 in 2020, which is close to the level we saw in Finland in 2017. Finland has the lowest fertility among Norway's neighboring countries and has also had a lower TFR than Norway almost every year since 1960. In the long run, the low alternative is assumed to gradually approach a TFR of 1.59. This long-term low alternative level is 10 per cent below the long-term level of the main alternative […] The high alternative for the TFR is expected to reach a level of 1.72 in the short term, which is close to the level we had in Norway in 2015. In the longer term, the high alternative is assumed to gradually approach a TFR of 1.94. This long-term high level is 10 per cent above the long-term level of the main alternative" (2018, p. 41).

However, the "factor-method" is not explicit or easy to understand, and it is also difficult to justify why the age-pattern is assumed to remain constant in the future. As such, this issue tends to be undercommunicated in the documentation.

# 4. Results

## 4.1 Document Review

The document review consists primarily of information gathered from available online documentation (see Appendix A3) and from documentation from published articles and/or reports. In addition, the information is complemented by information gathered through the survey. Results for the United Nations are presented first, followed by those for Eurostat, before the results for the eight countries are presented in alphabetical order.

***United Nations***

The United Nations Department for Economic and Social Affairs (UN DESA) has produced 26 rounds of the World Population Prospects (WPP), projecting future population trends related to fertility, mortality, and international migration every other year. Currently, data from more than 230 countries or areas are included. The United Nations has a two-track system and produce both deterministic and probabilistic population projections. The median fertility trajectory resulting from probabilistic methods constitutes the medium-fertility assumption in both the deterministic and probabilistic population projections. This review is based on the most recent WPP, published in 2019. It includes estimates of TFR going back to 1950, as well as fertility projections until 2100 (UN DESA, 2019b).

The United Nations generates assumptions about future ASFRs for most countries by projecting forward the overall TFR, accounting for the uncertainty of the projections based on the historical variability of changes in fertility. The demographic transition theory is the basis for projections of future country-specific fertility levels, accounting for three broad historical phases of fertility development: (i) a high-fertility, pre-transition phase (phase I), (ii) a fertility transition phase (phase II), and, (iii) a low fertility, post-transition phase (phase III). The method takes into account the past experience of each country, while also reflecting uncertainty about future changes based on the past experience of other countries under similar conditions. Next, the overall fertility level is converted to ASFRs taking into account changing age patterns for fertility (UN DESA, 2019b). The methods employed are explained in detail in a methodological report and are thus not further elaborated on here (UN DESA, 2019c).

The fertility projection model in the most recent WPP had three major updates, first to "include the experience of a larger number of countries currently with low levels of fertility" (UN DESA, 2019a, p. 1). Second, the model utilized to "project the age patterns of fertility was also updated to include new empirical evidence. The projection model combines past national trends of the age pattern of fertility with a trend leading towards a global model age pattern of fertility" (UN DESA, 2019a, p. 1). Lastly, the level of fertility projected for countries with fertility below 2.1 live births per woman was adjusted "to smooth the transition between a recent downward trend in fertility and an expected future increase" (UN DESA, 2019a, p. 1).

In addition to the medium alternative, the United Nations produces four deterministic fertility variants: Low, high, constant-fertility, and instant-replacement-fertility (UN DESA, 2019c). A comparison of the results from the five variants allows an assessment of the effects that different fertility assumptions have on other demographic parameters. The high, low, constant-fertility and instant-replacement variants differ from the medium variant only in the projected level of total fertility. In the high variant, total fertility is projected to reach a fertility level that is 0.5 births above the total fertility in the medium variant. In the low variant, total fertility is projected to remain 0.5 births below the total fertility in the medium variant. In the constant-fertility variant, total fertility remains constant at the level estimated for 2015-2020. In the instant-replacement variant, fertility for each country is set to the level necessary to ensure a net reproduction rate of 1.0 starting in 2020-2025. Fertility varies slightly over the projection period (to 2100) in such a way that the net reproduction rate always remains equal to one, thus ensuring the replacement of the population over the long run.

The median fertility trajectory results from probabilistic methods, as stated above. Based on these methods, the United Nations also publishes the 80 and 95 per cent prediction intervals of future fertility levels (TFR), based on 100,000 simulations (UN DESA, 2019b).

***Eurostat***

Eurostat, the statistical office of the European Union, produces population projections regularly (two- to three-year intervals), using data on births, deaths, and migration reported by countries in the EU and EFTA countries. Data on population demography such as fertility are reported by the individual countries to Eurostat every year. The population projections reviewed here, EUROPOP2018, were published June 2019 and provide national estimates for 31 countries[1] and aggregate measures for select country groups (Eurostat, 2019a).[2]

To project TFR, Eurostat utilizes a statistical model that combines "a country-specific trend extrapolation and the convergence assumption" (Eurostat, 2019b, p. 3). The convergence assumption has been assessed based on past trends of fertility (Lanzieri, 2009) and can be summarized as "socio-economic differentials among EU Member States are expected to be fading out in the very long term" (Eurostat, 2017, p. 3). Thus, it is assumed that the countries are following a similar pattern of demographic development. The trend extrapolation has full weight for the years before and including 2020 (Eurostat, 2019b). After 2020 "…the convergence assumption starts operating, with linearly increasing weight towards the end of the projections period. Country-specific trend extrapolations are obtained from a constrained ARIMA (1,0,1) model applied to the time series 1950-2017. Missing Eurostat TFR data have been replaced with data extracted from the Human Fertility Database.

[1] The countries include all EU-28 countries and three EFTA-countries (Norway, Switzerland and Iceland).

[2] 2020 EUROPOP2019 was published in April 2020 and is thus not included in this survey or document review.

Convergence is modelled by assuming a tendency of fertility in all countries towards an ultimate value never reached during the horizon of the projections, namely equal to 1.83. This value represents the maximum TFR that UN's World Population Prospects 2019 project for 2100 for the countries included in EUROPOP-2018" (Eurostat, 2019b). Despite using a statistical model for the extrapolation, Eurostat defines their method for projecting TFR as deterministic because the specification of the ARIMA model 'forces' the long-term extrapolation towards a target value defined a priori. The model serves the purpose of providing values of the TFR, while the distribution of future births across ages to obtain age-specific fertility rates is obtained using the Schmertmann (2003) model.

***Belgium***

In Belgium, the Federal Planning Bureau is responsible for annually updated population projections. Up until 2019, Belgium used a straightforward statistical model to project fertility. The long-term fertility (2030-2070) was fixed at a constant level, defined as the observed mean in TFR prior to the economic crisis of 2008. In the short-term, the ASFRs gradually converge to this long-term fertility level. The underlying assumption is that the sharp decline in fertility observed since 2008 is (at least partly) explained by the consequences of the economic and financial crisis that started in 2008. It is thus expected that the ASFRs will gradually increase (up to 2030) to the level observed before the economic and financial crisis. For the 2019 projection, the long-term TFR was set to around 1.85.

In its population projection published in March 2020, Belgium has revised its fertility model. They are using a formal statistical model that in its first step consists of a projection of the TFR, taking into account structural trends for the long-term projection and economic determinants for the short-term projection. The second step applies the methodology proposed by Schmertmann (2003) to estimate the ASFRs. This latter approach allows Belgium to take modifications in the fertility schedule, i.e. the postponement of births, into account. However, some parameters of the Schmertmann model are adapted to account more adequately for the evolution of the fertility schedule over time. A working paper with a description of the methodology will be released mid-2020.

***Denmark***

Denmark published their first population projection in 1963 and has produced projections annually since 1978. From 2010, Statistics Denmark has made their projections in cooperation with DREAM (The Danish Research Institute for Economic Analysis and Modeling), an independent semi-governmental Danish research institution. Each February, Statistics Denmark updates DREAM with the most recent data on immigration, emigration, births, deaths, and change in citizenship. DREAM and Statistics Denmark discuss assumptions on all components, including that of fertility. Next, DREAM utilizes these data to run "the actual projection model for the whole of Denmark" (Statistics Denmark, 2019, p. 2) and provide Statistics Denmark with data used to publish the national population projections (Statistics Denmark, 2019). DREAM and Statistics Denmark used to have an expert panel for fertility projections, but that was terminated in 2019. The fertility assumptions are calculated using two formal methods to assess the short- and long-term fertility patterns, respectively. Short-term fertility is determined based on current fertility trends, while long-term fertility is converging towards a long-term level, determined by examining historic development of cohort fertility and assuming that this pattern is stable over time (Frank Hansen & Stephensen, 2013, p. 11). The Richards Curve is used to model the convergence for the short-term towards the long-term development and Cubic Spline Smoothing is employed to calculate the trend in age-related fertility. Denmark's population projections are deterministic (based on historical experience), creating only one scenario utilizing one set of assumptions (Statistics Denmark, 2019). Fertility is allowed to vary across groups, depending on region of origin, immigrant background and citizenship.[3] The long-term TFR for the various groups ranged from 1.65 to around 2 in the last published projections.

### *Finland*

Statistics Finland is the agency responsible for population projections in Finland. They describe their projections as "a demographic trend calculation where population development is assumed to continue as in the last few years" (Official Statistics of Finland, 2020). Finland is utilizing a formal statistical model to project fertility in which they derive fertility rates based on observed data from a select period of time, usually the last five years. They then select certain target TFRs for the projection period. Next, they fix age-specific (and area-specific) fertility rates to match that target value. The ASFRs are kept constant over the projection period, i.e. changing fertility schedules are not accounted for. The TFR is assumed to be 1.45 in Finland's 2018 projections (Official Statistics of Finland, 2019). Following this, a cohort-component model provides the number of live births for each projection year. It is a bottom-up approach and the constant fertility rates do not stay fully constant for the whole country. When a person migrates (internally) in the projection, she will adopt the fertility level and rates associated with the destination area. This leads in the long run to a slight change in the TFR for the whole country (about one per cent over a 50-year time period). In their projections, Finland provides one scenario only and on average the projections are updated on a three-year basis.

[3] More specifically, both immigrants and descendants of immigrants are divided by Western and non-Western origin (i.e. four groups), whereas women of Danish origin comprise a separate group. Next, these five groups are further divided according to Danish or non-Danish citizenship, resulting in a total of 10 groups.

***France***

The National Institute of Statistics and Economic Studies (INSEE) produces the official population projections for France. The projections are based on the population census and vital event registers and are published every five years, with the most recent projection made public in 2016. INSEE does not use a formal statistical model to project fertility (INSEE, 2020). A first set of assumptions is obtained by extrapolating recent trends on specific fertility rates at each age. This set is improved and validated with a panel of experts, and three fertility variants are provided. Recently, INSEE conducted an experiment to compare the last projections with what was obtained using probabilistic methods. The results were found to be similar and a report will be published in 2020.

***Germany***

The Federal Statistical Office of Germany (Destatis) is responsible for the population projections in Germany. Using linear regression, the cohort ASFRs of German women are extrapolated and Bayesian forecasting of cohort fertility (Schmermann, 2003) is used to validate the projected cohort fertility and the parity distribution of cohorts. The results of the extrapolation are transferred to a period perspective: From cohort ASFRs into period ASFRs. Lastly, the period ASFRs of German women are multiplied by the factors that take into account the influence of foreign women on total fertility. The period ASFRs of German women are multiplied by factors derived from the relation of the ASFRs of all women and the ASFRs of the German women in the years with different levels of immigration. Three scenarios are produced, and Destatis uses an international expert group of advisors. The projections are updated every three years, projecting both national and regional fertility, with the most recent projection published in 2019. In the median scenario, the TFR was set at around 1.4, with lower and upper bounds of 1.2 to 1.6.

***Italy***

Italy has produced population projections since 1988, with the Italian National Institute of Statistics (Istat) currently updating projections every year for short-term projections and every third year for long-term projections. Ex-post nowcasting methods are employed for adjusting the short-term projections. The last projection was published in 2019. Istat provides projections at both regional and national levels, with the regional being part of the national projections. Istat’s projections utilize a formal model as described by Schmertmann (2003) and provide one scenario with surrounding prediction intervals based on probabilistic/stochastic methods. In the last projection, the median TFR is assumed to increase from a current level of 1.3 to around 1.6 in 2060. Istat uses time series from 1977 to the latest observed years as their input years in the formal model and has tested the robustness of time series going back to 1952. Istat uses expert-based random scenarios for the TFR and a system of quadratic splines functions for the distribution of ASFRs as described by Schmertmann (2003). Istat uses the same method for short, medium and long-term projections.

***Poland***

Poland publishes an overview of the population, including demographic developments, projections, and methods in a demographic yearbook (Statistics Poland, 2014). The first yearbook was published in 1968, accompanied by an English version since 1993, and includes both TFR and gross reproduction rate.

Poland's last official population projection was published in 2014, with a projection horizon to 2050. For the fertility projections, assumptions about TFR, mean age of childbirth (MAC) and ASFRs are published. The ASFRs are published routinely for select years, but all estimates are available on demand. In this projection, the official TFR was set to 1.52 in 2050 However, there were also three alternative variants, including one where a systematic growth of the fertility rate for the whole projection period to the level of 1.85 in 2050 was assumed. Their projections are based on extrapolation of trends of the last 25 years, as well as on assumption on convergence to countries in Europe with higher fertility. Future TFR schedules are also based on those countries which currently have higher MACs than Poland.

***Sweden***

Statistics Sweden is responsible for the population projections in Sweden and publishes population projections on an annual basis. The long-term assumptions are revised every three years, based on advice and viewpoints from an expert reference group. Currently, the projection period runs through 2070. For the years between, an update of input data is made, as well as a revision of the short-term projections (Statistics Sweden, 2019). Sweden has a long history of producing population projections. Sweden does not utilize a formal statistical model for projecting fertility. Instead, fertility is projected using a cohort model with a parity component for Swedish-born women. No parity-specific assumptions are made for foreign-born women, instead, foreign-born women are divided into six groups based on country of birth (Nordic countries, non-Nordic countries of the EU27, non-EU27 countries in Europe, and a non-European country grouped by the UN Human Development Index; high, medium or low). When making fertility projections for foreign-born women, Statistics Sweden uses annual ASFRs that have been projected for each of the seven country groups. Several deterministic alternatives are provided (low, main and high), as well as stochastic prediction intervals. In their 2019-projections, the overall TFR for all women in Sweden is assumed to increase from 1.76 today to 1.88 in 2070.

***Summary***

In short, Belgium, Denmark, Finland, France and Germany use model-based deterministic methods, whereas Italy is the only country who use a model-based stochastic method. Norway and Sweden rely solely on research of historical developments and expert opinions. With the exception of Denmark, all selected countries use experts, incorporating their opinions in their models or as an additional element in their fertility projections. For instance, experts may be used to discuss where to set long-term TFR levels or the future mean age at childbirth, facilitate discussions of outer bounds for high or low alternatives, and/or contribute with input for the documentation to accompany the projected fertility figures.

## 4.2 Survey

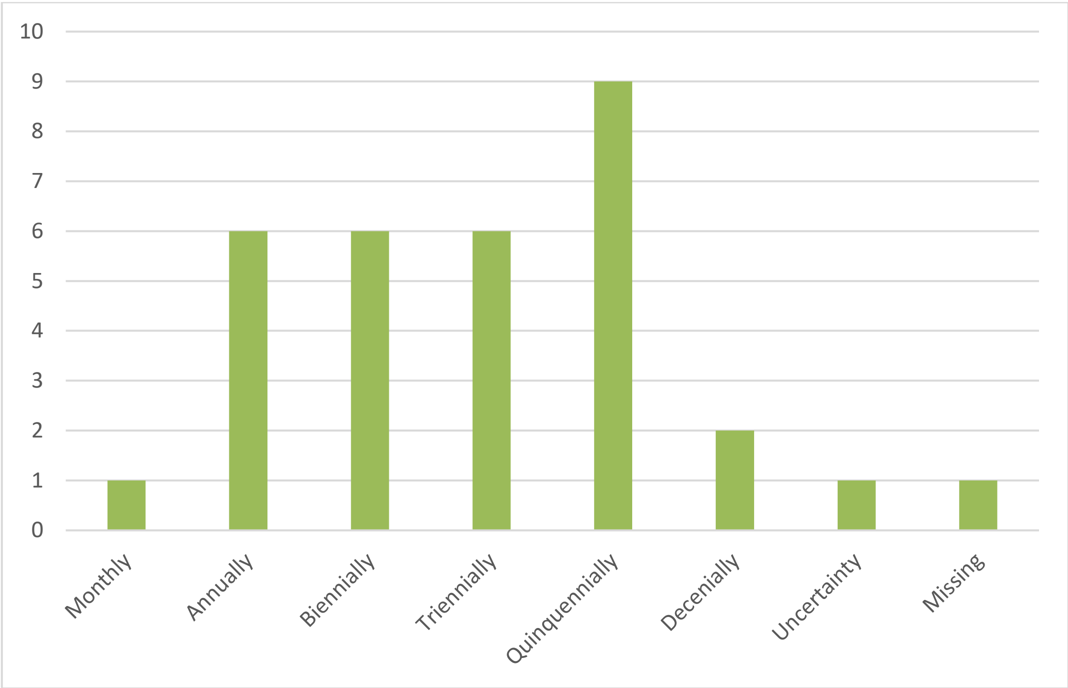
Altogether 30 countries, as well as Eurostat and the United Nations, produce fertility projections in the European context. All responded to the survey and are thus included in this analysis. The Faroe Islands and Greenland are viewed as being distinct from Denmark in this context, as they make their own population projections. It should be noted that the population size and composition vary markedly between the countries, ranging from the Faroe Islands with around 49,000 people (2017) to more than 80 million in both Germany (2019) and Turkey (2019), which has implications for the type of methods they choose to utilize in their population projections, as well as the resources available.

***Resources available to produce fertility projections***

To get a handle on the available resources in each country, we asked about the number of persons involved in fertility projections, as well as the highest level of education held, and in which areas those persons were educated. We asked about the time allocated to fertility projections, and how often the projections are published. We also wanted to know whether the agencies have some measures of the usage of the projections. Furthermore, we asked about the level of detail in the data available, whether fertility is projected for any sub-groups, and the historical time period used directly or indirectly in the projections. We also asked whether assumptions and projections were produced at the regional level.

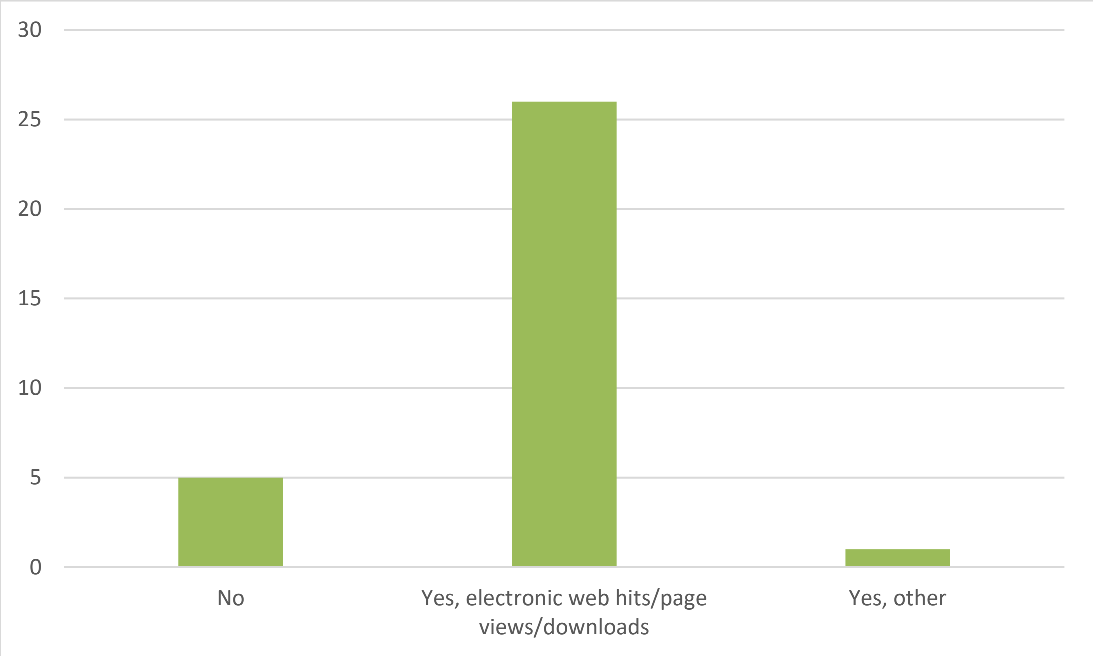
In summary, the average number of people involved in the fertility projections was three, but ranged from one to more than five, and most had either a master’s or doctoral degree. Statistics, demography, and economics were the most common backgrounds held by the people responsible for fertility projections, but there were other common backgrounds from health and social sciences. Most countries reported spending an average of two months per year on fertility projections (ranging from less than one to more than four). The Faroe Islands updates their fertility projections most often (monthly), 18 countries make updates on an annual, biennial or triennial basis, while nine countries make updates every fifth year, and two on a ten-year basis (Figure 2). Ukraine is currently working on plans to update projections annually or biennially, but currently their last projection was in 2014. Two countries reported having poor data quality.

Figure 2. Frequency of updates



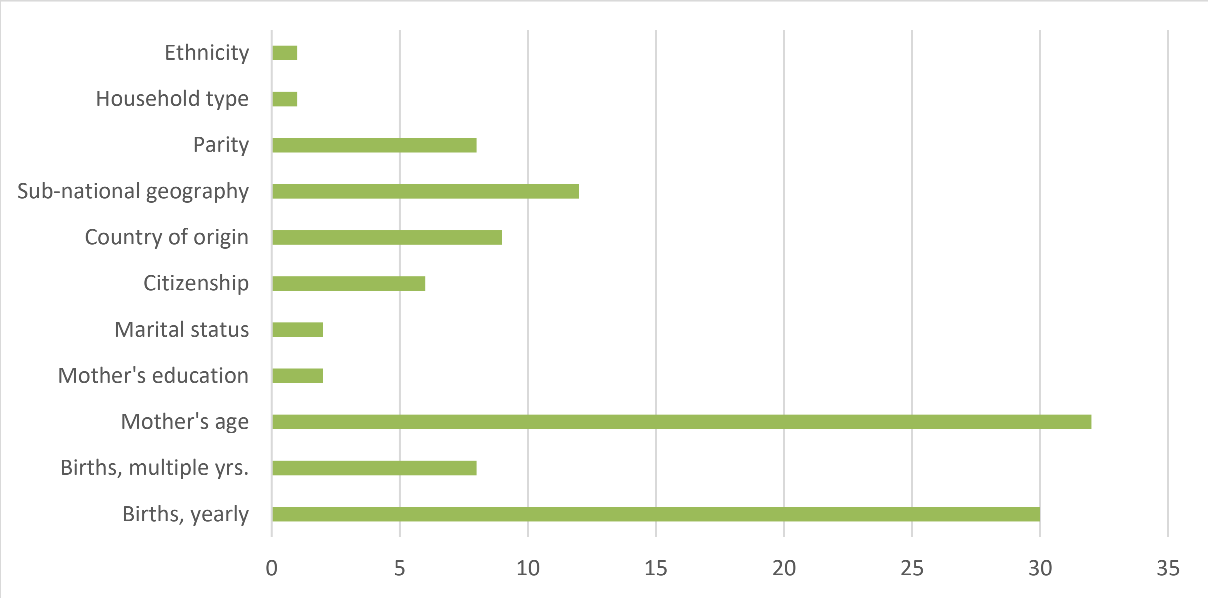

The most common methods to measure the usage of the projections were electronic web hits, page views, or downloads. Other measures were mentioned by the Czech Republic, Italy, Serbia, Switzerland, Turkey, and the United Nations and included user needs, direct feedback from institutional stakeholders, media coverage, government feedback, and data requests. Figure 3 shows the methods used to measure usage of projections, with five countries reporting that they had no usage measure for their projections (Faroe Islands, Hungary, Poland, Romania, and Ukraine).

Figure 3. Do you have some measures of the usage of your projections?



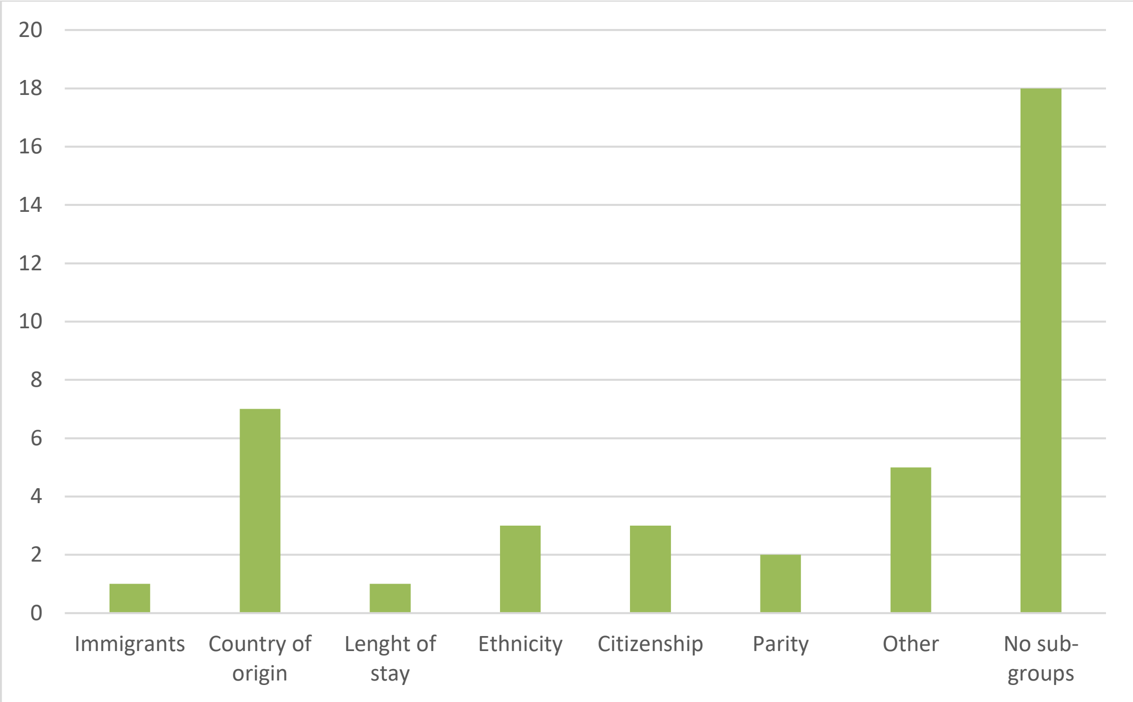

Most agencies produce detailed data (see Figure 4). All 32 agencies use mother's age and while 30 use yearly information on births, eight use information from multiple years. Some agencies thus utilize both yearly and multiple years in their work. Sub-national geography, as well as country of origin was used by approximately one-third of the agencies, while household type, ethnicity, mother's education, and marital status were the least utilized types of information. Mother's age, the only variable available for all respondents, is most commonly provided in single years (29 agencies), while Romania, Serbia and the United Nations all provide mother's age in five-year age groups.

Figure 4. In the data you rely on, what type of information do you actually use?




Almost two-thirds of the agencies do not project fertility for sub-groups (see Figure 5). Six countries project fertility based on country (group) of origin (Austria, Denmark, Greenland, Netherlands, Norway, Spain, and Sweden), while ethnicity (Estonia, Hungary, and Slovakia), citizenship (Belgium, Denmark, and Switzerland), parity (Slovakia, Sweden), and immigrants (Bulgaria) and/or their descendants (Denmark) were less common. With the exception of Estonia, Iceland, Luxembourg, Sweden, and the United Nations, 27 agencies project regional fertility. Of those 27, 18 project regional fertility as part of their national projections, while 9 project regional fertility separately from the national projections.

Figure 5. For wich sub-groups do you project fertility?




***Statistical methods, number of alternatives and the use of experts***

We asked all respondents whether they use a formal statistical model to project fertility and whether they use different methods for short-, medium-, and long-term projections. Futhermore we wanted to know how many fertility scenarios and/or levels they publish and whether they involve any experts in their ferility projections. The results are summarized in Table 1.

18 of the 32 agencies (52 per cent) are currently utilizing a formal statistical model to project fertility. Such models are used by countries with large populations (e.g., Germany and Spain) and small population (e.g., Faroe Islands and Iceland).

The use of models differs between the agencies. While Switzerland does not use a formal model for the evolution of the TFR, they use a model for the age structure of fertility. Similarly, Turkey does not utilize a formal model for fertility – instead expert opinions are used to set fertility assumptions at the national level. However, a mathematical convergence model is used to adjust sub-regional-provincial fertility levels to the national figures, both for TFR and ASFRs. The Czech Republic also utilizes expert assumptions for low and high variants, although their medium variant is based solely on a formal model.

Four of the countries (Belgium, Germany, Italy, and Portugal) responded that they project TFR and then utilize Schmertmann's (2003) model to obtain ASFRs. In Austria, fertility is projected by first using a model to recover to the latest observed cohort fertility. Next, they use a model for tempo adjusted fertility and then employ the Hadwiger function (Hadwiger, 1940) to estimate ASFRs.

Four countries use a stochastic approach. Whereas the Netherlands looks at cohort- and period-patterns of fertility (by age and number of children) and then extrapolates forward by setting future TFR and age of motherhood, Iceland is utilizing a functional modelling approach. Iceland further constrains the long-term upper and lower bounds of the confidence interval to converge to expert assumptions, but otherwise reports that the fertility projections are entirely model-based. Istat's projections utilize a formal model as described by Schmertmann (2003) and provide one scenario with surrounding prediction intervals based on probabilistic/stochastic methods. The Faroe Islands use Hyndman's "Demogaphy" package in R to project fertility in a stochastic framework.

Denmark uses cubic spline smoothing and the Richard's curve for the convergence from the short- to the long-term development. Poland's fertility projections are based on extrapolation of trends of the last 25 years, as well as on assumptions on convergence to countries in Europe with higher fertility rates than Poland. Future TFRs are also based on European countries that currently have higher TFR than Poland. Spain reports that it adjusts future fertility rates to a known beta function, using a panel of experts, Spain establishes a hypothesis about the evolution of TFR at 15 and 50 years and a hypothesis about the average age at maternity (MAC)[4] at 15 and 50 years.

Lastly, while Eurostat utilizes a mix of extrapolations from ARIMA models and assumptions of partial convergence across countries in the long run, the United Nations uses a Bayesian hierarchical model to project the TFR for each country.

The 14 remaining countries (Albania, Bulgaria, Estonia, France, Greenland, Hungary, Ireland, Luxembourg, Norway, Romania, Serbia, Sweden, UK, and Ukraine) do not rely on a formal statistical model and base their fertility assumptions on deterministic methods. However, some of these methods are also model-based to some extent.

[4] MAC (mean age of childbirth) and AAM (average age at maternity) are used interchangeably in the survey responses. However, we have opted to use MAC throughout this article for consistency purposes.

All agencies, except those in Belgium, Denmark, Eurostat, Finland, Greenland, and Luxembourg provide several alternatives. Among those providing more than one alternative, the number of alternatives ranges from three (most common, provided by 14 of the agencies) to nine (the UN).

22 of the 44 respondents (Table 1) utilize advice from a panel of experts, while others do not currently use experts but have done so in the past, such as Denmark which ceased using experts in 2019.

Table 1. Categorization of methods for fertility projection[a]

| Type of fertility projection | | Classification of countries and organizations |
|---|---|---|
| **1.** | Model-based, deterministic | Austria, The Czech Republic, Belgium, Denmark, Eurostat, Finland, France, Germany, Greenland, Poland, Portugal, Romania, Spain, Ukraine, UK, UN |
| **2.** | Model-based, stochastic[b] | Faroe Islands, Iceland, Italy, Netherlands, UN |
| **3.** | Expert-opinion[c] | Belgium, The Czech Republic, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, UK, Ukraine |
| **4.** | Historical developments/other methods | Albania, Buglaria, Eurostat, Hungary |
| **5.** | No projection | Belarus, Bosnia and Herzegovina, Croatia, Cyprus, Greece, Latvia, Liechtenstein, Lithuania, Malta, Montenegro, North Macedonia, Slovenia |

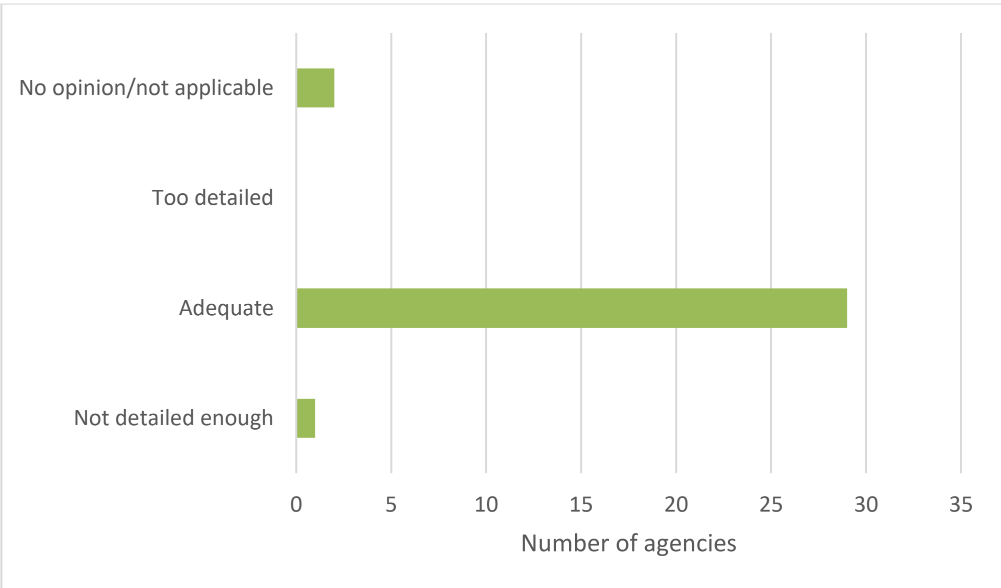
*[a]The countries are listed in alphabetical order. The countries and agencies were given the opportunity to amend their placement in this table. As such, there are minor discrepancies between the information provided from the survey and the results from this table. Some countries use both models and expert opinions and are thus categorized twice. [b]Both frequentist and Bayesian approaches are included here. [c]Most countries rely not only on experts, but also on analyses of historical trends as well as on research on fertility determinants.*

The majority (78 per cent) of agencies are not currently using different methods for short-, medium-, and long-term fertility projections. Among the seven countries that use different methods, Germany and Eurostat use nowcasts of births for the first projected year. Eurostat then bases their next years on trend extrapolations and the long-term projection of fertility is based on partial convergence assumptions. The UK uses an expert panel to obtain expectations of likely levels of fertility five and 25 years into the future of their projection. Furthermore, it tends to set assumptions for the first five years of the projections and then a different trajectory for years six to 25. From 25 years onwards, they hold the assumptions constant for the remaining years (up until 2118). Poland bases its short-term projections mostly on recent trend extrapolation. The more years that pass in the projections, the more weight is put on assumptions on convergence toward certain values take over. Poland also tries to differentiate the variants in the first years of projections to include the variabaility of births and TFR observed in recent years. Iceland carries out some adjustments in the first years of the forecast (one to approximately seven years) and after that the projections follow a more long-term trend. Belgium's new methodology includes explicit measures of certain economic determinants for the first one-five years (e.g. unemployment rates). Lastly, Denmark includes two formal methods in the calculations of fertility. Cubic spline smoothing (for calculating the trend in the age-related fertility) and the Richard's curve for the convergence from the short-term toward the long-term development. This approach is used for the three largest population groups. The fertility trends of small population groups are linked by regression to the three large groups. Long-run levels are however individually chosen for all population groups.

***Evaluation of the most recent population projections***

When asked to evaluate the most recent fertility projections (see Figure 6), 28 of the 32 agencies answered that the information available for making the fertility projections were adequate. Denmark is currently exploring whether it can elaborate on the input used in the fertility calculations and part of this exploration involves testing whether its current method is adequate or not.

Figure 6. Evaluation of most recent projection – information available



The majority of the countries (24) felt that enough time is spent on fertility projections (see Figure 7) and that the frequency of updates is adequate (25) (see Figure 8). Seven countries (Belgium, Estonia, Finland, Luxembourg, Portugal, Slovakia, and the UK) reported that they felt the time spent is insufficient, while Estonia, France, Poland, and Serbia indicated that the fertility projections were not updated frequently enough.

Figure 7. Evaluation of most recent projection – time spent

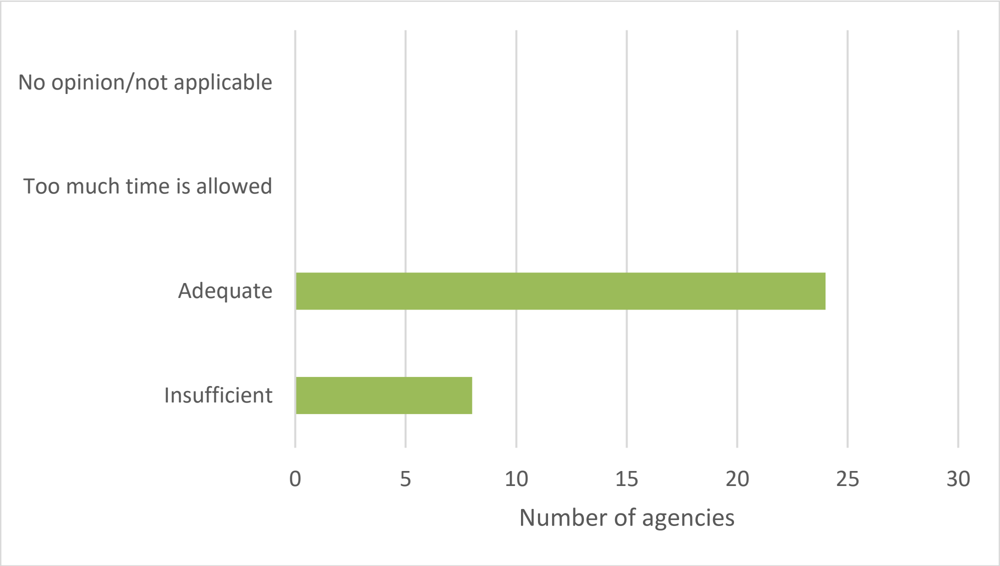
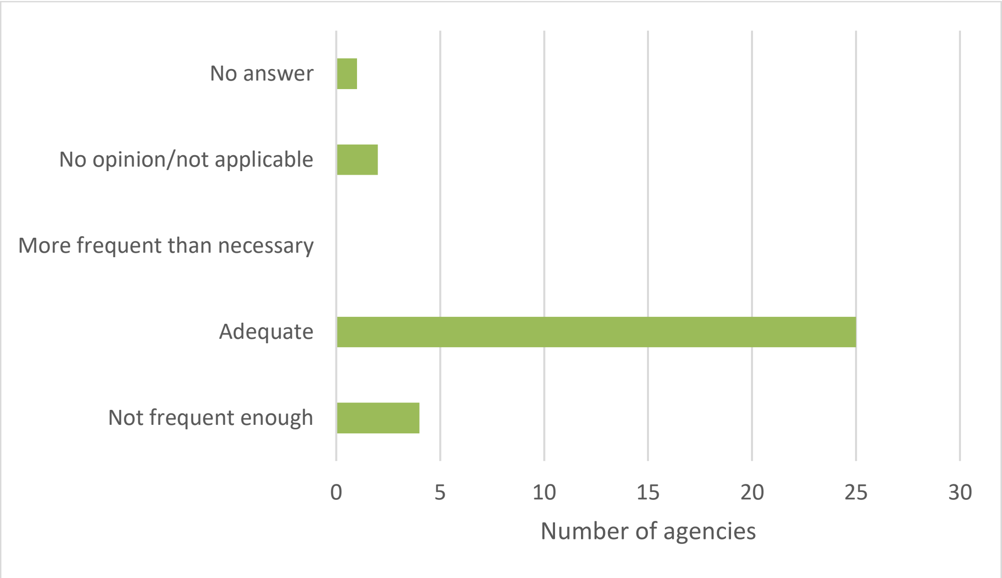
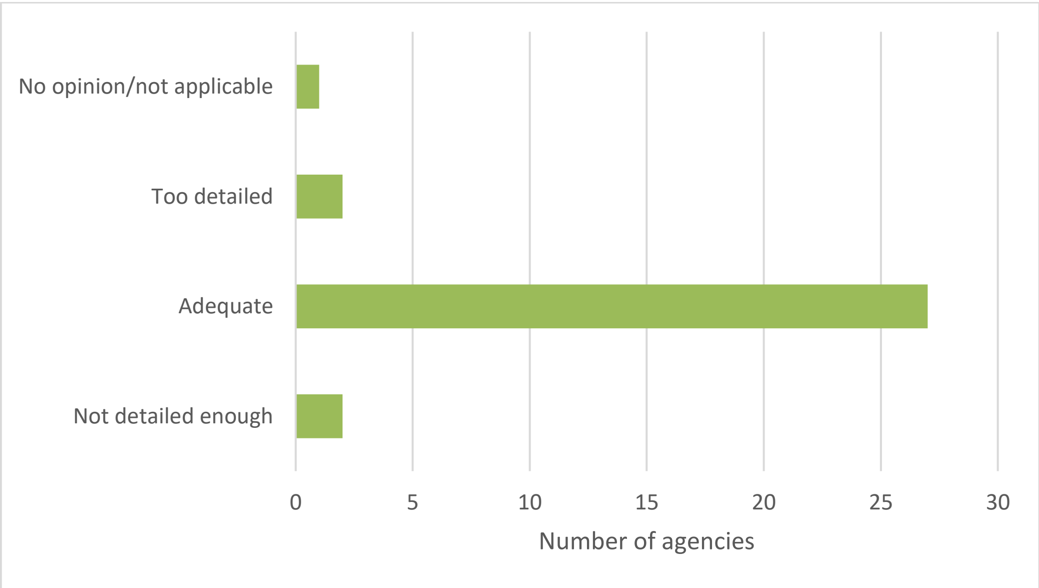



Figure 8. Evaluation of most recent projection – update frequency



Sweden explained that the number of scenarios/levels published is not detailed enough (see Figure 9), Denmark is currently evaluating whether more details are warranted, whereas Poland reported that probabilistic projection would be better, but for the deterministic approach the number is adequate. Denmark is also currently evaluating whether its fertility projections are adequate, while the three other countries answered that they view the fertility projections as adequate as of now. Iceland mentioned that it is currently experimenting with Bayesian methods, with the goal of improving small population estimates of rates and to incorporate expert assumptions into the models in a more nuanced way. Ukraine reported that after the next population census, it has plans to revise the projections for the country, as well as for the administrative regions, and to introduce probabilistic methods. The Netherlands does not have any specific changes planned, but they would like to review how other countries are currently projecting fertility.

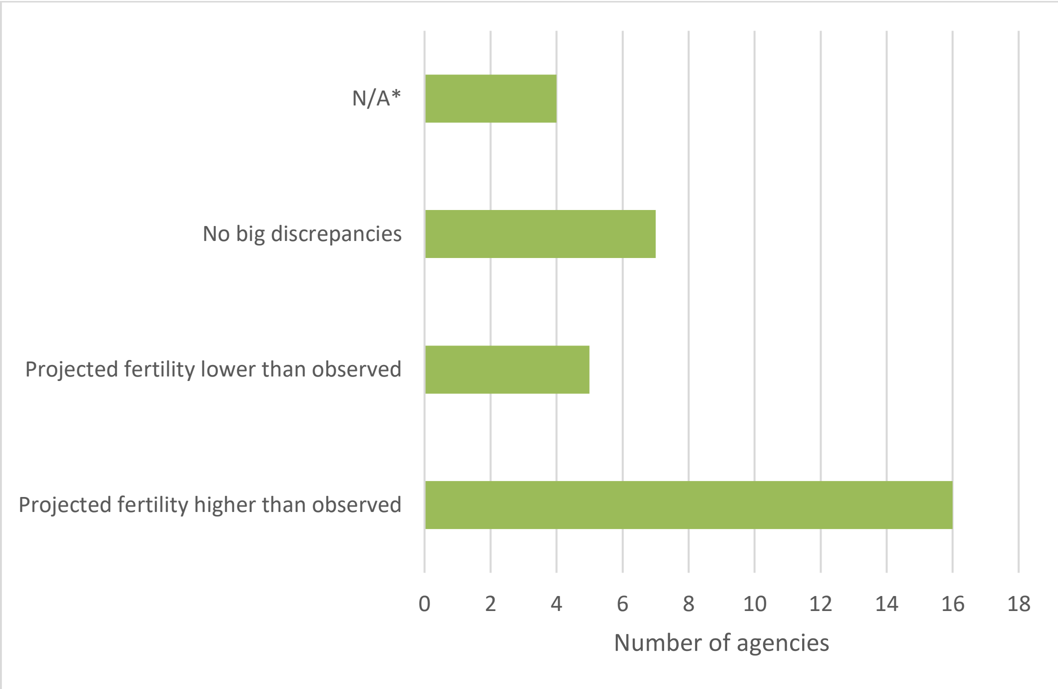
Figure 9. Evaluation of most recent projection – number of published scenarios/levels




***Discrepancies between projected and observed fertility***

In regard to discrepancies in trends between projected and observed fertility (see Figure 10), Denmark reported that because fertility varies, it is challenging to grasp these variations in their calculations and thus the projected fertility is currently a little higher than the observed fertility. While the Faroe Islands, Serbia, and Switzerland do not report pronouncd discrepancies between projected and observed fertility, Iceland, Luxembourg, and Ukraine reported projecting a higher level than what was actually observed once the numbers were available. The Netherlands explained that fertility was projected at a higher level than what was observed in their latest fertility projections and that the number of childless women stayed at 20 per cent, while they had projected this number to decrease to 18 per cent. Sweden has seen a decline in fertility since 2010, resulting in an overestimate of the projected fertility. However, for some groups of foreign-born women, it has underestimated the fertility because fertility is higher during the first years in Sweden, i.e. immigrants with short lengths of stay. Only two of the twelve countries, Poland and Spain, had seen an unexpected increase in fertility since their last projection. In both countries, this resulted in higher numbers for the observed fertility rates than what was projected.

Figure10. Discrepancies between projected and observed fertility




** Unclear, not available or varies by statistical office.*

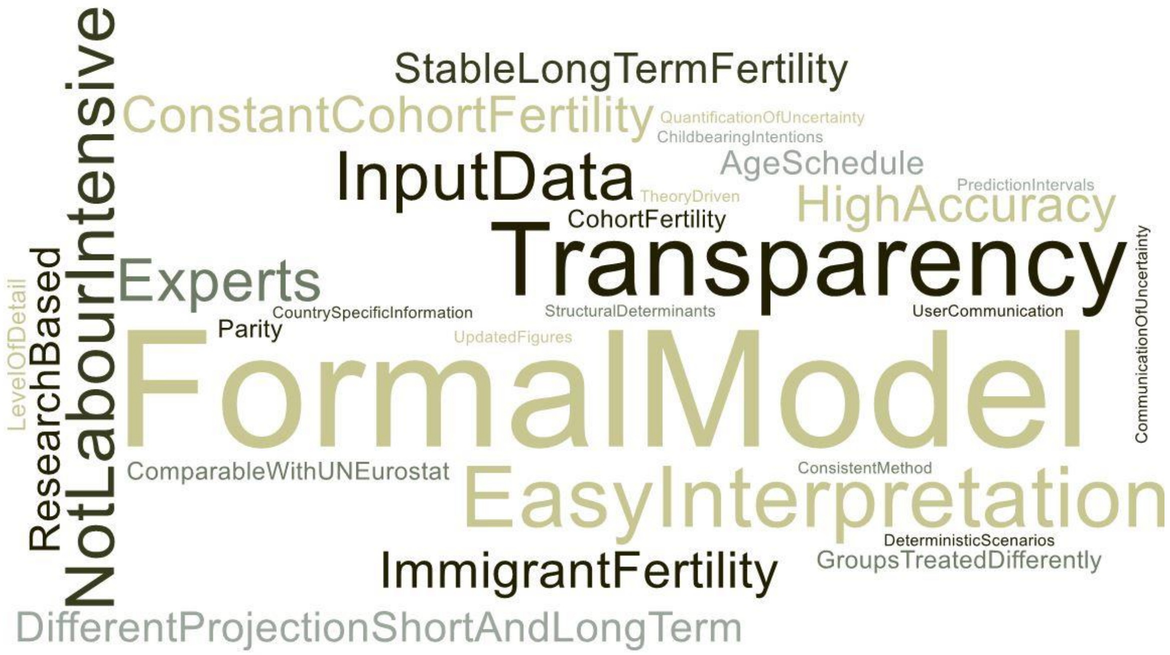
### *General trend*

Most agencies only informally assess their overall projection results as well as those related specifically to the fertility assumptions and projections. Moreoever, evaluations primarily only assess short-term discrepancies. We hypothesize that there might be something to be learned from assessing and documenting discrepancies short-, medium- and long-term in a more formal manner to learn from past experiences. Such documentation would likely be useful for users of projections as well, as such reports might help them understand the inherently uncertain nature of projections.

The ever-present discussion of whether projections a priori are better or more valuable when framed in a stochastic framework, with formal measures of uncertainty explicitly formulated, is not a topic of this paper. Interested readers are referred to de Beer (2011) for a more thorough discussion in this area. In summary, most countries use a deterministic approach to produce their fertility assumptions, although a number of agencies are experimenting with, or testing, stochastic approaches for possible future use. Only four countries, i.e. the Faroe Islands, Iceland, Italy, and the Netherlands currently produce official stochastic projections. In addition, the United Nations produces both deterministic and stochastic projections.

When asked to (freely) list the strengths of the current way of projecting fertility, some of the more common responses were satisfaction with the use of a formal model, quality of input data, transparency, high accuracy, and that the results are easy to interpret, explain and communicate to users (see Figure 11). Several compared their results to the projections made by Eurostat and the United Nations, mentioning that their projections are similar, while others mentioned having good results as their past projections have been in line with observed figures.

Figure 11. Strenghts of the current method*




** The size of each word indicates its frequency.*

Interestingly, while some of the agencies mentioned certain features as a strength, others found the same features to be a weakness (see Figure 12). This was particularly evident when discussing the use of expert groups. On the one hand, the use of experts was mentioned as being a strength, providing good insight and advice, as well as enabling the country to validate their assumptions for future fertility and the results. Although it could be challenging to find relevant experts, this was highlighted as a positive feature. On the other hand, other agencies viewed the use of expert groups as being a weakness of their current method, making the fertility projections dependent on subjective opinions of experts and based on consensus.

There seems to be an agreement surrounding short- and long-term projections, as well as the number of determinants used to project fertility. Those who used different methods for short-, medium- and long-term projections viewed this as a strength, while those not differentiating between short-, medium and long-term mentioned this as a weakness. Several discussed the strength in the number of determinants included and the importance of incorporating the latest available information in their projections. For those with limited number of determinants to project fertility, many listed other determinants of fertility they wished to be able to include to potentially improve their projections, such as for instance parity, mean age at childbirth, immigrant characteristics, and fertility intentions.

Figure 12. Weaknesses of current method*


** The size of each word indicates its frequency.*

Despite the high number of agencies indicating that they are satisfied with their current methods, many viewed their methods as having potential for improvement. Lack of formal models and predicition intervals, as well as quality of data and limited resources were mentioned by many as putting constraints on how much they were able to do. Having labor intensive methods that are difficult to use, as well as posing a challenge in terms of reproducing results, were additional weaknesses mentioned. Although being satisfied with their current practices, some mentioned that it is challenging to know whether the method is in line with the best practices within the field. Several discussed challenges surrounding communication of results to users, especially communicating the uncertain nature of projections. Some agencies also had concerns about whether the users could be bewildered when they are presented with multiple fertility alternatives.

# 6. Summary and discussion

## 6.1 Discussion

We have examined the many approaches taken in projecting fertility in Europe, as well as perceptions of current practices and their outcomes. Our results show that the majority of European countries produce fertility projections at the national level: Among the 44 recipients of the current survey, 32 currently create fertility projections (30 countries and two organizations). A full list is provided in Appendix A3 and might be used to enhance contact and collaboration among the agencies. This list also contains the main projection web pages, where additional documentation can be found.

A challenge that we encountered when registering and interpreting the survey responses was that the reporting in some cases was a mix of what *has* been done, what is *currently* being done, and *future* plans or ongoing work. This is not surprising, since most agencies continuously strive to improve their data, methods or results. In the survey, it was explicitly stated that we were looking for responses related to the *latest* published projection. As a result, we opted to communicate with respective agencies in cases where we were in doubt whether this was the case. Furthermore, all agencies were given an opportunitiy to quality assure all information mentioning them specifically. Any errors in descriptions and/or interpretations remain, however, the responsibility of the authors.[5]

The first step in making a projection is to assess the quality of the data. If data have poor quality, the accuracy of projections, regardless of the methods used, will be poor (Keilman, 2008). However, most

[5] We would like to underscore that we warmly welcome further comments on this working paper. Please contact the authors with any feedback, corrections and/or suggestions.

European countries have good data on fertility, although some countries state that there is information that they would have liked to have but which is not available and/or not reliable.

The cohort-component model is commonly used to make population projections. Starting from the current population numbers by age and sex, the cohort-component model projects how the population will change as a consequence of changes in the levels of fertility, mortality, and migration. We thus need to make assumptions about future changes in fertility, mortality, and migration. For fertility, assumptions may be based on quantitative models, such as time series models or explanatory models. Alternatively, assumptions may be argument based, i.e. they can be based on expert opinions about likely future developments in the main drivers of changes in fertility. Whether projections are based on models or expert opinion, it is important to note that subjective choices and assumptions are always made at some point in the projection process.

The most widely used indicator of fertility is the total fertility rate (TFR). The level of the TFR is determined not only by changes in the average number of children per woman across successive cohorts, but by changes in the timing of fertility as well. Since the effects of changes in the timing of fertility are temporary, one should take this into account in work on fertility assumptions.

Although a variety of approaches are used, utilizing a formal statistical model is the most common approach and used by 18 of the agencies included in this study. While the remaining 14 do not utilize a formal statistical model, some of them rely in part on a model for certain aspects of their work on the assumptions. Currently, the majority of countries use a deterministic approach to produce their fertility assumptions. Across many of the countries it appears that an important reasoning behind a chosen method corresponds with a combination of data quality, resources available and the expertise of the individuals working with the projections. However, it is important to note that more than 70 per cent of the responding agencies stated that they are satisfied with their current method of projecting fertility.

Although it is beyond the scope of this paper to compare the accuracy of the methods utilized across Europe, it would be interesting to see if there are particular methods that are more accurate than others. As of now, most of the participating countries only informally assess their projections and primarily in the short-run. Thus, there is potentially a learning-opportunity from assessing and documenting projections in a more formal manner to learn from past experiences and across countries. Also, as the premises for accurate short-term projections are likely to differ from those likely to be important in the longer-term, some criteria as to what comprises “adequate” fertility projection results in which settings, could be advocated for. Population projections were initially developed to lay the basis for long-term planning, and as such the majority of current methods commonly reflects this goal. Therefore, it is perhaps unfortunate that most evaluations only assess short-term accuracy.

Whether an extrapolation method or an explanatory model is used to make projections, responsible agencies need to make choices and assumptions about the type of method to be used, the base period, the selection of indicators and explanatory variables. Additionally, they need to make assumptions about the continuation of past trends in the future and/or future changes in driving forces. It is important that those who produce projections make their decisions and assumptions underlying the choice and application of methods explicit as this will allow the user to determine how projections can be used. De Beer (2011) argues that users often cannot judge the quality of a projection, but they can decide whether the projection process was reasonable. This requires that users have information about the decisions made by the respective agencies. In other words, projections should be transparent. Transparency requires that in addition to explaining which method is used, the responsible agencies should specify which underlying choices and assumptions are made, what the arguments for these choices and assumptions are, and what the consequences of these choices and arguments are, e.g. by means of sensitivity analyses or by presenting alternative scenarios. Since the accuracy of projections and the plausibility of the alternative scenarios are not known at the moment that projections are made, the user can only judge the way the projections are produced. This requires that the projection process is made transparent. Reports of such kinds would likely be useful for both people working with fertility projections and users of such projections as they would illustrate the uncertain nature of population projections.

If we consider the document review, readily available documentation in English is limited to some degree, in various manners, for most countries, Norway included. Eurostat, Finland, Ireland, Luxembourg, the Netherlands, Spain, the United Kingdom, and the United Nations are exceptions, with extensive information available online in English and in some published articles. Thus, it seems evident that most of the countries would benefit from expanding their websites and/or published documentation to include a more detailed overview of their projections, methods, and accuracy. Projection agencies should make the methods and assumptions transparent to make it possible for users to determine how to interpret the outcomes of the projections. Armstrong (2001) describes several principles for such work, covering the collection and preparation of data, the selection and application of methods, and the evaluation and presentation of projections. He emphasizes two principles in particular: i) provide complete, simple and clear explanations of methods; and ii) describe your assumptions. The former principles imply that for projections to be transparent, the methods should be as simple as possible. It should be clearly stated which choices that have been made and what the consequences of these choices are. If methods are complicated or not well enough documented and explained, projections appear “black box”. Projection makers must make choices, and it is thus important that these choices are made on the basis of arguments explicitly stated. The users should know which choices are made, what the reasons for those choices are, and what the impact of those choices is on the outcomes. Armstrong (2001) argues that by adhering to these two principles, and by examining the projection processes and improving them, the usefulness can be increased. Unfortunately, our survey only asked about usage, and the most commonly reported measures were electronic web hits, page views, or downloads. We did not ask specifically about whether user surveys or other interaction with users had been attempted, to assess how useful users find the respective projections. This should be examined in more detail in future studies, to ensure that projection makers and users have the same understanding of how well the methods and results are communicated and understood. In addition, it would be interesting to know whether there are measures that may be easily incorporated to improve usefulness of a certain method.

Interestingly, countries appear aware of the inherent uncertainties associated with projections, but how well this is communicated does not appear as major concern in our survey responses, in contrast to what was indicated in a recent report from UNECE (2018). For instance, some of the agencies produce only one scenario – and have no plans to increase the number of alternatives. However, portraying different alternative futures is only one way of communicating uncertainty, since many others are available (Eurostat 2018; UNECE, 2018).

## 6.2 Conclusion

In summary, the majority of European countries seem to view their methods for fertility projections as adequate, but with certain challenges. Although the challenges are perceived to differ, several countries state that they are experimenting and testing whether certain changes can improve their models and the projected fertility. This pertains both to the transparency of the models and/or assumptions made, the uncertainty associated with projections, as well as the short-term results. A common trend seems to be a slight overprediction of fertility levels over the past years in all countries except for the Faroe Islands, Serbia, and Switzerland. This might be a result of the observed decline in fertility in many countries during the past decade, perhaps stronger than foreseen, in line with the conclusions drawn for Norway in the review by Rogne (2016).

From the perspective of future projections at Statistics Norway, this study identifies several tried and tested methods that could be used to account for the changing age-patterns in fertility in Norway. It is hoped this background information will act as a useful basis from which to consider, implement and test various approaches in the near future. Of course, selecting and testing certain methods will depend on existing data availability, output requirements, available resources (personal and skill sets) as well as their potential for enhancing accuracy and transparency.

To conclude, fertility projections will never be perfect predictions of the future. They are merely efforts at understanding what would happen to the current population under specified assumptions of fertility in future years. However, countries are likely to benefit from increased interaction and exchange of ideas regarding fertility projections, and efforts to increase such collaboration in the Nordic countries have already been initiated by the national statistical agency of Denmark, to be followed-up soon by Norway in 2021. The meetings and seminars organized by Eurostat are to be welcomed, as further exchange of information outside the Nordic area appears warranted to improve fertility projections and learning from countries and organizations that do well in this area. It is our hope that this paper can be a helpful resource to increase learning and the exchange of ideas across European countries to a greater extent than what is the case today.

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# Appendix A1: Survey letter

Dear Sir/Madame Oslo, November 5 2019

This survey is part of an exploratory study of how European countries choose to project fertility in their national population projections. Norway is currently considering changing the way in which fertility is projected, and this survey has been created with the aim of exploring how other European countries are currently projecting fertility.

We ask the Offices of National Statistics in Europe to respond to this survey regarding your current practices, strenghts and weaknesses of the current method(s), as well as potential suggestions for change in how fertility is projected. We aim to use the results of this survey to improve Norway's fertility projections. We will publish a summary of the results in a working paper with the hope that our findings may be useful for other Offices of National Statistics.

We emphasize that the results will be presented at a group level. No country will be identified in a negative manner, irrespective of the responses provided. Furthermore, in the working paper, no references to individual countries will be made unless this has been approved by the respective countries – and then primarily to examplify "best practice" approaches.

If you work with population projections in your country, we ask you to support our work by completing the present survey. Your responses will be used in the exploration of how to best project fertility and will help identify different methods and their positive and negative aspects. As a result, your elaboration in as much detail as possible is greatly appreciated. The results of this study will be made public and we hope they might be useful for your own work as well as ours.

If you feel that there are other persons within your organization that might be in a better position to respond to this survey, or that could provide an additional perspective on how to best project fertility, please invite them to participate in the survey by forwarding this email. We are happy to receive more than one response per country.

We recognize that we are asking you to take time from your busy schedule to participate in this survey, but we would greatly appreciate your feedback. As we would like to present preliminary results at the Eurostat meeting in Belgrade late November, rapid responses will be highly valued. The deadline for the response is set to **November 15**. We estimate that the survey will take 20-30 minutes to complete. The survey can be completed electronically, using the link provided in this email. You can also complete the survey using the attached pdf document. If you choose the latter, the survey may be filled out in adobe, or it may be printed and filled in by hand, or the information requested may be sent in a separate file. Additional information is also useful and appreciated, if there are questions we have not asked that you feel are pertinent. If you utilize word or a separate document to complete the survey, please send this to ecc@ssb.no.

If you have any questions or concerns about the survey, please contact Astri Syse (sya@ssb.no) or Rebecca Gleditsch (ecc@ssb.no).

Thank you in advance for your feedback!

Yours sincerely

Astri Syse, PhD Rebecca Gleditsch, PhD

## Appendix A2: Survey for current fertility projection practices

Please provide the following identification information:

1. Country:

2. Responsible agency:

3. Responsible person and email for population projections:

4. Reference to webpage(s) in English or other documentation in English

Please send a copy of any English documentation to ecc@ssb.no

5. Do you currently use a formal statistical model(s) to project fertility?

   ☐ No ☐ Yes (please explain below):

6. How many fertility scenarios and/or levels do you provide?

   ☐ One scenario only

   ☐ One scenario with surrounding confidence interval based on probabilistic/stochastic methods

   ☐ Several scenarios/variants based on determinist methods (please specify the number of scenarios/variants below):

7. Please provide a short description of how fertility is projected in your country (e.g., how are future fertility trends determined, do you have an expert panel, etc.):

8. What year was your last projection published?

   ☐ 2019 ☐ 2018 ☐ 2017 ☐ 2016 ☐ 2015

   ☐ 2014 ☐ 2013 ☐ 2012 ☐ 2011 ☐ 2010 or earlier

9. How often are the fertility projections updated?

   ☐ Quarterly ☐ Annually ☐ Biennially ☐ Triennially ☐ Other (please explain):

10. What were the input years in formal models (e.g., historical time series)?

11. What time periods did you emphasize the most if you did not use a formal model?

12. Have your agency used other methods to project fertility previously?

    ☐ No ☐ I don't know ☐ Yes (please explain below):

13. How do you assess your projections when information on the actual fertility becomes available – e.g., do you measure if your projections are on the right track short-term? What about long-term?

14. Please give a short description of any discrepancies in trends between projected and actual fertility:

15. Do you use different methods for short (1-4 years), medium (5-10) and long-term (11+ years) projections?

    ☐ No ☐ Yes (please describe or list the web page where we can read about this):

16. How many people work with the fertility projections in your country (including yourself)?

    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5+

17. What is the highest level of education the person(s) that is responsible for fertility projections have?

    ☐ Bachelor's degree ☐ Master's degree ☐ Doctoral degree

18. What type of background does the person(s) responsible for fertility projections have?

    ☐ Demography ☐ Economics ☐ Social Sciences

    ☐ Statistics ☐ Health sciences ☐ Other

19. About how many months per year is spent on fertility projections in your country? Please include both time spent on the actual projections, as well as background studies. (If you publish projections biennially, please average the time spent per year):

20. In the data you rely on, what type of information do you actually use? Please mark all that applies:

    ☐ Births, yearly☐ Births, multiple yrs.☐ Mother’s age ☐ Mothers’ education

    ☐ Marital Status☐ Citizenship ☐ Country of origin ☐ Sub-national geography

    ☐ Parity ☐ Household type ☐ Ethnicity ☐ Length of stay (immigrants)

21. For information about mother’s age, what level of detail is projected?

    ☐ Single years ☐ 5-year age groups ☐ Other (please specify below):

22. For which sub-groups do you project fertility?

    ☐ Immigrants ☐ Country of origin ☐ Length of stay ☐ Ethnicity

    ☐ Citizenship ☐ Parity ☐ Other (please specify below):

23. Does your country also project regional fertility?

    ☐ No ☐ Yes (please explain below):

24. Are you satisfied with your method of projecting fertility?

    ☐ Yes ☐ No (please explain below):

25. Please list at least 3 strengths of your current fertility projection method:

26. Please list at least 3 weaknesses of your current fertility projection method:

27. Do you know of any future plans to make changes to the way your country projects fertility?

    ☐ No ☐ Yes (please explain below):

28. If you could choose freely, do you have any suggestions of changes to the way your country projects fertility?

    ☐ No ☐ Yes (please explain below):

29. For what purpose do you use projections?

☐ Publish national projections

☐ Research

☐ Publications (journals, etc.)

☐ Other, please specify below:

30. Do you have some measures of the usage of the projections? Indicate all that apply.

☐ No

☐ Yes, electronic web hits/page views views/downloads

☐ Yes, other (please explain below):

**Please respond with reference to the most recent edition of your country's population projection:**

31. In your opinion, the <u>information available for making the fertility projections are</u>:

☐ Not detailed enough

☐ Adequate

☐ Too detailed

☐ No opinion/not applicable

Comments (optional):

32. In your opinion, the <u>number of scenarios/levels your country provides is:</u>

☐ Not detailed enough

☐ Adequate

☐ Too detailed

☐ No opinion/not applicable

Comments (optional):

33. In your opinion, the time spent on fertility projections in your country is:

☐ Insufficient

☐ Adequate

☐ Too much time is allowed

☐ No opinion/not applicable

Comments (optional):

34. In your opinion, the fertility projections are:

☐ Not detailed enough

☐ Adequate

☐ Too detailed

☐ No opinion/not applicable

Comments (optional):

35. In your opinion, the frequency of the fertility projection updates is:

☐ Not frequent enough

☐ Adequate

☐ More frequent than necessary

☐ No opinion/not applicable

Comments (optional):

36. Can we contact you if we have any follow-up questions? If yes, please provide your contact information (name, email address, phone number):

## END OF THE SURVEY

Thank you for taking the time to complete this survey/questionnaire. If you have any additional comments (regarding method of fertility projections or the survey itself), please send them to ecc@ssb.no or provide them below.

# Appendix A3: Contact information

| | Country | Organization | Name of contact | Email address |
|---|---|---|---|---|
| 1 | Albania | Institute of Statistics of Albania | Olta Caca | ocaca@instat.gov.al info@instat.gov.al |
| 2 | Austria | Statistics Austria | Alexander Hanika | demographie@statistik.gv.at alexander.hanika@statistik.gv.at |
| 3 | Belgium | Federal Planning Bureau | Marie Vandresse ; Duyck Johan | vm@plan.be jd@plan.be demo@plan.be vm@plan.be |
| 4 | Bulgaria | National Statistical Institute | Ivaylo Gavazki | igavazki@nsi.bg |
| 5 | Czechia | Czech Statistial office | Roman Kurkin | roman.kurkin@czso.cz |
| 6 | Denmark | Statistics Denmark, The Danish Research Institute for Economic Analysis and Modelling (DREAM) | Lisbeth Harbo; Annika Klintefelt; Marianne Frank Hansen | lhb@dst.dk akf@dst.dk mfr@dreammodel.dk |
| 7 | Estonia | Statistics Estonia | Alis Tammur | alis.tammur@stat.ee |
| 8 | Eurostat (EU and EFTA countries) | Eurostat | Giampaolo Lanzieri | Giampao-lo.Lanzieri@ec.europa.eu ESTAT-Pop-Projections@ec.europa.eu |
| 9 | Faroe Islands | Hagstova Føroya | Jón Joensen | jon@hagstova.fo |
| 10 | Finland | Statistics Finland | Markus Rapo | markus.rapo@stat.fi |
| 11 | France | Insee | Nathalie Blanpain ; Elisabeth Algava | nathalie.blanpain@insee.fr elisabeth.algava@insee.fr |
| 12 | Germany | Statistisches Bundesamt | Olga Pötzsch | olga.poetzsch@destatis.de demografie@destatis.de |
| 13 | Greenland | Statistics Greenland | Lars Pedersen | larp@stat.gl |
| 14 | Hungary | HCSO Hungarian Demographic Research Institute | Csilla Obadovics | obadovics@demografia.hu |
| 15 | Iceland | Statistics Iceland | Violeta Calian | violeta.calian@hagstofa.is |
| 16 | Ireland | Central Statistics Office | James Hegarty | james.hegarty@cso.ie demography@cso.ie |
| 17 | Italy | Istat | Marco Marsili | marsili@istat.it |
| 18 | Luxembourg | Statec | François Peltier | francois.peltier@statec.etat.lu |

| | | | | |
|---|---|---|---|---|
| 19 | Netherlands | Statistics Netherlands | Lenny Stoeldraijer | l.stoeldraijer@cbs.nl |
| 20 | Norway | Statstics Norway | Astri Syse | nasjfram@ssb.no |
| 21 | Poland | Statistics Poland | Maciej Potyra | m.potyra@stat.gov.pl |
| 22 | Portugal | Statistics Portugla | Edvides Coelho | edviges.coelho@ine.pt |
| 23 | Romania | National Institute of Statistics | Dragos Mondiru | dragos.mondiru@insse.ro |
| 24 | Serbia | Statistical Office of the Republic of Serbia | Ljiljana Sekulic | ljiljana.sekulic@stat.gov.rs |
| 25 | Slovakia | Infostat | Branislav Šprocha | sprocha@infostat.sk<br>vdc@infostat.sk |
| 26 | Spain | Ine | Jorge Vega Valle | jorgeluis.vega.valle@ine.es |
| 27 | Sweden | Statistics Sweden | Johan Tollebrant | johan.tollebrant@scb.se<br>befolkning@scb.se |
| 28 | Switzerland | Federal Statistical Office | Raymond Kohli | raymond.kohli@bfs.admin.ch |
| 29 | Turkey | TurkStat | Şebnem Beşe Canpolat (Dir)<br>Metin Aytac<br>Doğu Karakaya<br>Neriman Can Ergan<br>Utkucan Alaşlar | sebnem.canpolat@tuik.gov.tr<br>metin.aytac@tuik.gov.tr<br>dogukarakaya@tuik.gov.tr<br>nerimancan@tuik.gov.tr<br>utkucan.alaslar@tuik.gov.tr |
| 30 | United Kingdom (UK) | Office of National Statistics | Paula Guy | projections@ons.gov.uk |
| 31 | Ukraine | Ptoukha Institute for Demography and Social Studies of the National Academy of Sciences of Ukraine | Pavlo Shevchuk | pavlo-shevchuk@ukr.net |
| 32 | United Nations (UN) | United Nations Population Division | Patrick Gerland | gerland@und.org |

## Appendix A4: Sources*

*Listed by countries from the document review, followed by the participating countries in alphabetical order.

| | Country | Organization | Website |
|---|---|---|---|
| 1 | UN | United Nations Population Division | https://population.un.org/wpp/<br>https://population.un.org/wpp/DefinitionOfProjectionVariants/<br>https://population.un.org/wpp/Methodology/<br>https://population.un.org/wpp/Publications/Files/WPP2019_DataBooklet.pdf |
| 2 | EU and EFTA countries | Eurostat | https://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data<br>https://ec.europa.eu/eurostat/cache/metadata/Annexes/proj_esms_an2.pdf.<br>https://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-projections-data# |
| 3 | Belgium | Federal Planning Bureau | https://www.plan.be/index.php?lang=en<br>https://www.plan.be/publications/publication.php?lang=en |
| 4 | Denmark | Statistics Denmark, The Danish Research Institute for Economic Analysis and Modelling (DREAM) | https://www.dst.dk/en/Statistik/dokumentation/documentationofstatistics/population-projections<br>www.statbank.dk/FRDK319<br>http://www.dreammodel.dk/pdf/Befolkningsfremskrivning2013.pdf<br>https://www.dst.dk/da/Statistik/dokumentation/statistikdokumentation/befolkningsfremskrivning |
| 5 | Finland | Statistics Finland | http://tilastokeskus.fi/til/vaenn/index_en.html<br>http://tilastokeskus.fi/til/vaenn/2019/vaenn_2019_2019-09-30_laa_001_en.html<br>http://www.stat.fi/til/vaenn/kas_en.html<br>http://www.stat.fi/til/vaenn/2019/vaenn_2019_2019-09-30_laa_001_en.html |
| 6 | France | Insee | https://www.insee.fr/fr/information/2546485<br>https://www.insee.fr/en/metadonnees/source/serie/s1316 |

| | | | |
|---|---|---|---|
| 7 | Germany | Statistisches Bundesamt | https://www.destatis.de/EN/Themes/Society-Environment/Population/Population-Projection/_node.html |
| 8 | Italy | Istat | http://demo.istat.it/previsioni2017/index.php?lingua=eng |
| 9 | Poland | Statistics Poland | https://stat.gov.pl/en/topics/population/ https://stat.gov.pl/en/topics/population/population-projection/household-projection-for-the-years-2016-2050,3,4.html https://stat.gov.pl/en/topics/statistical-yearbooks/statistical-yearbooks/demographic-yearbook-of-poland-2019,3,13.html https://stat.gov.pl/en/topics/population/population-projection/population-projection-2014-2050,2,5.html |
| 10 | Sweden | Statistics Sweden | https://www.scb.se/hitta-statistik/statistik-efter-amne/befolkning/befolkningsframskrivningar/befolkningsframskrivningar/ https://www.scb.se/contentassets/77d1f12a07214b528b2141df9bb818cf/be0401_kd_2019_ll_190319.pdf |
| 11 | Albania | Institute of Statistics of Albania | http://www.instat.gov.al/media/5224/projections-of-the-population-2019-2031.pdf http://www.instat.gov.al/media/5223/updated-population-projections-hypothesis-2019-2031.pdf |
| 12 | Austria | Statistics Austria | http://www.statistik.at/web_en/statistics/PeopleSociety/population/demographic_forecasts/population_forecasts/index.html |
| 13 | Bulgaria | National Statistical Institute | https://www.nsi.bg/en/content/6722/population-projections |
| 14 | Czechia | Czech Statistical Office | https://www.czso.cz/csu/czso/projekce-obyvatelstva-ceske-republiky-2018-2100 |
| 15 | Estonia | Statistics Estonia | http://pub.stat.ee/px-web.2001/I_Databas/Population/01Population_indicators_and_composition/04Population_figure_and_composition/04Population_figure_and_composition.asp |

| | | | |
|---|---|---|---|
| 16 | Faroe Islands | Hagstova Føroya | https://www.hagstova.fo/en<br>Reference to:<br>https://github.com/robjhyndman/demography |
| 17 | Greenland | Statistics Greenland | http://bank.stat.gl/pxweb/en/Greenland/Greenland__BE__BE01__BE0150 |
| 18 | Hungary | Hungarian Demographic Research Institute | http://www.demografia.hu/en |
| 19 | Iceland | Statistics Iceland | https://hagstofa.is/media/49266/hag_151118.pdf |
| 20 | Ireland | Central Statistics Office | https://www.cso.ie/en/releasesandpublications/ep/p-plfp/populationandlabourforceprojections2017-2051/fertilityassumptions/ |
| 21 | Luxembourg | Statec | https://statistiques.public.lu/en/index.html |
| 22 | Netherlands | Statistics Netherlands | https://www.cbs.nl/en-gb/news/2018/51/forecast-18-million-inhabitants-in-2029<br>https://www.cbs.nl/en-gb/faq/infoservice/how-will-the-population-of-the-netherlands-develop-in-the-future- |
| 23 | Norway | Statistics Norway | https://www.ssb.no/en/befolkning/statistikker/folkfram<br>https://www.ssb.no/en/befolkning/artikler-og-publikasjoner/norways-2018-population-projections<br>https://www.ssb.no/befolkning/artikler-og-publikasjoner/_attachment/270397?_ts=1556db62308 |
| 24 | Portugal | Statistics Portugal | https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_destaques&DESTAQUESdest_boui=354227920&DESTAQUEStema=5414321&DESTAQUESmodo=2 |
| 25 | Romania | National Institute of Statistics | |
| 26 | Serbia | Statistical Office of the Republic of Serbia | https://www.stat.gov.rs/en-us/oblasti/stanovnistvo/projekcije-stanovnistva/ |
| 27 | Slovakia | Infostat | http://www.infostat.sk/vdc/en/index.php?option=com_content&view=category&layout=blog&id=5&Itemid=40 |

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| 28 | Spain | Ine | https://www.ine.es/dyngs/INEbase/en/operacion.htm?c=Estadistica_C&cid=1254736176953&menu=ultiDatos&idp=1254735572981 |
| 29 | Switzerland | Federal Statistical Office | https://www.bfs.admin.ch/bfs/en/home/statistics/population/population-projections/national-projections.html |
| 30 | Turkey | TurkStat | http://www.turkstat.gov.tr/PreIstatistikMeta.do?istab_id=1637 http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=30567 http://www.turkstat.gov.tr/PreTablo.do?alt_id=1027 |
| 31 | UK | Office for National Statistics | https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsfertilityassumptions2018based |
| 32 | Ukraine | Ptoukha Institute for Demography and Social Studies of the National Academy of Sciences of Ukraine | https://idss.org.ua/forecasts/pop_proj_en |

## Appendix A5: Glossary of terms and definitions

**AAM:** Average age at maternity. Used interchangeably with mean age of childbirth (MAC).

**Age schedule:** Age schedule refers to the distribution of events across ages or age groups. In the context of fertility, it usually refers to the distribution of births across women of different ages or in different age groups, usually in the age span 15-49 years. The age schedule might slide toward higher or lower ages reflecting postponement or advancement of births, thus directly affecting the mean age of childbirth (MAC). In the context of population projections, the terms current and future age schedules are often used, and refer to the observed and projected age schedule, respectively.

**Age-specific fertility rates (ASFR)**: ASFRs are calculated by dividing the number of births to women of a given age by the mid-year population of women of the same age for a given time period. The mid-year population of women is the average number of women of the age in question who reside in the given geographic area during the period in question, usually a calendar year. Commonly, the ASFRs are calculated for women 15-49 years old.

**Fertility projections:** The term fertility projections may refer both to the fertility assumptions made (usually future TFR levels) and to the results from such assumptions when for instance assumed probabilities or rates for future fertility (usually in the form of ASFRs) are applied to the female population in fertile ages thus providing the future number of births in a population.

**Fertility scenarios/levels:** For observed time periods, fertility levels are usually measured by the total fertility rate (TFR). For projected time periods, fertility levels are usually indicated by a projected TFR. Since different assumptions regarding future TFRs may be made, several future fertility levels may be provided. Fertility scenarios and fertility levels are used interchangeably in this paper. However, the term *scenarios* is commonly only used in deterministic projections, whereas the term *levels* may be used in both deterministic and stochastic projections.

**MAC:** Mean age of childbirth. Used interchangeably with average age at maternity (AAM).

**Population projectio**n: An estimate of the future size and composition of a population, given certain assumptions of future fertility, life expectancy, domestic migration, immigration and emigration. The term projection is used for any estimate of the future population, also less likely ones.

**Projection:** A term used for any estimate of the future population, including less likely ones.

**Reproduction rate:** *Gross reproduction* rate is the average number of girls born alive who under the prevailing fertility conditions are born to a woman who survives her entire reproductive period (15 to 49 years). This reproduction rate does not take into consideration the fact that some women die before or during their reproductive period. *Net reproduction*, on the other hand, corresponds to gross reproduction rate, but also takes current mortality factors into consideration.

**Total fertility rate (TFR):** The sum of the age-specific fertility rates from women aged 15-49 years in a given period, normally a calendar year. TFR can be interpreted as the average number of children each woman will give birth to, provided that the period-specific fertility pattern in the period will persist and that no deaths occur before age 50.