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Norway's 2020 population projections

National level results, methods and assumptions

TALL SOM FORTELLER

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Preface

This report presents results from the 2020 national population projections, along with a detailed account of the underlying assumptions. It also describes how Statistics Norway produces the Norwegian national population projections, using the BEFINN model. The national population projections are published biennially. More information about the population projections is available at https://www.ssb.no/en/folkfram.

Statistics Norway, 19 May 2020

Linda Nøstbakken

Abstract

The 2020 national population projections show lower population growth and stronger ageing than in the previous projection produced in 2018. Nevertheless, the main alternative suggests that Norway will experience population growth throughout this century, from around 5.4 million today to 6.1 million in 2060, and around 6.3 million in 2100. This is mainly due to positive net migration. We expect more births than deaths until 2050, after which the situation reverses. We also expect more elderly people in the population, with the population aged 65 years or above doubling by 2075 (from today’s 940 000) and reaching almost 2 million by 2100. The number of the very old, persons aged 90 or over, will also increase, from 45 000 to 210 000 by 2060, which corresponds to an almost fivefold increase. Within 10 years, and for the first time, there will be more elderly (65+ years) than children and teenagers (0-19 years), with the trend towards an ever-older population set to continue throughout the century.

Our main assumption (low and high in parentheses) is that the total fertility rate will remain stable at the current level (1.5) until 2025, before rising again and stabilising at around 1.7 (1.3-1.9). Life expectancy at birth is also expected to rise, from around 81.2 years for men and 84.7 years for women today, to 89 (86-91) and 91 (88-93) years in 2060, and 93 (90-97) and 95 (91-98) years in 2100. Immigration is expected to decline somewhat: In 2019, there were just over 50 000 immigrations to Norway. Due to travel restrictions and other circumstances related to the COVID-19 pandemic, we expect particularly low immigration in 2020 and 2021. From 2022 onwards, we project that annual immigration will decline from around 45 000 (39 000-52 000) to around 37 000 (18 000-84 000) in 2100. The projected emigrations depend partly on the immigrations. In the main alternative, annual net migration remains stable at around 10 000-12 000 up to 2100.

The report also documents how the national population projections are produced, using the BEFINN model. The population is projected by age and sex to the year 2100. Immigrants from three country groups, Norwegian-born children with two immigrant parents and the rest of the population are projected as separate groups.

We use the cohort-component method, with two types of input:

- Updated figures for the population by sex and one-year age groups
- Assumptions about future developments in the demographic components (fertility, life expectancy and international migration)

The results of a population projection largely depend on the assumptions used for the three demographic components. We therefore apply different assumptions for future developments in fertility, life expectancy, and immigration: Medium (M); high (H); low (L); constant (C); zero net migration (E); and no migration (0). Taken together, Statistics Norway projects the population in 15 combinations of these assumptions. Each projection alternative is described using three letters in the following order: Fertility, life expectancy, and immigration. The term ‘main alternative' is used to refer to the MMM alternative, which indicates that the medium level assumption has been used for all three components. We also produce a stochastic projection, with probability intervals around the deterministic medium assumptions, to provide users with a formal assessment of the uncertainty.

Population projections are inherently uncertain. The uncertainty usually increases the further into the future we look. However, due to the COVID-19 pandemic, it has been especially challenging to formulate assumptions this year – even for the short term. Users must bear this in mind when they employ the different alternatives of the 2020 national population projections in their work.

Sammendrag

Resultatene fra de nasjonale befolkningsframskrivingene 2020 gir en lavere befolkningsvekst enn tidligere år, kombinert med en sterkere aldring. Likevel er det fortsatt befolkningsvekst i Norge gjennom hele århundret i vårt hovedalternativ, fra dagens rundt 5,4 millioner innbyggere til 6,1 millioner i 2060 og 6,3 millioner i 2100. Dette skyldes hovedsakelig positiv nettoinnvandring. Det vil fødes flere enn det dør fram mot 2050 før det snur og det vil dø flere enn det fødes. Likevel blir det stadig flere eldre og antallet som er 65 år eller eldre vil mer enn dobles fra dagens 940 000 fram mot 2075 og nå nær 2 millioner i 2100. Antallet 80 år og eldre vil mer enn tredobles innen 2060 (fra 230 000 til 720 000), mens antallet i 90- og 100-årene vil øke dramatisk og nær femdobles (fra 45 000 til 210 000) før 2060. Innen bare 10 år blir det for første gang flere eldre (65+ år) enn barn og unge (0-19 år) i Norge dersom hovedalternativet slår til, og i 2060 vil det være mer enn 500 000 flere eldre over 65 år enn barn og unge.

I våre hovedforutsetninger (lav- og høy- alternativer i parentes) antar vi at fruktbarheten vil ligge stabilt på dagens nivå (1,5) fram til 2025, før den igjen stiger og stabiliserer seg på rundt 1,7 (1,3-1,9). Levealderen forutsettes også å stige, fra dagens 81,2 år for menn og 84,7 år for kvinner, til henholdsvis 89 (86-91) og 91 (88-93) år i 2060, og 93 (90-97) og 95 (91-98) år i 2100. Innvandringen forutsettes å gå noe ned: I 2019 var det i overkant av 50 000 innvandringer til Norge. På grunn av reiserestriksjoner og andre forhold knyttet til COVID-19 pandemien forventer vi spesielt lav innvandring i 2020 og 2021. Etter dette forutsetter vi at den årlige innvandringen vil gå ned fra 45 000 (39 000-52 000) i 2022 til rundt 37 000 (18 000-84 000) i 2100. Det framskrevne antallet utvandringer avhenger dels av antallet innvandringer, og i hovedalternativet vil den årlige nettoinnvandringen ligge stabilt på rundt 10 000-12 000 fram mot 2100.

Rapporten dokumenterer hvordan befolkningsframskrivingene utarbeides, ved bruk av modellen BEFINN. Modellen framskriver folketallet etter alder og kjønn på nasjonalt nivå til og med år 2100. Innvandrere fra tre landgrupper, norskfødte med to innvandrerforeldre og den øvrige befolkningen framskrives som egne grupper.

Vi bruker kohort-komponentmetoden med to typer input:

- Oppdaterte tall for befolkningen etter kjønn og ettårig alder
- Forutsetninger om framtidig utvikling i de demografiske komponentene fruktbarhet, levealder, inn- og utvandring.

Resultatene av en befolkningsframskriving avhenger i stor grad av hvilke forutsetninger som gjøres. Forutsetningene om framtidig fruktbarhet, levealder og innvandring lages derfor i ulike alternativer: Medium eller mellom (M); høy (H); lav (L); konstant (C); null nettoinnvandring (E); og null inn- og utvandring (0).

Til sammen framskriver Statistisk sentralbyrå befolkningen i 15 kombinasjoner av disse M-, L-, H-, C-, E- og 0-alternativene. Et beregningsalternativ beskrives ved tre bokstaver i denne rekkefølgen: fruktbarhet, levealder og innvandring. Betegnelsen 'hovedalternativ' brukes om MMM-alternativet, som angir at mellomnivået er brukt for alle komponentene. Nytt i år er at vi også har laget en stokastisk framskriving, som gir en mer formalisert beskrivelse av usikkerheten.

Befolkningsframskrivinger er i utgangspunktet usikre, og vanligvis øker usikkerheten jo lenger inn i framtiden vi ser. På grunn av COVID-19-pandemien har det imidlertid vært ekstremt utfordrende å lage forutsetninger i år – også i nær framtid. Brukere må huske på dette når de bruker de ulike alternativene fra 2020-framskrivingene i arbeidet sitt, både på kort og lang sikt.

Contents

1. Main results – national population projections

Pronounced ageing, low population growth and pronounced uncertainty, also in the short term due to the COVID-19 pandemic, are the main results from the 2020 national population projections.

The results of Statistics Norway’s 2020 national population projections show lower population growth than in previous projections, combined with stronger ageing. Nevertheless, there will still be population growth in Norway throughout the century, with the main alternative projecting an increase from around 5.4 million today, to 6.1 million in 2060 (Figure 1.1) and 6.3 million in 2100. This is mainly due to positive net migration. In the main alternative, we expect a higher number of births than deaths until 2050, before the situation reverses. We expect an increasing number of elderly people in the population, with the number of persons aged 65 years or above doubling by 2075 and reaching almost 2 million by 2100. Within the coming decade, and for the first time, the main alternative suggests there will be more elderly (65+ years) than children and teenagers (0-19 years): By 2060 there will be 500 000 more elderly than children and teenagers (Figure 1.2), a number that increases to 750 000 by 2100.

Box 1.1. What do the H-M-L abbreviations mean?

The national population projections are produced using the BEFINN model. The population is projected by age and sex to the year 2100. Immigrants from three country groups, Norwegian-born children with two immigrant parents and the rest of the population are projected as separate groups.

We use the cohort-component method, with two types of input: i) Updated figures for the national population by sex and one-year age groups; and ii) assumptions about future developments in the demographic components (fertility, life expectancy and international migration).

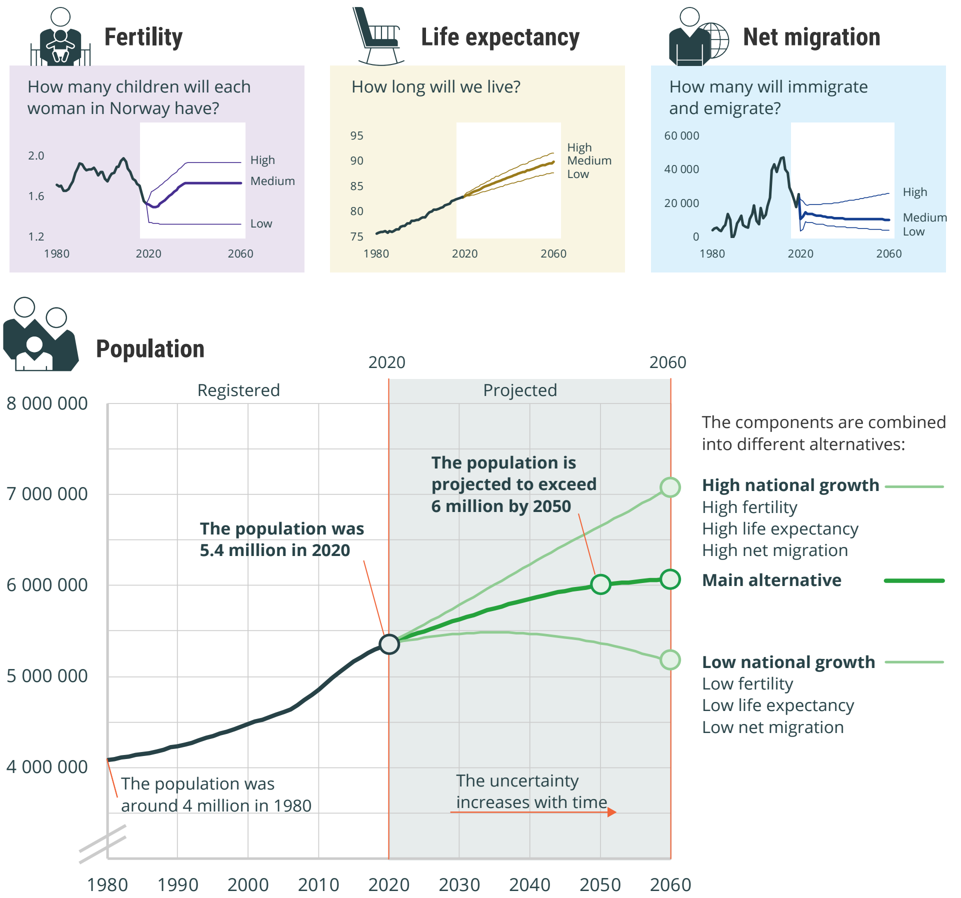
The results of a population projection are largely dependent on the assumptions used for the different components. With projections inherently uncertain, it can be useful to formulate a range of possible scenarios for the future development of the population. As such, several alternative projections are developed, with different combinations of assumptions. These alternative projections are described using three letters in the following order: 1) Fertility; 2) Life expectancy; and 3) Immigration.

The main alternative, MMM, uses the medium level for each of the three components. These medium level assumptions are those that we consider to be the most plausible. The assumptions can be combined in a variety of ways. As an example, the LHL alternative describes a population trend with low fertility, high life expectancy, and low immigration, i.e. strong ageing.

For fertility, life expectancy and immigration, we create high, medium and low alternatives, whereas for emigration we primarily use a medium alternative. We draw up alternatives with constant immigration (MMC) and constant life expectancy (MCM), as well as alternatives without international migration (MM0) and with zero net migration (MME), i.e. equal in- and out-migration. The latter four alternatives are primarily used for analytical purposes.

It is unlikely that fertility, life expectancy and immigration will all remain high (or low) throughout the relevant period. Nevertheless, the span between the HHH and LLL alternatives illustrates a potential degree of uncertainty surrounding the projected total population figures and demonstrates the degree to which the results depend on the different assumptions used. The inherent uncertainty associated with population projections is discussed in greater detail in Chapter 8. In addition, Chapter 9 presents a stochastic (probabilistic) population projection around the medium assumptions of the components.

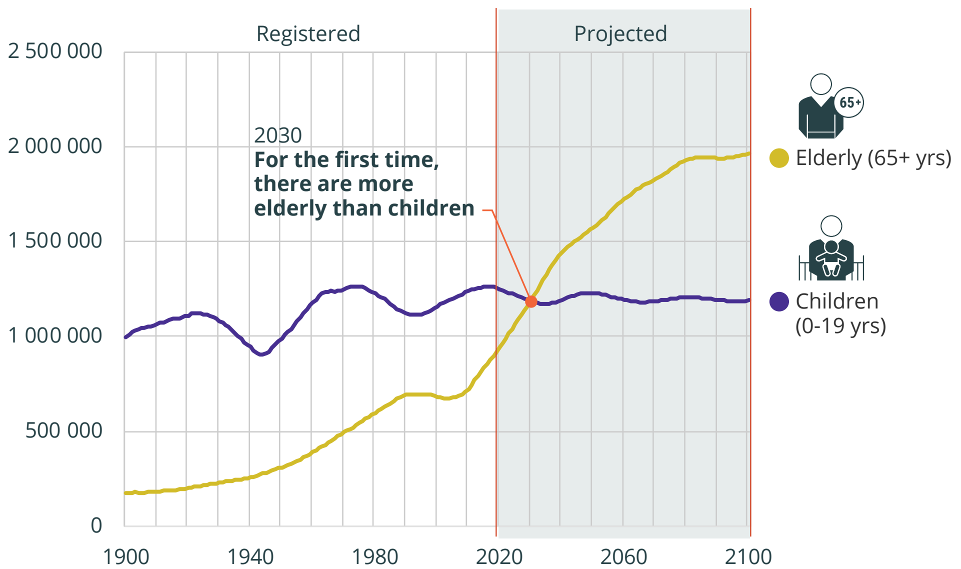
Figure 1.1 An overview of the assumptions and the resulting population figures for Norway, registered and projected in three alternatives



Source: Statistics Norway

As population projections are uncertain, different scenarios are employed. The population growth varies considerably according to these: Using alternatives for low and high national growth, the population ranges from 5.2 to 7.1 million in 2060. However, all our alternatives indicate a pronounced ageing of the population in the years to come.

Figure 1.2 A comparison of the number of elderly versus children and teenagers, registered 1900-2020 and projected 2021-2100, main alternative (MMM)



Source: Statistics Norway

Our main assumption (low and high in parentheses) is that the total fertility rate (TFR) will remain stable at the current level (1.5 children per woman) until 2025, before rising again and stabilizing at around 1.7 (1.3-1.9). Life expectancy is also expected to rise, from today's 81.2 years for men and 84.7 years for women, to 89 (86-91) and 91 (88-93) years in 2060, and 93 (90-97) and 95 (91-98) years in 2100. Immigration is expected to decline somewhat: In 2019, there were just over 50 000 immigrations to Norway. Due to travel restrictions and other circumstances related to the COVID-19 pandemic, we expect a pronounced drop in immigration in 2020 and 2021. From 2022 onwards, we project annual immigration to decline from around 45 000 (39 000-52 000) to around 37 000 (18 000-84 000) in 2100. The projected emigrations depend partly on the immigrations. In the main alternative, the annual net migration will remain stable at around 10 000-12 000 until 2100.

Table 1.1 Population projections 2020. Key figures of the assumptions[1]

	Registered 2019	Medium (M) assumption	High (H) assumption	Low (L) assumption
Total fertility rate, children per woman	1.53			
2025		1.53	1.71	1.33
2040		1.74	1.94	1.33
2060		1.74	1.94	1.33
2100		1.73	1.93	1.34
Life expectancy at birth, men	81.2			
2025		82.6	83.5	81.7
2040		85.6	87.3	83.7
2060		88.9	91.3	86.0
2100		93.4	96.6	89.7
Life expectancy at birth, women	84.7			
2025		85.7	86.4	84.9
2040		88.1	89.7	86.4
2060		90.9	93.2	88.4
2100		94.9	98.0	91.4
Yearly immigrations	50 868			
2025		43 500	51 200	36 900
2040		40 100	55 400	32 200
2060		37 200	64 600	25 900
2100		36 900	84 300	18 300
Yearly emigrations[2]	25 547			
2025		29 800	31 800	28 200
2040		29 000	34 100	26 200
2060		26 700	38 400	21 800
2100		24 800	49 900	15 200

[1] The figures for registered life expectancy are calculated slightly differently than those published in the official statistics. The figures on yearly immigrations and emigrations do not include persons who have moved to and from Norway (or vice versa) during the same calendar year. As such, these figures are not fully comparable with those presented in the population statistics.
[2] The M, H and L figures for projected emigrations are obtained from the MMM, MMH and MML alternatives respectively.
Source: Statistics Norway

In this chapter, we will present the main results from the 2020 national population projections. These results stem from the assumptions made regarding future fertility, mortality, immigration and emigration, outlined above and presented in more detail in the later chapters of this report. The assumptions are also summarized in Table 1.1 and in Figure 1.1.

1.1. Lower population growth

Population growth has slowed markedly over the last few years. In the population projections' main alternative (MMM), population growth continues to decelerate throughout this century. In 2060, the annual growth is assumed to be approximately 0.1 percent in the main alternative, compared to 0.7 percent today. With that said, the main alternative suggests population growth will remain positive throughout the century. In the low national growth (LLL) scenario, the population begins to decline by around 2035, with an annual change of -0.5 percent by 2060. In the high national growth (HHH) scenario, the population grows noticeably, with an annual growth rate of 0.6 percent by 2060. Yet, this is still lower than the observed growth rate in 2019 (0.7 percent).

During the period 2006–2016, the population grew more than 0.8 percent annually, and in the peak years 2011-2012 growth was above 1.3 percent. This is very high, both compared to earlier periods in Norway and compared to other countries, something we discuss in more detail below. Since 2016, annual growth has been between 0.6-0.7 percent. In our projections, we expect it to drop quite sharply to around 0.5 percent over the next couple of years, largely as a response to the COVID-19 pandemic.

COVID-19 pandemic

The 2020 national population projections were produced during a particularly unusual and uncertain time, with all populations experiencing at least some effect of the COVID-19 pandemic. Since the WHO declared a pandemic on 11 March, strict global measures affecting economies and societies across the world have been implemented, with Norway no different in facing school closures, raised unemployment, job layoffs, national and international travel bans, social distancing measures and many other significant courses of action. According to the Norwegian prime minister, the current measures put in place are the most radical seen since the end of World War II. They encompass many areas of life and will have unavoidable effects on the demographic behaviours we are projecting into the future.

While many other countries, such as Italy, Spain, Sweden and the United States have experienced high death tolls (EuroMOMO 2020, NCHS 2020), according to figures from StatBank Norway, reported mortality figures for Norway have not exceeded normal levels for the time of year (https://www.ssb.no/en/statbank/table/07995/). This is also confirmed by the number of deaths in the first quarter of 2020 (10 837), which is close to the figure published in the first quarter of 2019 (10 778). According to the Norwegian Institute of Public Health (NIPH), fewer than 240 persons had died of COVID-19 by the end of May 2020, and most of these deaths involved the elderly and those with underlying diseases (NIPH 2020a, Zhou et al. 2020). The mean age at death of victims of COVID-19 is currently 82 in Norway, with the majority of deaths taking place in nursing homes (NIPH, 2020a). To offer some perspective, the median survival time in Norwegian nursing homes in non-pandemic contexts is approximately two years (Vossius et al. 2018). Based on the low number of deaths, the current knowledge of risk factors, and after dialogue with the advisory reference group for mortality, it is our opinion that many of these deaths would likely have occurred within the next few years even without the pandemic. Consequently, we do not expect to observe appreciable increases in mortality in our medium assumption of life expectancy. If there are appreciable effects on the mortality rate resulting from COVID-19, the low and constant assumptions of future life expectancy may be more appropriate in the short term. These various life expectancy assumptions are discussed in Chapter 6.

In terms of fertility, research into the Spanish influenza pandemic of 1918 has shown that health crises, especially when coupled with increased mortality, tend to reduce fertility, at least short-term (Mamelund 2004). Norway's fertility is currently at its lowest ever. At the same time, economic uncertainty can also work to lower the level of fertility, or at least to delay childbearing (Sobotka et al. 2011).

As such, the current crisis is likely to negatively influence fertility. This has been accounted for in the short-term in our medium fertility assumption, and potential long-term effects have been accounted for in our low fertility assumption. Indeed, the low fertility assumption has been substantially lowered in this projection as compared to earlier projections, also in the long run. We return to this point in the chapter on fertility (Chapter 5).

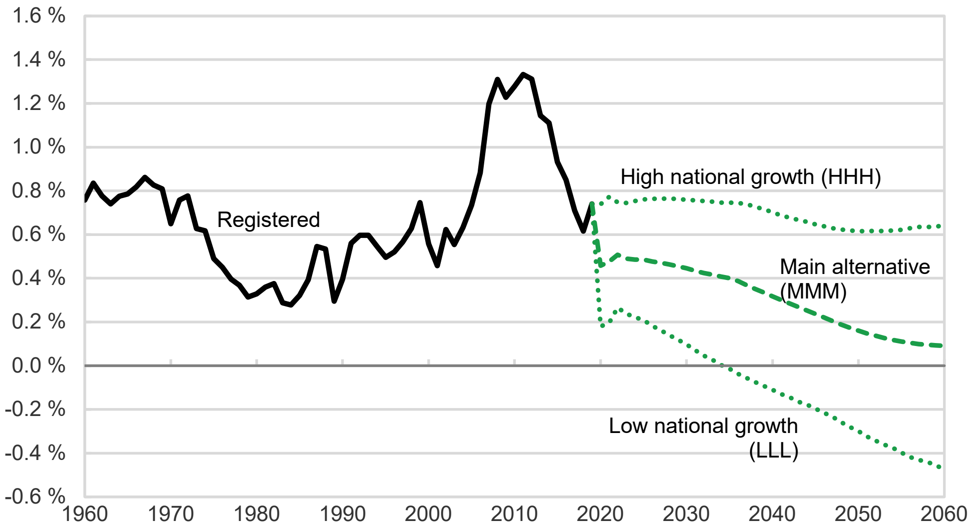
For migration, unless the circumstances are especially dire, people tend to stay put in times of uncertainty (Lindley 2014). During the current health crisis, and subsequent economic crisis, most borders have been closed, and international travel is very difficult. This will have clear effects on all forms of migration, including labour, student, refugee and family migration. In addition, quarantine regulations make it difficult to work cross-nationally, and most schools and university campuses have been closed, although electronic education is still offered. Meanwhile, the resettlement of refugees in Norway is also affected as municipalities focus their efforts on managing health and social care systems during the pandemic. Indeed, the 3 000 resettlement refugees that Norway had agreed to receive in 2020 are still yet to be granted access, according to the Norwegian Directorate of Immigration (UDI 2020a). This is on top of the fact that very few asylum seekers have been entering Norway, with the number of applications having fallen drastically (UDI 2020b). As such, we have opted to reduce the number of immigrations markedly for 2020 and 2021. However, since Norway is less affected than some other countries, both in terms of the number of deaths and the economic impacts, fewer people might opt to emigrate from Norway in the current situation. As a consequence, short-term net migration should be less affected. The impact of the pandemic on immigration, emigration and net migration, both short and long term, is discussed in more detail in the chapter on migration (Chapter 7).

The length of this crisis, and the speed at which a relative state of normality will return, is still unknown. In our projections, we have assumed a return to relative normality in terms of migration by 2022, but for fertility, we expect the level to remain low until 2025. This might not be the case, with the effect of delayed childbearing being another source of uncertainty. Given the changing influence of different health and economic crises on demographic behaviour, we reiterate that our projections are more uncertain than usual this year, and particularly in the short-term. For that reason, relatively large random (i.e. non-systematic) errors in the assumed levels of fertility, mortality and net migration are shown in the stochastic population projection in Chapter 9.

Past, present and future growth

The pronounced growth during 2006-2016 had multiple causes. Immigration to Norway was unusually high following the eastward expansion of the EU in 2004, while emigration saw a more moderate increase. In the first half of the period, fertility in Norway was relatively high, peaking in 2009 with a TFR of 1.98. Combined with a large share of the female population at an age when it is common to have children, this resulted in many births. High immigration was also a contributory factor: Immigrant women tend to have raised levels of fertility the first few years following arrival (Tønnessen 2019). In addition, the number of deaths was very low during the period. This is primarily a consequence of the small birth cohorts from the period between World War I and World War II constituting the oldest ages, but also due to a general increase in life expectancy.

Figure 1.3 Annual rate of growth in the population of Norway, registered 1960-2019 and projected 2020-2060 in three alternatives

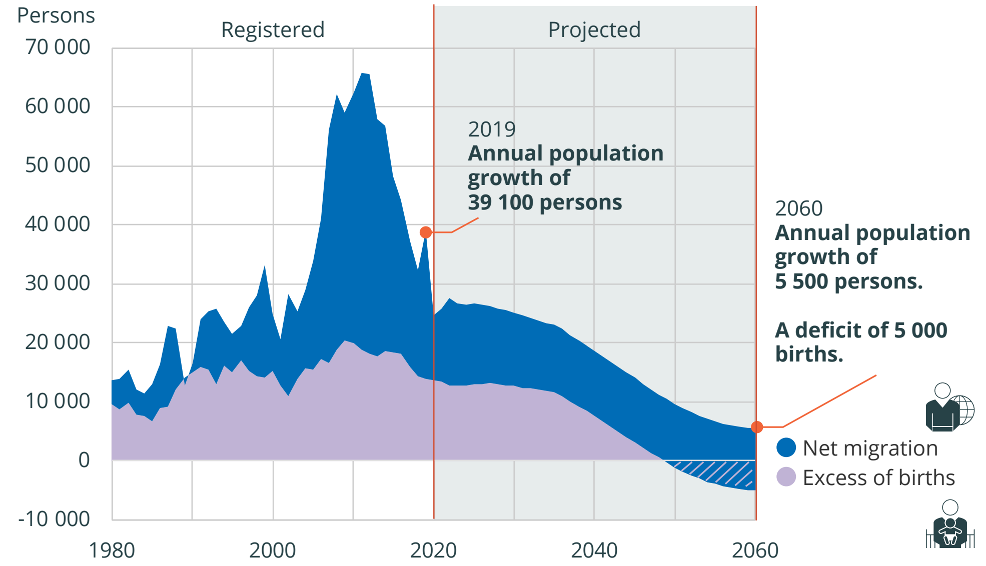


Source: Statistics Norway

In the years to come, we expect somewhat lower immigration, especially from Eastern European EU countries. Consequently, the number of women in childbearing ages will not increase as much as it has in the past. In addition, we expect fertility to remain low in the short term. Although we expect a continued fall in the mortality rate, the number of deaths is likely to increase as the large cohorts born after World War II grow older, reaching an age where it is more common to die. In combination, this leads us to expect weaker population growth in the future, as compared to the last decade.

Population growth can result from an excess of births, i.e. where the number of births exceeds that of deaths, or from a positive net migration, where more people immigrate than emigrate, or indeed from both. Figures 1.4 and 1.5 show the relative contribution of excess of births and net migration over time in Norway. Traditionally, the excess of births has been the largest contributor to population growth. Indeed, if we go back one hundred years, net migration was negative. However, over the past decade, net migration has contributed most to the growth of the Norwegian population. According to the main alternative (MMM), net migration will continue to be a greater contributory factor than the excess of births, especially in the long term.

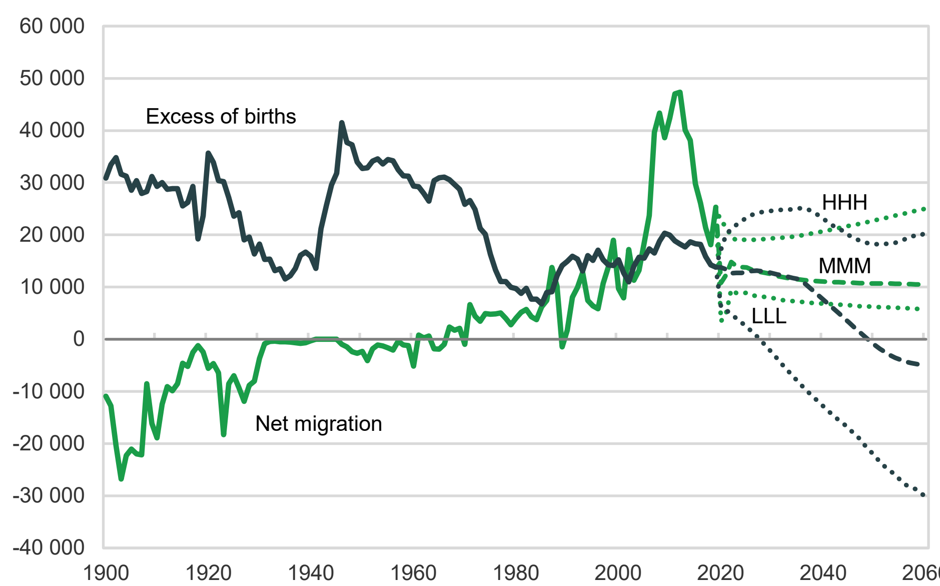
Figure 1.4 Population growth, net migration and excess of births, registered 1980-2019 and projected 2020-2060, main alternative (MMM)[1]



[1] Excess of births is births minus deaths. Net migration is immigrations minus emigrations.
Source: Statistics Norway

While Figure 1.4 shows only the main alternative, Figure 1.5 includes the variation in the low and high national growth alternatives. According to the high growth alternative, net migration becomes the main contributor to population growth after 2040. However, in the longer-term the situation is expected to begin to reverse. In the low growth alternative, net migration will continue to contribute to growth, while low fertility will result in more deaths than births and, as consequence, a fairly pronounced deficit of births within the next 10 years.

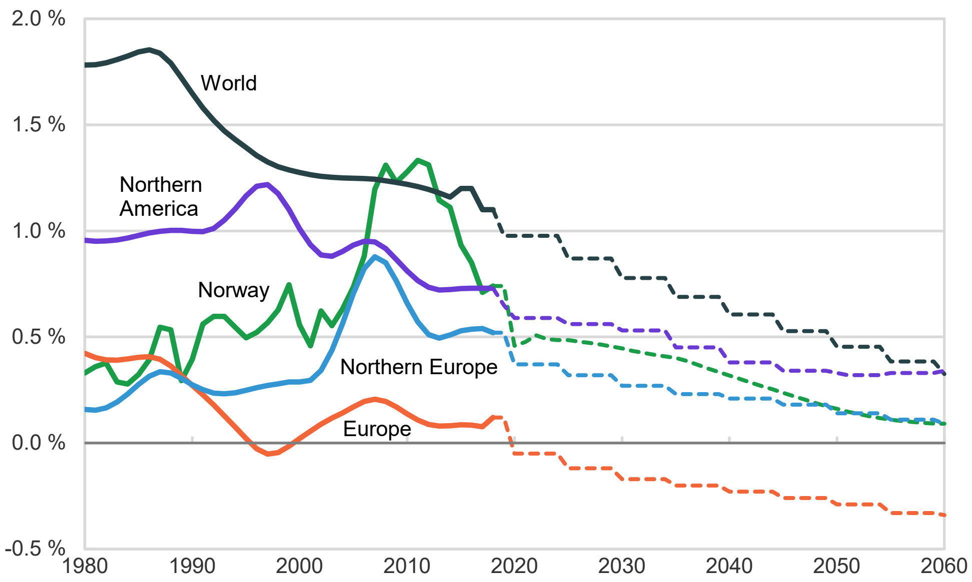
Figure 1.5 Excess of births and net migration, registered 1900-2019 and projected 2020-2060 in three alternatives[1]



[1] Excess of births is births minus deaths. Net migration is immigrations minus emigrations.
Source: Statistics Norway

Although future population growth will be somewhat lower than in the last 10-15 years, growth in Norway will nevertheless be high compared with many other countries, not least in Europe. Figure 1.6 shows the percentage growth in Norway compared to what has been registered and projected by the United Nations for other parts of the world, in the main and baseline scenario. In Europe, several countries already have negative population growth. This is especially true in Eastern Europe, but in recent years there has also been a decline in the populations of Southern Europe. For Europe as a whole, the United Nations expects a persistent decline in the population over the coming years. This is largely driven by countries in Eastern Europe and Southern Europe, while in Northern Europe the United Nations expects continued population growth. Our projected population growth for Norway is higher than that of Northern Europe, slightly lower than that of Northern America, and considerably lower than the projected global population growth.

Figure 1.6 **Population growth as a percentage, Norway and other parts of the world, registered 1980-2020 and projected 2021-2060 in the United Nations medium-variant and Statistics Norway main alternative (MMM)[1]**



[1] Northern Europe comprises the UK, Ireland, the Nordic and the Baltic countries. All figures are from the United Nations medium-variant (United Nations 2019) and from Statistics Norway main alternative (MMM).
Source: United Nations and Statistics Norway

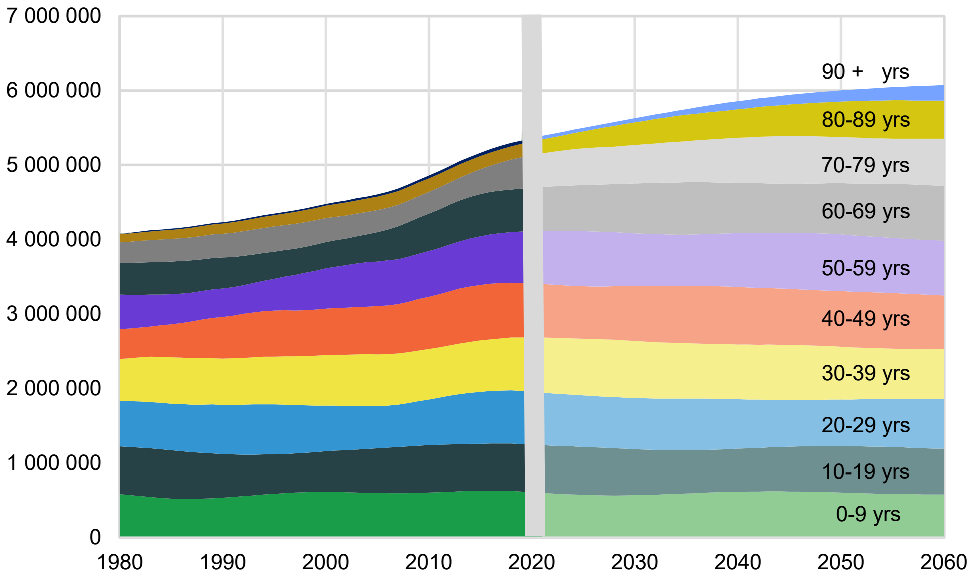
1.2. Strong ageing

The ageing of a population is determined by the number of births, the number of immigrants and emigrants and (remaining) life expectancy, as well as the current age structure of the population. The more new-borns, the more (young) immigrants, the fewer (young) emigrants and the lower the life expectancy, the younger the population will be. Similarly, fewer new-borns, fewer immigrants, many emigrants and a higher life expectancy will result in an older population. In 2019, the number of births was historically low, life expectancy was historically high, and immigration continued downward. Overall, this resulted in a more pronounced ageing in 2019 than what we have seen during the last decade. Furthermore, the phenomenon is projected to increase in the years to come.

Twice as many elderly

We expect an increasing number of elderly people in the population: The population aged 65 years or above will double by 2075 (from 940 000 today) and will reach nearly 2 million by 2100, according to the main alternative. They will also increase as a share of the total population, from 18 percent today to around 30 percent by 2070, before stabilising. The number of persons aged 70 or over will more than double by 2060, from nearly 670 000 this year to close to 1.4 million, according to the main alternative.

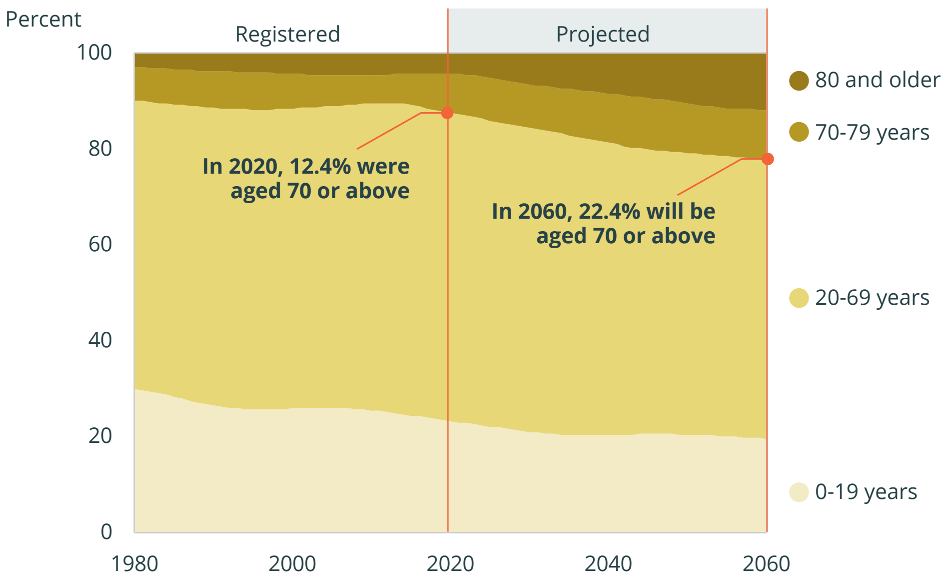
Figure 1.7 The population by age, registered 1980-2020 and projected 2021-2060, main alternative (MMM)



Source: Statistics Norway

Figure 1.7 shows the population divided into age groups, revealing that the oldest age groups are expected to grow the most. While the number of people under age 70 will remain stable in the future, there is a sharp increase among the over 70s, and especially among the oldest in this group. The group aged 80 and over will more than triple by 2060, from 230 000 to 720 000. The number of persons in their 90s and 100s will also increase dramatically, from 45 000 to 210 000, which corresponds to an almost fivefold increase. What is also noticeable from Figure 1.7 is that the share of the population in the typical working age groups gradually declines (see the sub-section on the 'dependency ratio' below). With that said, in absolute terms one may see a small increase over the period 2020-2060. The main alternative suggests that the population aged 20-69 will increase from 3.45 million in 2020 to a high of 3.59 million in 2035, before falling back to 3.52 million in 2060.

Figure 1.8 The population as a percentage in four broad age groups, registered 1980-2020 and projected 2021-2060, main alternative (MMM)



Source: Statistics Norway

The increase is also considerable when measured as a share of the population, as shown in Figure 1.8. Today, every eighth person (12 percent) in Norway is aged 70 or over. By 2060, this number will be one in five (22 percent), according to the main alternative. It should be noted that the small birth cohorts born in the 1930s caused the share of the elderly (70+) to decrease around 2010, with ageing temporarily reversed.

Population projections are made in several alternatives, with different assumptions about fertility, mortality, and immigration. These assumptions can be combined so that we get an alternative with strong ageing – where fertility is low, life expectancy high and immigration low – and an alternative with weak ageing – where fertility is high, life expectancy low and immigration high. These alternatives can help to illustrate how confident we are of the projected future ageing. Table 1.2 outlines figures in the main alternative as well as in the strong and weak ageing alternatives. From this table we see that in the case of weak ageing, i.e. high fertility, mortality and immigration, we still expect the group aged 70 years or above to increase, both in absolute and relative terms, but at a slower rate, with only to 1.3 million (18 percent) in 2060 (i.e. 100 000 fewer persons than the main alternative). The group aged 80 or older will also increase more slowly, to 620 000 (9 percent) (again with 100 000 fewer than in the main alternative). On the other hand, in the strong ageing alternative the increase will be approximately 100 000 people higher for both groups, than in the main alternative, with absolute numbers reaching 1.5 million people aged 70 or over (27 percent) and more than 800 000 people aged 80 or above (15 percent).

Table 1.2 Elderly in different age groups in numbers (N) and percentages (%), registered and projected for selected years in three alternatives[1]

	Total population	70+ years		80+ years		90+ years	
	N	N	%	N	%	N	%
2020	5 367 580	666 544	12.4	230 710	4.3	45 230	0.8
Main							
2040	5 856 800	1 096 500	18.7	491 900	8.4	108 800	1.9
2060	6 073 600	1 358 100	22.4	718 000	11.8	210 400	3.5
2100	6 253 700	1 619 800	25.9	983 485	15.7	376 200	6.0
Strong ageing							
2040	5 597 600	1 146 200	20.5	531 100	9.5	126 900	2.3
2060	5 444 400	1 462 500	26.9	816 800	15.0	273 400	5.0
2100	4 448 800	1 641 700	36.9	1 110 000	25.0	508 900	11.4
Weak ageing							
2040	6 104 000	1 044 400	17.1	452 300	7.4	92 200	1.5
2060	6 789 100	1 252 300	18.4	620 400	9.1	156 300	2.3
2100	8 761 400	1 662 300	19.0	888 200	10.1	267 700	3.1

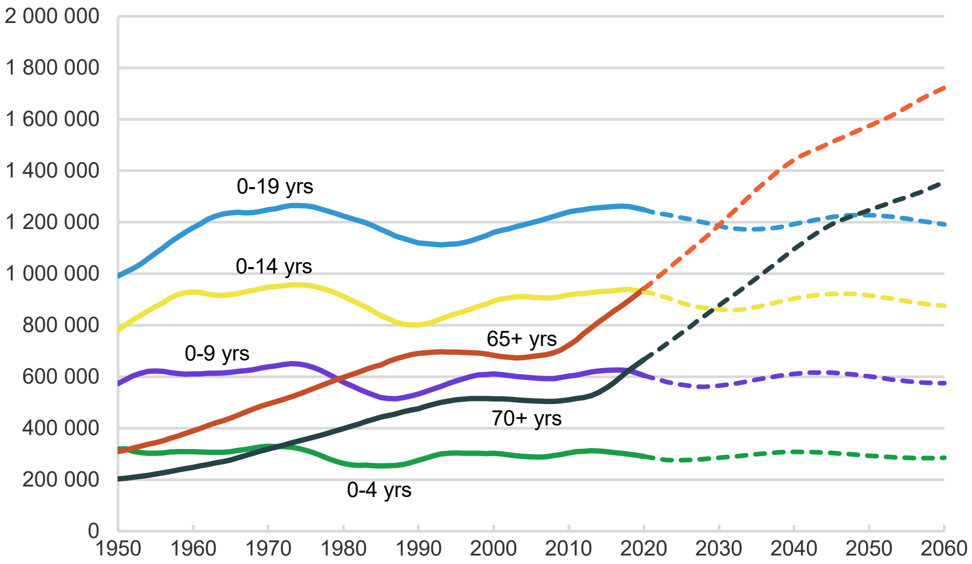
[1] The population estimates refer to the population on 1 January.
Source: Statistics Norway

Soon to be more elderly than children and teenagers

Throughout Norway's history, there have always been more children and teenagers than elderly. This year's national population projections show that this will change. As shown in Figure 1.9, while the number of young people will remain fairly stable, the number of elderly will continue to grow rapidly.

In approximately 10 years, our main alternative suggests that, for the first time, there will be more elderly (65+ years) than children and teenagers (0-19 years) in Norway, with the trend towards an ever-older population set to continue throughout the century. Indeed, by 2060 the elderly will outnumber children and teenagers by approximately 500 000. As Figure 1.9 shows, our main alternative also suggests that the number of elderly aged 70 or above will overtake the number of children and teenagers by 2060.

Figure 1.9 The number of children and teenagers in four age groups versus the number of elderly in two age groups, registered 1950-2020 and projected 2021-2060, main alternative (MMM)



Source: Statistics Norway

Dependency ratio

Ageing strongly influences the old age dependency ratio (OADR). This measure shows the ratio of the number of elderly to the number of persons in working ages. As such, it provides a rough approximation of the 'burden' associated with the elderly, to the 'productive' population, though it does not account for the actual employment rates of these groups, nor the share of older people who are truly dependent, in need of care, or contribute to care-related activities. Nevertheless, it is a simple and widely used measure that can illustrate aspects of the population structure that are of major importance for employment and government revenues on the one hand, and pension costs, nursing and care needs and the like on the other.

In this report, we have chosen to calculate the OADR as the ratio between the number of persons aged 65 and over and the number of persons aged 20–64. The age of 65 is chosen as a cut-off point because it is close to the average old-age retirement age in Norway (65.4 years for both sexes combined), according to the Norwegian Labor and Welfare Administration (NAV 2020a).[1] The average retirement age was 66.0 years for women and 64.8 years for men at the end of 2019. According to NAV, there were around 960 000 elderly who received old-age pensions in 2019.[2] In addition, there were more than 350 000 who received disability pensions. In total, more than 1.3 million people received a pension of some kind in 2019.

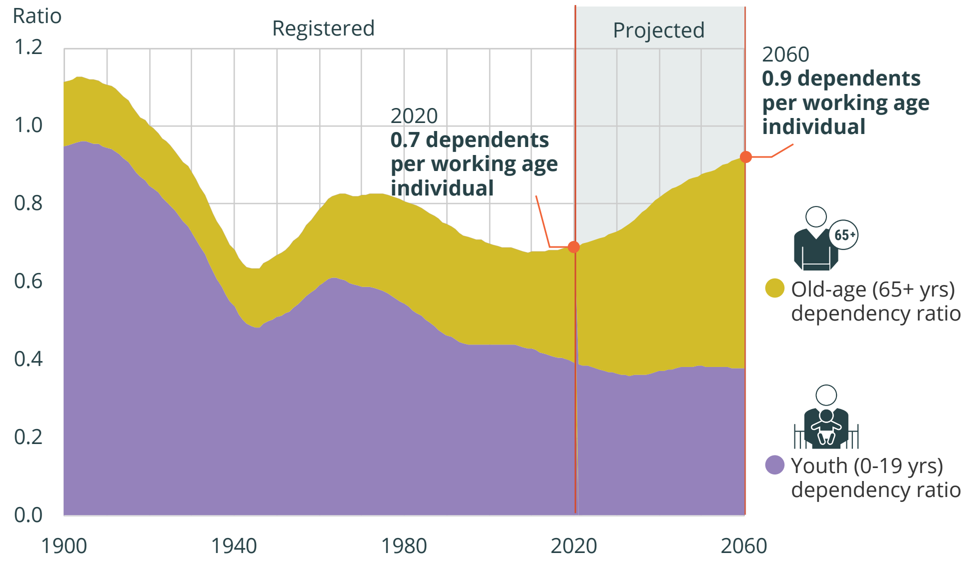
The youth dependency ratio (YDR) is defined as the number of people aged 0–19 divided by the same denominator as is used for the OADR, i.e. the population aged 20–64.

[1] The age cut-off of 65 years is also the most commonly applied definition internationally, although some also use age 70. In the latter case, the working age population would be defined as those aged 20-69.

[2] After the introduction of the pension reform in 2011, elderly individuals may choose when they want to take out their retirement pension, within the age range 62-75 years. The retirement pension can be freely combined with work without a reduction to the pension. As such, some old-age pensioners continue to work. This is most common among the youngest of this age group, i.e. those aged 62-66 years. In total, nearly 60 percent of these pensioners are registered with an attachment to the labour market. The percentage falls markedly with increasing age, and among those aged 67-69 years, the share is only around 16 percent.

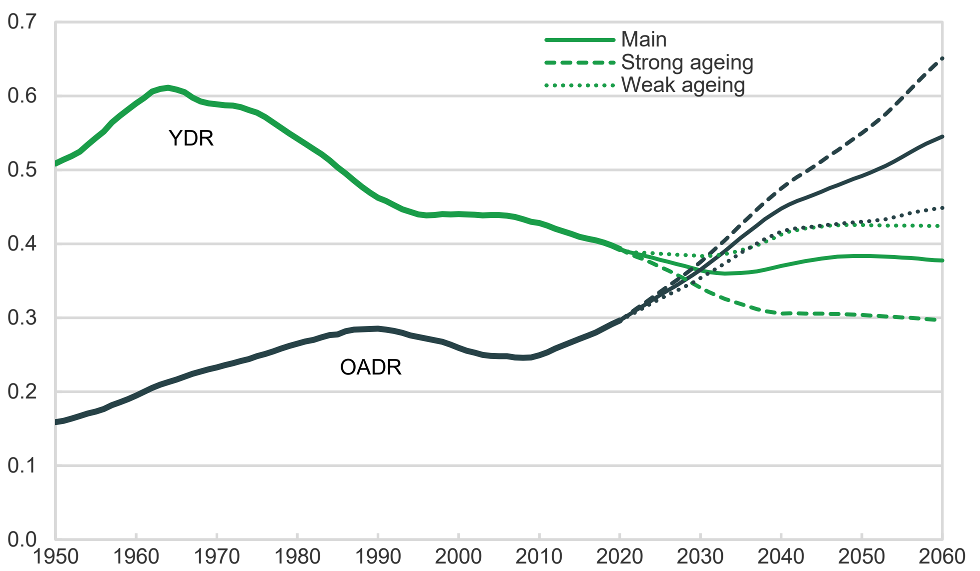
High dependency ratios imply a society with a large number of young people and/or elderly in relation to the number of people of working age. Figure 1.10 and 1.11 shows the development in these two dependency ratios. The youth dependency ratio is slightly higher than that for the elderly today: Every person of working age must on average support 0.4 children and 0.3 elderly. However, from 2030 onwards, i.e. 10 years from now, the OADR will exceed that of the YDR in our main alternative (Figure 1.11). By 2060, every person of working age will have to support on average 0.4 children and 0.5 elderly. This means that there is almost a one-to-one relationship, which will have significant consequences for public finances and labour supply. As shown in Figure 1.11, the OADR increases and exceeds 0.4 in 2060 even in the weak ageing alternative. In the strong ageing alternative, it rises to above 0.6.

Figure 1.10 Total, old age and youth dependency ratios, registered 1900-2020 and projected 2021-2060, main alternative (MMM)[1]



[1] The dependency ratio is the number of youths (0-19 years) and/or elderly (65+) divided by the number of working age persons (20-64 years).
Source: Statistics Norway

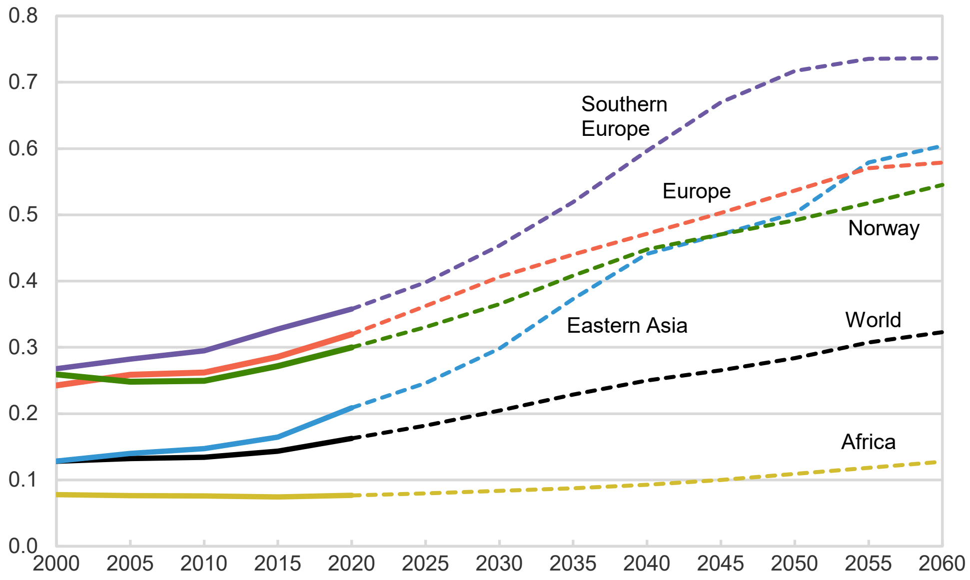
Figure 1.11 Youth and old age dependency ratios, registered 1950-2020 and projected 2021-2060 in three alternatives[1]



[1] The numerator is the dependents. For youth, age 0-19, and for old age, age 65 or older. The denominator is the working age population, here defined as age 20-64.
Source: Statistics Norway

Although the OADR will rise markedly in Norway, the challenges associated with a relative decline in the working age population and the relative rise in the elderly population will be much greater elsewhere in the world. Figure 1.12 shows that Norway has a lower OADR than the European average, with Southern Europe having an especially high OADR. East Asia has a low OADR today but will experience a strong increase due to the pronounced ageing which is itself a legacy of prolonged and very low fertility in previous decades. Indeed, the OADR in East Asia will surpass the OADR in Norway, and even Europe, within the next 30-35 years. In Africa, where fertility remains relatively high, a much weaker increase in the OADR is expected throughout this century.

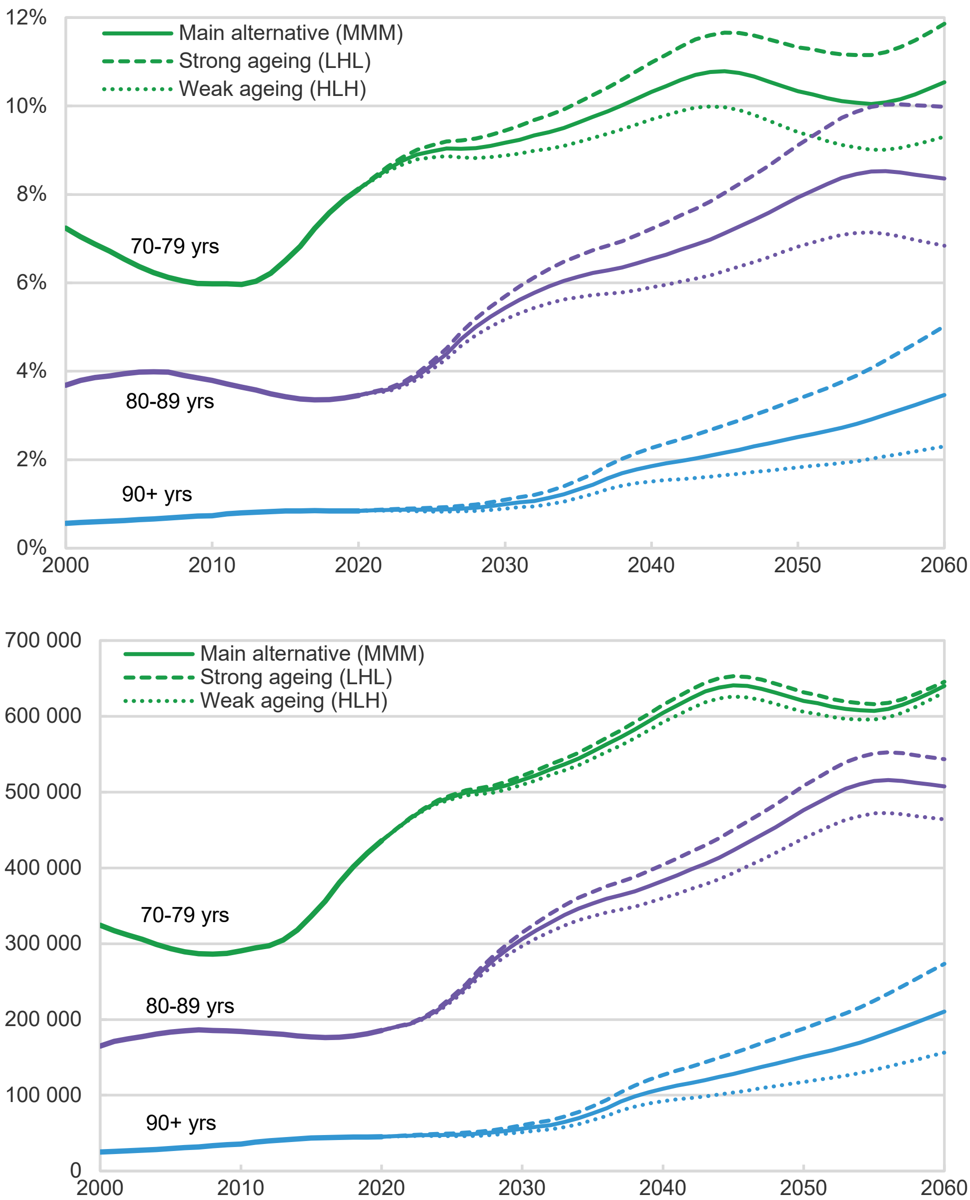
Figure 1.12 Old age dependency ratios, registered 2000-2020 and projected 2021-2060 for Norway and selected world regions[1]



[1] Old-age dependency ratio is defined as the number of persons aged 65+ divided by the number of persons aged 20-64. All figures are from the United Nations medium-variant (United Nations 2019) and from Statistics Norway main alternative (MMM).
Source: United Nations and Statistics Norway

Figure 1.13 shows the numbers and proportions of the population in the oldest age groups, recorded and projected in the main alternative (MMM) as well as the alternatives for strong (LHL) and weak ageing (HLH). As the figure shows, there will be a clear increase in the proportions aged 80–89 and 90 and over, whatever the alternative. The increase in the number and share of 80–89-year-olds gains real momentum after 2025, the period around which the large post-war cohorts begin to enter this age group. These birth cohorts reach their 90s in the mid-2030s, as shown in the rise in the number and share of the population in this age group in Figure 1.13. In the short term, there will also be an increase of the population aged 70–79, regardless of the alternative, but after 2040 this percentage will fall somewhat.

Figure 1.13 Share (top) and number (bottom) of the population in older age groups, registered 2000-2020 and projected 2021-2060 in three alternatives



Source: Statistics Norway

Ageing in Norway today is weaker than in many comparable countries, and the projected 'grey tsunami' in Norway will be far weaker than expected elsewhere (United Nations 2019). This is because Norway, until recently, has had a smaller fall in fertility and a relatively higher immigration of younger cohorts compared with other countries in, for example, Europe, while life expectancy is not among the very highest. However, this has not always been the case. In the 1960s, Norway had one of Europe's oldest populations measured by median age. Since then, the ageing phenomenon has taken place at a faster pace in other European countries (Eurostat 2020). Today, Italy (47 years) and Germany (46 years) have some of Europe's oldest populations, with a median age of around 46-47 years meaning half of all Germans and Italians are over that age. These two countries also experience relatively low fertility rates. To contrast with other Nordic countries, on average the population is also older in Sweden (41 years), Denmark (42 years) and Finland (43 years) than in Norway (40 years).

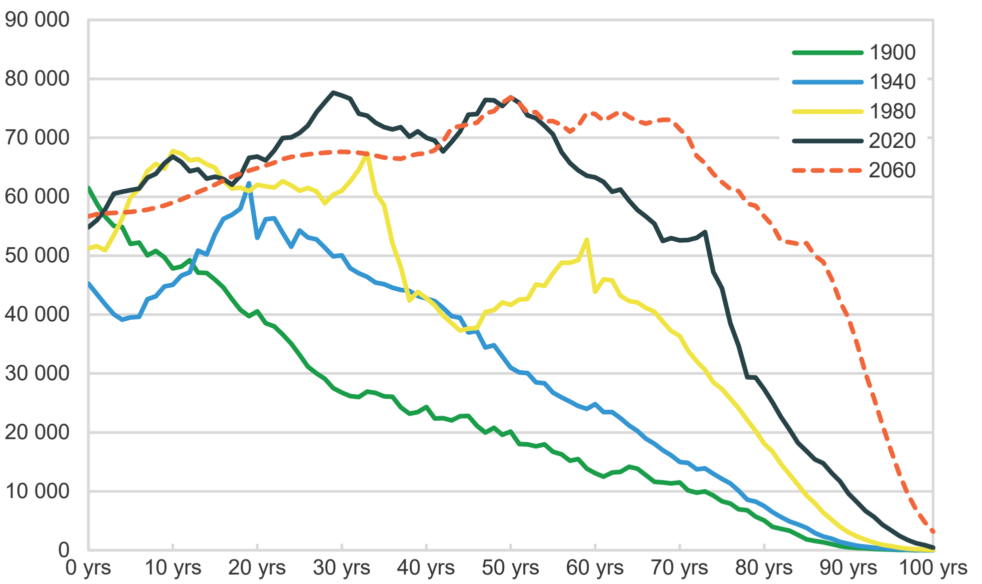
The fact that population ageing in Norway is weaker than in other comparable countries allows us to examine the ways other countries meet the resulting challenges, design policy and attempt solutions. Thus, there are some benefits to the fact that our ageing has been relatively modest so far, leaving some room to plan and implement possible solutions and/or adaptions. It may be appropriate to start by examining neighbouring Nordic countries, given their many similarities in terms of geography, health and welfare systems.

Population age structure

The average age in Norway has increased every year for which we have figures. On 1 January 2020, the population was on average 40.5 years old. In only two years, the average age has increased by half a year (0.46), while the increase over the last 50 years (since 1971) is exactly five years. From 2019 to 2020, we observed a decline of almost 10 000 in the number of children aged under 10. At the same time, the number of 70-year-olds has increased by as much as 16 000, and this is also where we find the largest increase in percentage terms. This is partly a consequence of the post-war baby boom, wherein more children were born in the years during and after World War II than in the years before the war. We also see a significant increase in the number of persons aged 80 years or older, close to 5 000. With that said, the number of people aged 20-64 has also increased from last year to this year, by around 23 000. Thus, we see only a marginal increase in the OADR (number 65+ years / number 20-64 years) from 0.29 to 0.30.

Throughout the last hundred years, the number of Norway's youngest inhabitants has barely changed. Figure 1.14 shows the population's age distribution in selected years from 1900 as well as the main alternative projected distribution for 2060. For the youngest children, the numbers have barely changed in a hundred years and we expect only a slight increase in this group by 2060. In the older age groups, however, we observe a marked growth, with a rectangularization of the curves (i.e. the curve takes the form of a rectangle as the population ages).

Figure 1.14 Age distributions of the population for selected years, registered and projected, main alternative (MMM)



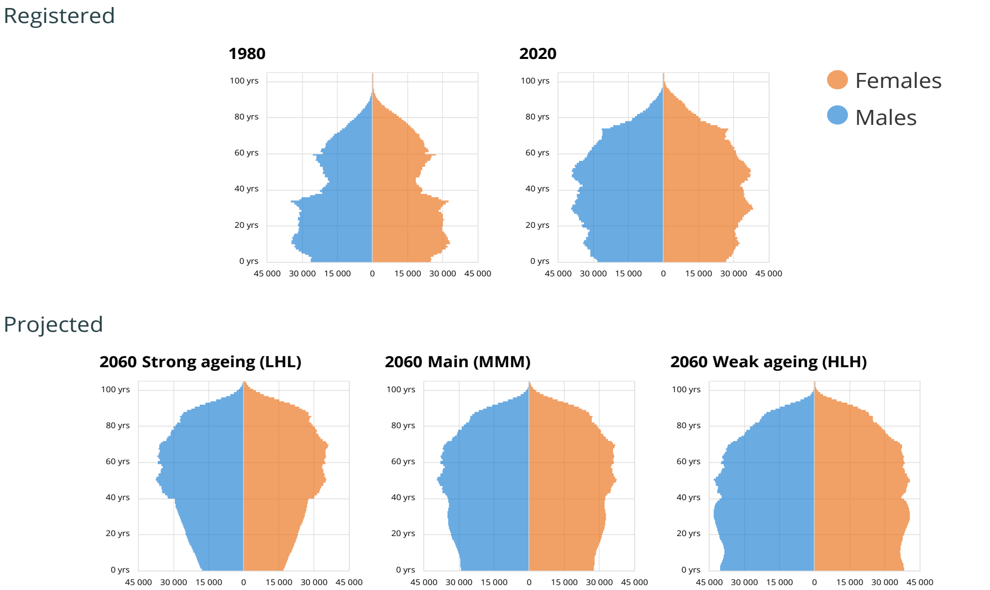
Source: Statistics Norway

The figure is also useful in demonstrating the relative size of different birth cohorts. In the 2020-line (black) we see a local peak at age 73. This represents the 1946 birth cohort, which is the largest cohort ever born in Norway. This peak can also be seen in the line for 1980 (yellow, age 33). This cohort remained the largest in the Norwegian population from birth and through the 1950s and 1960s, before international migration and mortality took effect and this cohort was replaced by the 1969 birth cohort as the largest group. Today (black), the 1990 cohort is the largest, with a peak at age 29. In the future, according to the main alternative, this 1990-cohort will remain Norway's largest up for the next decades. Thereafter, the cohort born when fertility last peaked in 2009 will become the largest, and immigration will contribute to growth also for this cohort.

Population pyramids

Figure 1.15 shows five different population pyramids. The first pyramid (top left) shows the age and sex distribution of the population 40 years ago, in 1980. We observe the local peaks mentioned above, for the 1920-, 1946- and 1969-cohorts. More strikingly, however, is the young age structure. The pyramid has a broad base, and a narrow top. Today's population pyramid (top right) shows that the population has aged considerably, but that there are fairly few in the very oldest of old ages. When we look 40 years into the future (bottom), we see that the population pyramids vary depending on the assumptions we use for fertility, mortality and immigration, though all alternatives show pronounced future ageing. The main alternative (MMM) has greater numbers towards the top than the weak ageing alternative (HLH), where fertility, mortality and immigration are all high. Indeed, the weak ageing alternative is characterized by larger numbers at the base and fewer at the top. In contrast, the strong ageing alternative (LHL), where fertility, mortality and immigration are all low, shows a very top-heavy pyramid, which appears almost inverted. The base is very narrow with few persons in the young age groups, and therefore with older age groups dominating.

Figure 1.15 Population pyramids, 1980, 2020 and 2060, registered and projected in three alternatives[1]

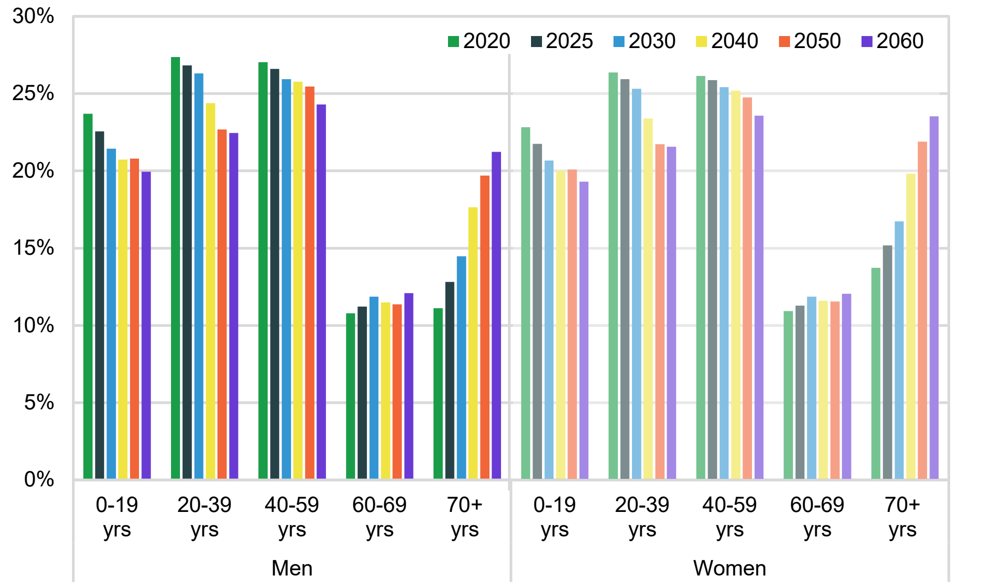


[1] The alternatives shown are: Main alternative (MMM); weak ageing (HLH); and strong ageing (LHL).
Source: Statistics Norway

1.3. An increasing surplus of men

There are more men than women in Norway, currently around 45 000. The surplus of men is primarily concentrated in younger age groups, especially in ages 20-49, but is found to also exist right up to age 65 according to registered data for 2020. This is because there are more boys born than girls, and because there are more immigrations by men than women. Even though more men emigrate than women, the net migration to Norway is higher for men.

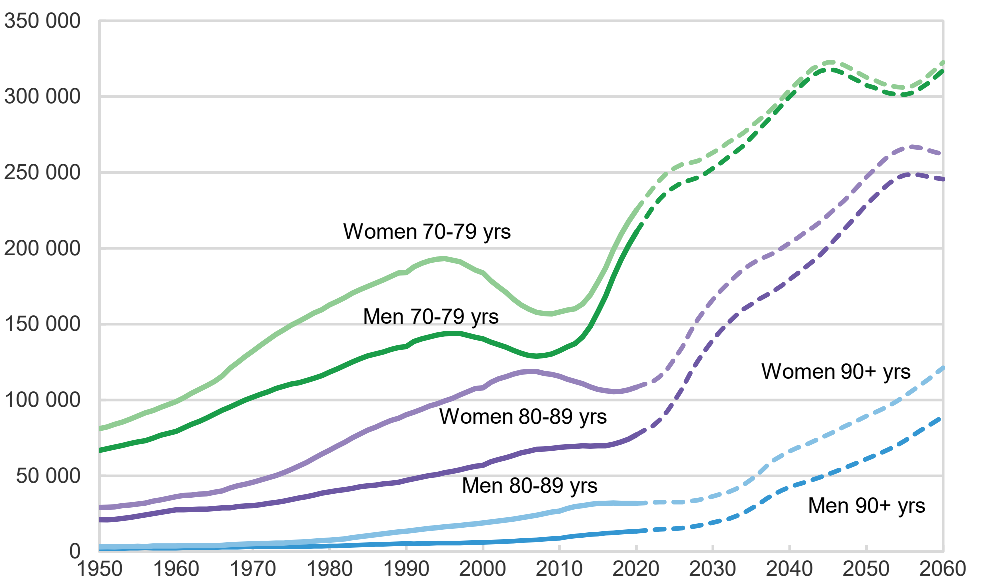
Figure 1.16 Number of men and women in broad age groups for selected time periods, registered 2020 and projected 2025-2060, main alternative (MMM)



Source: Statistics Norway

As shown in the population pyramids, but even more clearly in Figure 1.16, the main alternative assumes the surplus of men to increase to 63 000 in 2040 and 73 000 by 2060, with more men than women in all age groups up to near age 70. Figure 1.17 shows that the oldest age groups in Norway are currently made up of a majority of women. Today, men account for less than 40 percent of the over 80s and around 30 percent of the over 90s. According to the main alternative, this gender disparity is expected to continue to increase for the oldest old. In the age group 70-79 years, however, there will be about the same number of men as women. For those aged 80 or above, the share of men increases to 45 percent in 2040 and 48 percent in 2060. After age 90, the share of men increases at a faster rate (to 39 and 42 percent in 2040 and 2060, respectively), although the total number of older women remains considerably larger.

Figure 1.17 Men and women in the oldest age groups, registered 1950-2020 and projected 2021-2060, main alternative (MMM)



Source: Statistics Norway

There are two reasons for this development: i) there are more men than women in the Norwegian population in general, and ii) life expectancy is expected to increase more rapidly among men than women. This may mean fewer elderly women living alone in the future (Rogne and Syse 2017). Additionally, elderly couples can be assumed to have less need for public nursing and care services compared to those living alone.

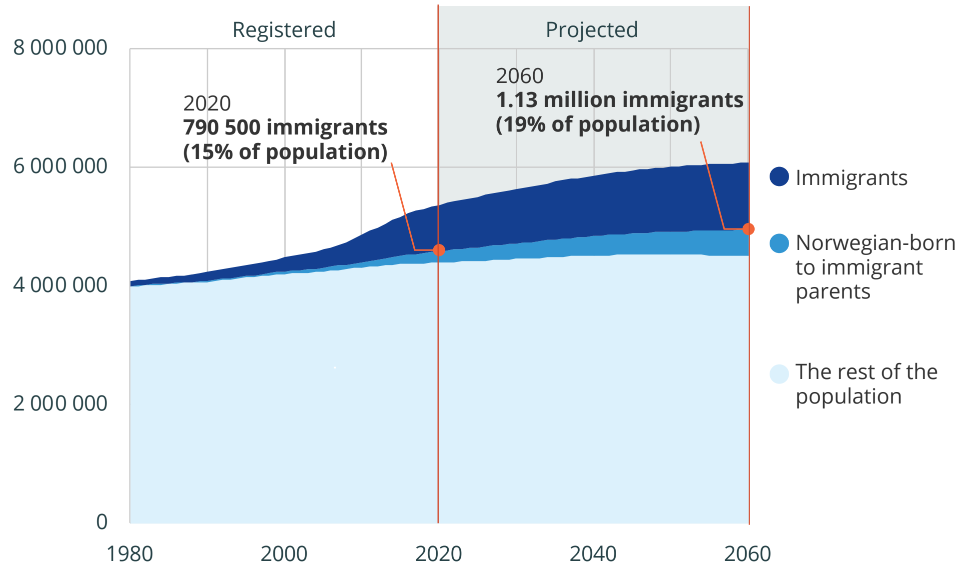
Prior to 2011, and as far back as 1846 when records on the population by sex began, a surplus of women has been the norm. Even though more boys were born than girls, mortality was much higher among the male population. The majority of emigrants in the 1800s and early 1900s was also male. The historical norm of more men than women however changed in 2011, and since then there have been more men than women in the population. A large part of this change was due to male-dominated immigration, which was particularly strong after the expansion of the EU in 2004, while recent decades have also witnessed a catching up in male life expectancy with the trend increasing more rapidly than for women.

We expect the sex gap in life expectancy to continue to narrow in the future. This is discussed in more detail in the chapter on life expectancy and mortality (Chapter 6). In addition, net migration is also expected to remain positive, albeit at a lower rate than in the previous decade. This is discussed in the chapter on immigration and emigration (Chapter 7). Taken together, both these factors result in the future population of Norway comprising a larger proportion of men than is the case today.

1.4. The number of immigrants continues to increase

In the main alternative of the population projections (MMM), we have assumed higher immigration than emigration throughout the projection period. This contributes to a continued increase in the number of immigrants in Norway. Figure 1.18 shows the population by immigrant background in the main alternative. Until 2060, the number of immigrants will increase from around 790 000 to near 1.13 million. This corresponds to a more than 40 percent increase. The number of Norwegian-born to two immigrant parents will increase from around 190 000 today to around 440 000 in 2060, which is a more than doubling.

Figure 1.18 The population in three groups by immigrant background, registered 1980-2020 and projected 2021-2060, main alternative (MMM)

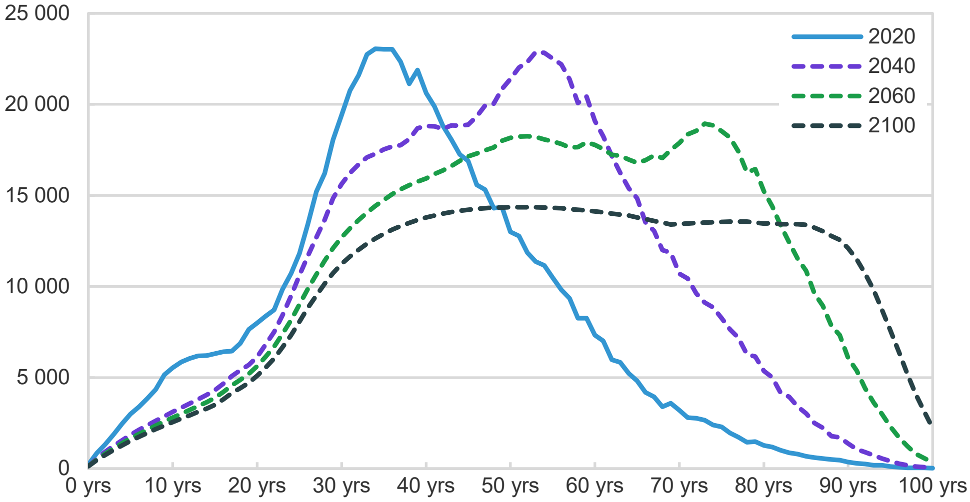


Source: Statistics Norway

More immigrants in older age groups

The number of immigrants does not increase in all age groups. In the main alternative (MMM), the number of immigrants in younger age groups is projected to decline in the coming years. Population growth among immigrants in Norway is confined to age groups above 40 years in 2040, and above 45 years in 2060, as shown in Figure 1.19. The projected increase in the number of immigrants in the oldest age groups (i.e. age 70 or older) is particularly striking, with the trend expected to continue throughout this century.

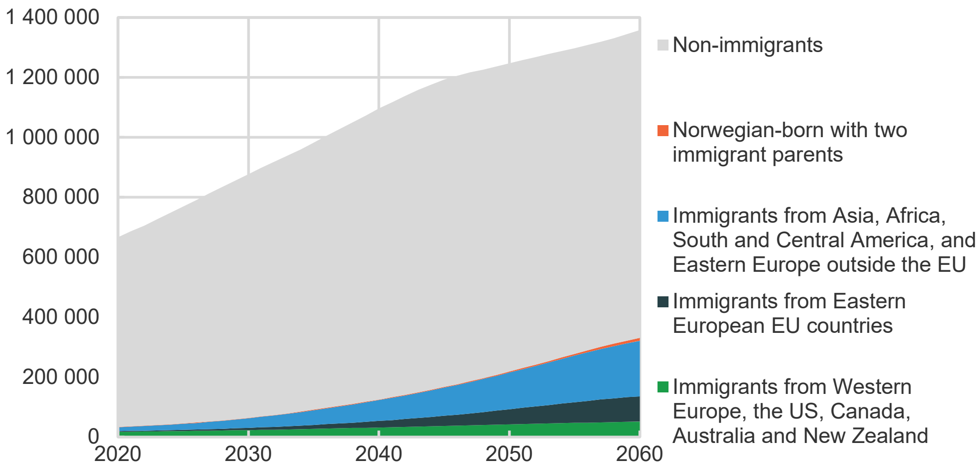
Figure 1.19 Immigrants in Norway by age, registered 2020 and projected in 2040, 2060 and 2100, main alternative (MMM)



Source: Statistics Norway

Today, there are very few immigrants among the elderly in Norway. Less than 5 percent of all persons aged 70 and over are immigrants. In the future, this share will increase. By 2060, immigrants will account for 24 percent of the total population aged 70 and over, i.e. one in four elderly, according to the main alternative. Figure 1.20 illustrates this point and shows that most of the older immigrants in 2060 will have a background from Asia, Africa, South and Central America or Eastern Europe outside the EU. By 2060, therefore, we can expect immigrants not only to be working in the health and care sector, but also to be users of these services. Norwegian-born to two immigrant parents will comprise a minor share of the elderly in 2060, representing just 0.7 percent of the population aged 70 and over.

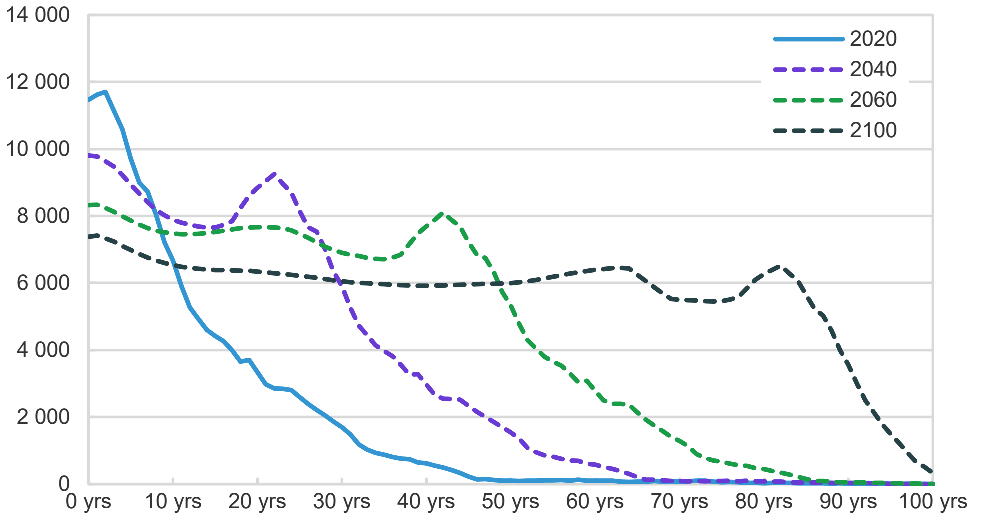
Figure 1.20 The population aged 70 and over by immigrant background, registered 2020 and projected 2021-2060, main alternative (MMM)



Source: Statistics Norway

One should note that many of these older immigrants will have lived in Norway for many years, and they themselves will have children. As such, descendants of immigrants will also age in Norway. Figure 1.21 shows how this ageing will occur more gradually, as they are younger to begin with, and even by 2060 they will comprise only a small share of the elderly in our main alternative. However, towards the end of the century, there will be appreciable ageing among this group. Chapter 7, on immigration and emigration, provides more information on the numbers of immigrants and descendants projected to live in Norway in the future, for example, by duration of stay and country group.

Figure 1.21 Norwegian-born children of immigrants in Norway by age, registered 2020 and projected in 2040, 2060 and 2100, main alternative (MMM)



Source: Statistics Norway

1.5. New this year

The national and regional projections are produced and published as two separate projects in 2020. The regional projections, to be published in August, will be based, at least in part, on assumptions and results from the national projections.

Fertility

Currently, Statistics Norway does not use a formal statistical model for fertility, but instead examines observed trends in the TFR over recent years, changes in age at first and higher order births, changes in parities and shifts in cohort fertility, as well as differences between immigrant and non-immigrant women in their fertility outcomes. We examine these trends for Norway and other European countries, especially the Nordic countries.

This year we have begun explorative analyses into the potential use a formal model in future projection rounds. We have reviewed documents and surveyed how other European countries opt to produce fertility assumptions (Gleditsch and Syse 2020). The results are discussed in more detail in the chapter on fertility (Chapter 5).

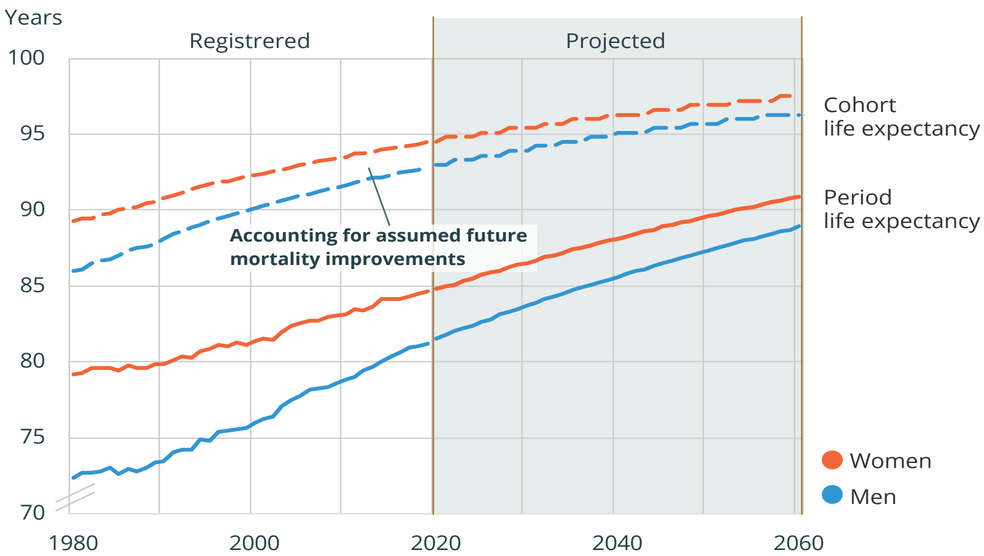
Life expectancy

For life expectancy and mortality, we previously only produced period life expectancies. This year, we also produce cohort life expectancies, and the estimates have been included in an additional StatBank table (https://www.ssb.no/en/statbank/table/12889/).

To have a definitive measure of life expectancy we must wait until everyone in a cohort has died. Consequently, it is common to construct a hypothetical cohort from which trajectories in life expectancy at birth, and remaining life expectancy, can be estimated. The most common means of estimating life expectancy is through the period approach. Period life expectancy estimates represent the average number of years a person can be expected to live according to the mortality experience of the entire population in a single-year. Period life expectancies are often criticised however, due to an assumption that mortality rates remain fixed throughout the remainder of a person's life. If, as expected, mortality improves over time, period life expectancies will underestimate expected lifespans. Cohort life expectancy, on the other hand, provides estimates representing the average number of additional years a person can be expected to live according to the assumed future changes in mortality for their cohort over the remainder of the life course. These estimates are calculated using registered and projected age-specific death rates for the same cohort. The benefit of this approach is that we better are able to take into account assumed mortality improvements over time, and from this perspective cohort life expectancies can be considered a more realistic measure of how long a person of a given age in a given year will be expected to live, on average. However, it should be noted that the assumptions on future mortality improvements become less reliable the further forward we move from the projection baseline.

A comparison between the period and cohort estimates of life expectancy at birth, based on registered and projected mortality rates for men and women separately, is shown in Figure 1.22 and a more thorough discussion of the implications are included in the chapter on life expectancy and mortality (Chapter 6). It is immediately apparent that life expectancy calculated from a cohort perspective is considerably higher than life expectancy calculated from the period perspective. Indeed, by taking into account assumed improvements in mortality, cohort life expectancy at birth in 2040 is estimated to be more than 9 years higher for men, and 8 years higher for women, than the equivalent period estimates. By 2060, cohort-based life expectancy at birth is estimated to be approximately 96 years for men and 98 years for women. Policy makers should be aware of this when they use our projected figures to plan for the future – be it for pensions, health and care services, infrastructure planning or housing.

Figure 1.22 A comparison of cohort and period life expectancy at birth for men and women, main alternative (MMM)[1]



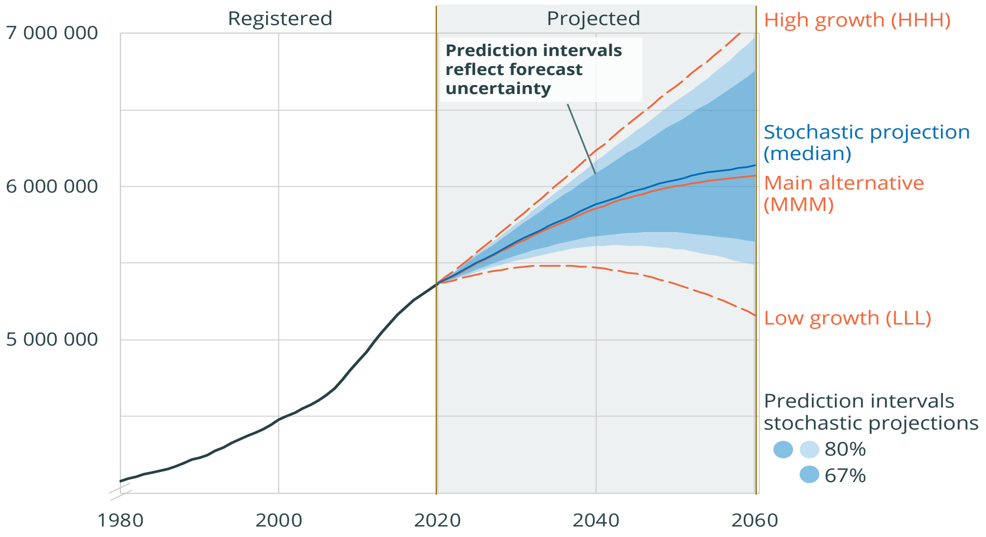
[1] Period life expectancies use the mortality experience of the entire population in a single year. Cohort life expectancies track birth cohorts through time to include assumed future mortality improvements.
Source: Statistics Norway

Immigration
For the immigration model, we have taken advantage of the model development work performed by Tønnessen and Skjerpen (2019). This work shows that future immigration to Norway not only depends on the population size of the country groups, but also on their age distributions, since migration is much more common in younger age groups (i.e. 15-39 years of age) than in older age groups. Consequently, the immigration model now accounts for the future age distributions of sending countries and provides a more accurate picture of the true population at risk of migrating to Norway. This is discussed in more detail in the chapter on immigration and emigration (Chapter 7). In short, the revised method has reduced the expected number of future immigrations to Norway, and as a result the population growth from net migration is generally lower than what has been the case in previous projections where this has not been accounted for.

Stochastic projections
Finally, a stochastic projection has been produced based on the medium assumptions applied in the deterministic projections, i.e. the projections presented so far. Selected results are provided in a new StatBank table (https://www.ssb.no/en/statbank/table/12890/), and details of the methods and results are presented in Chapter 9. Figure 1.23 compares future total population size projections according to the main alternative with the median ('most likely') population size from the stochastic projection. In addition, the figure shows results from the high and low national growth scenarios (HHH and LLL, respectively) and 80 and 67 percent prediction intervals from the stochastic projection. There is a fifty percent chance that actual population size will be higher than the numbers given by the curve labelled as median – a population size lower than the median is equally likely. The 80 percent prediction interval is assumed to cover real population size with 80 percent probability, and likewise for the 67 percent prediction interval.

As is evident from Figure 1.23, the median from the stochastic projection is slightly higher (around 65 000) than the main alternative (MMM) estimate for 2060. The 80 percent prediction interval illustrates an uncertainty ranging from 5.5-7.0 million, while the 67 percent prediction interval ranges from 5.6-6.8 million. In contrast, the deterministic high and low national growth alternatives range from 5.2 million to 7.1 million in 2060. In providing estimates from a stochastic projection alongside the main deterministic projection, we hope to offer a more detailed understanding of the inherent uncertainty associated with projecting populations into the future. At the same time, the relative agreement in estimates between the two models is also useful in supporting the conclusions we draw from this year's projection.

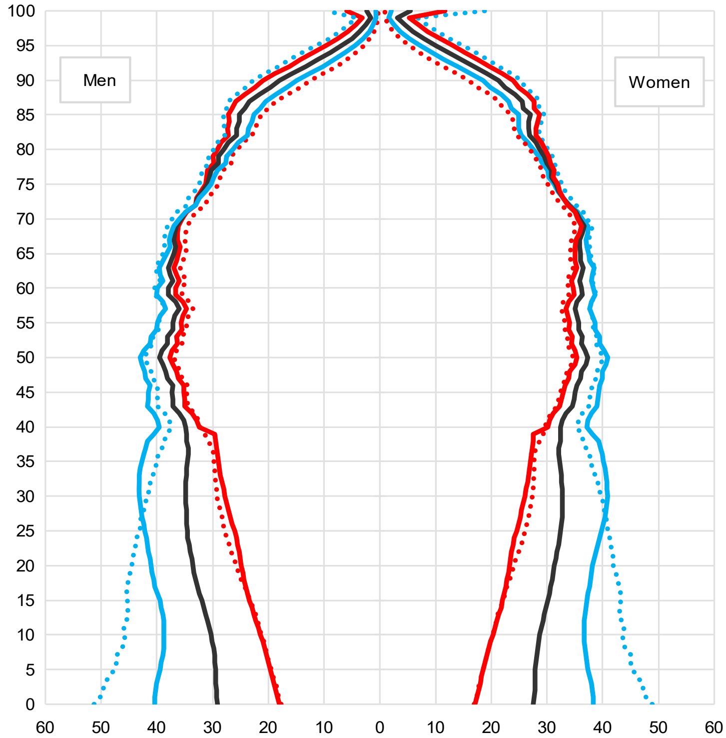
Figure 1.23 Comparing projected total population size based on the deterministic and stochastic projections, registered 1980-2020 and projected 2021-2060[1]



[1] Projected total population size according to the main alternative (MMM), the low (LLL) and high (HHH) national growth alternatives, as well as the median (50th percentile) and the 67 and 80 percent prediction intervals from the stochastic projection. The 80 percent prediction interval corresponds to the light and dark blue shaded areas combined.
Source: Statistics Norway

Given the assumed changes in the future age structure of the population, it is also useful to compare the two models in terms of their projected age distributions. Based on estimates for 2060, Figure 1.24 provides a means of comparing the main alternative (MMM), and strong (LHL) and weak (HLH) ageing alternatives of the deterministic model, with the 80 percent prediction interval from the stochastic projections. The latter projections suggest that it is less than 80 percent likely that actual numbers of children and adolescents (up to 20 years of age) in 2060 will be between low and high numbers given by alternatives LHL and HLH. Young children in particular are very difficult to predict with large precision, i.e. with narrow prediction intervals. Though it should be noted that the upper bounds of the stochastic projection would require a very high future fertility rate, since the TFR in 2060 for the weak ageing alternative is 1.94. For the elderly too, the margins defined by LHL and HLH are narrow, compared to the 80 percent prediction intervals, but here differences are much smaller than that for young children. Note that the curves for alternatives LHL and HLH cross each other around age 72. Uncertainty is discussed in more detail in Section 1.7

Figure 1.24 The projected age distribution by sex (in 1 000s) in 2060 based on deterministic (solid lines) and stochastic projections (dotted lines)[1]



[1] Solid lines refer to the deterministic projection: Main alternative (MMM) (black), the weak ageing alternative (HLH) (blue) and strong ageing alternative (LHL) (red). Dotted lines refer to the bounds of the 80 percent prediction intervals (lower bounds in red, upper bounds in blue) from the stochastic projection.
Source: Statistics Norway

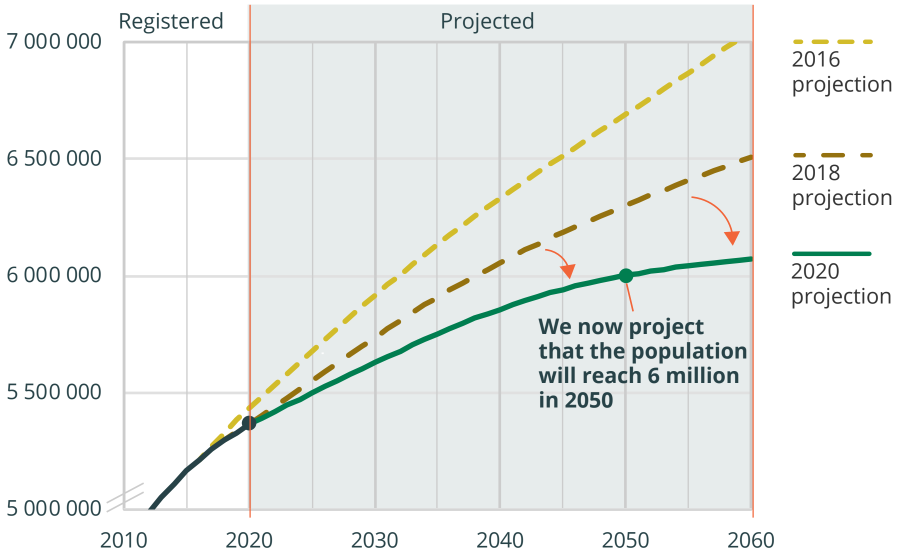
1.6. Changes from previous projections

The projected population growth in Norway is not only lower than in the last ten-year period, it is also lower than what was reported in the two previous population projections, published in June 2016 and 2018 respectively. This is because the assumptions of both the projected immigration and the projected fertility are lower, at least in the short and medium term. Figure 1.25 illustrates how the total population in the main alternative of the 2020 projection differs from that of the main alternatives from the two previous projections. The figure shows that in the 2016 projection, the population was expected to reach 6 million around 2030, and the total population in 2060 was projected to be 7 million. In the 2018 projection, the population was expected to reach 6 million shortly before 2040, and the total population in 2060 was projected to be 6.5 million.

In this year's projection, we project that we will reach 6 million inhabitants by 2050 in the main alternative, and the total population is projected to be around 6.1 million in 2060. This corresponds to a 7 percent reduction in the projected total population, and a larger decrease in the younger half than in the older half of the population. Such a reduction among persons in prime working ages would normally result in a lower total GDP, but not necessarily in GDP per capita. It would also have implications for the per capita income of the oil fund, where we could expect an increase in the per capita income. However, the expenses for pensions and health and care services are unlikely to change much or might even be slightly higher since the life expectancy is assumed to increase more than previously projected.

In the 2020 low national growth alternative, the population begins to decline around 2035, never reaching the 6 million mark. In 2060, the low growth alternative population is projected to be 5.2 million. In the 2020 high national growth alternative, we project pronounced growth wherein the population reaches 6 million in the early 2030s, and 7.1 million in 2060.

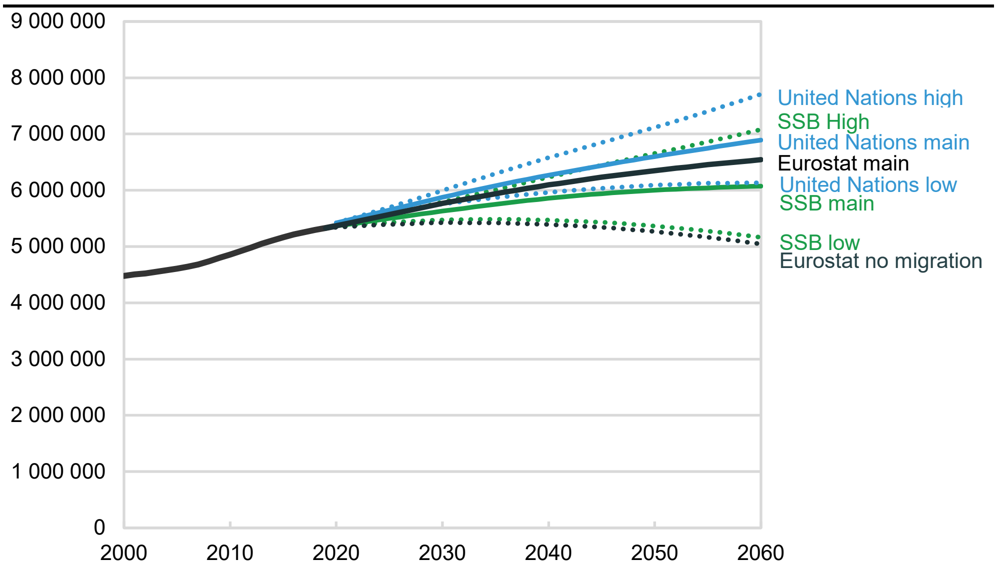
Figure 1.25 Projected population from the 2016, 2018 and 2020 population projections, main alternatives



Source: Statistics Norway

If we compare our 2020 projections to the Norwegian population projections made by the United Nations and Eurostat, we find that the projected total population in our main alternative is lowest throughout the projection period, as shown in Figure 1.26. In 2060, the United Nations baseline scenario projects a population of 6.9 million, whereas the respective figure from Eurostat's baseline scenario is 6.5 million. The baseline projections from both the United Nations and Eurostat assume a much higher net migration compared to our main alternative (see Chapter 7 for details). The United Nations fertility assumptions are comparable to ours, whereas those from Eurostat are lower (see Chapter 5 for details). Statistics Norway projects lower mortality than both the United Nations and Eurostat (see Chapter 6 for details), but the impact is minor for overall population figures.

Figure 1.26 Population in Norway, registered 2000-2020 and projected 2021-2060 by the United Nations, Eurostat and Statistics Norway[1]



[1] The United Nations high and low alternatives correspond to the 'high-fertility variant' and 'low-fertility variant', respectively. The alternative we have labelled 'main' corresponds to the 'medium-variant'. For Eurostat, there is only one alternative ('no migration') in addition to the baseline alternative ('main').
Source: United Nations (2019), Eurostat (2020) and Statistics Norway

1.7. Uncertainty

All projections of the future population and its composition are inherently uncertain. As shown in Figures 1.1 and 1.23, the uncertainty increases the further into the future we look. Generally, uncertainty is greater when projections refer to small population sub-groups, such as specific immigrant population groups by sex, age and duration of stay, and to people who are not yet part of the population. Future immigration is subject to the most pronounced degree of uncertainty, but trends in fertility, mortality and emigration can also end up rather different than expected. The assumptions used in projections determine the outcomes of the different alternatives, as evidenced by the variations between the different alternatives and the disparities between projections by other institutions. This is discussed in more detail in Chapter 8, and a formal assessment of the uncertainty in a stochastic perspective as briefly mentioned in Section 1.5. Chapter 9 provides a detailed discussion of the stochastic projections.

Accuracy of 2018 national projection

We now have two years of observed data from which we can compare the estimates of the previous population projection, released in June 2018 (Table 1.3). In the main alternative, the population growth was overestimated by around 3 500 for the first year and underestimated to almost the same extent the second year. As such, the deviation for the total population on 1 January 2020, was extremely small, at only 71 persons. However, it is important to note that the net migration in the observed data is artificially elevated for 2019 due to reduced administrative out-registrations of emigration in the National Population Register, administered by the Norwegian Tax Administration, during the latter half of 2019 (see Box 7.3). There were, as a consequence, around 5 000 fewer administrative out-migrations compared to previous years. If this had not been the case, we would have overestimated the population growth from 2018 to 2020. The number of births was also lower than projected, both in 2018 and 2019. We had projected a total fertility rate (TFR) of 1.59 for these years, whereas the TFR fell to 1.56 in 2018 and 1.53 in 2019. This resulted in an overestimation in the number of births by around 1 100 in 2018 and 2 200 in 2019. The number of projected deaths was fairly accurate in 2018, with a deviation of around 200 deaths in total. In 2019 the estimate was almost exact, with a deviation of only 3 deaths in total. Together, this meant that the population in Norway witnessed a slightly higher ageing than was stipulated in our main alternative in 2018.

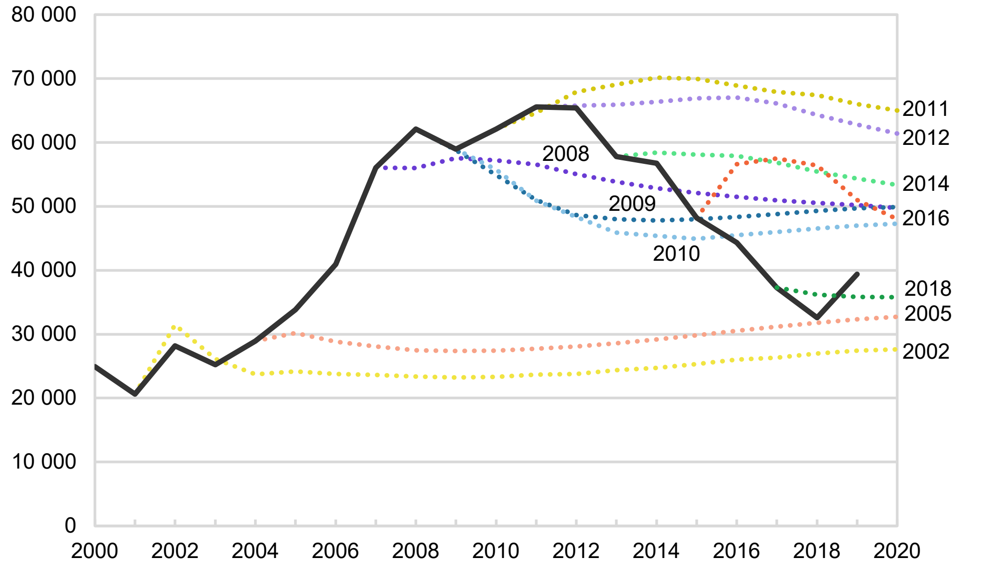
Table 1.3 2018 projections, comparing projected and registered figures for the first two years[1]

	2018			2019		
	Projected	Registered	Deviation	Projected	Registered	Deviation
Births	56 200	55 120	1 055	56 600	54 495	2 162
Deaths	40 600	40 840	-210	40 700	40 684	-3
Immigrations	53 500	50 961	2 544	52 200	50 868	1 786
Emigrations	32 900	32 867	-9	32 300	25 547	6 749
Population growth	36 200	32 593	3 601	35 800	39 368	-3 530
Population at year-end	5 331 800	5 328 212	3 601	5 367 650	5 367 580	71

[1] Immigrations and emigrations exclude persons who immigrate and emigrate during the same calendar year. The figures are thus not directly comparable to the official statistics. The actual figures for birth, death, immigration and emigration do not sum exactly to the population growth figures. Population growth is defined as the change in population size from 1 January one year to the same date the following year. Rounded figures are shown for projected numbers, to underscore the uncertainty. However, all deviations are calculated using exact projected and registered figures.
Source: Statistics Norway

Figure 1.27 shows the population growth in Norway, registered and predicted in main alternatives since 2000. While the population growth projected at the beginning of the 2000s was too low, the actual growth in 2017 was lower than in any of the projections since the 2008 projection. However, the growth in 2019 was higher than what we projected in 2018, primarily due to the artificially low number of administrative out-registrations noted above.

Figure 1.27 Population growth in absolute numbers, registered (solid line) and projected 2000-2020, main alternatives[1]



[1] The years denoted in the figure refer to the release of the respective projections.
Source: Statistics Norway

2. About the population projections

2.1. An overview of the report

Chapter 1 presented the main results from this year’s population projection. In this chapter we provide an introduction to population projections in general, as well as those produced at Statistics Norway more specifically. Chapter 3 describes the BEFINN model used to project the Norwegian population. Chapter 4 provides a summary of the assumptions used to produce the projections. Next, we explain how we arrive at the assumptions concerning fertility, mortality, and immigration and emigration, as well as more details of results relating to these components (Chapters 5–7). Finally, we will discuss the inherent uncertainty associated with population projections, and specifically in the context of Statistics Norway’s projections (Chapter 8). For the 2020 projections, a stochastic population projection was produced as an additional product, providing formalised estimates of uncertainty (Chapter 9). Lastly, we offer some brief conclusions (Chapter 10).

2.2. What are population projections?

Every two years, Statistics Norway projects the Norwegian population at the national and regional levels. For the 2020 projections, the national and regional projections are published separately. This report documents the model, assumptions and results pertaining to the national projections.

To project the population at the national level, we use the BEFINN model. This model projects the population by age and sex at the national level up to and including the year 2100. Immigrants from three country groups, Norwegian-born children with two immigrant parents and the rest of the population are projected as separate groups. Immigrants are also projected by duration of stay based on when they first immigrated to Norway.

Box 2.1. Population projection or population forecast?

A population projection is a calculation of the size and composition of a future population, usually by sex and age, but sometimes also by place of residence or other characteristics such as immigration category and country background. Projections are made by applying assumed probabilities or rates for future fertility, mortality, immigration and emigration to the population by age and sex, along with other relevant characteristics used in the specific projection. The extent to which an assumption can be deemed realistic can vary. The term ‘projection’ is used for any estimate of the future population, including less likely ones.

A population forecast, or prognosis, is a calculation of a future population based on the assumptions that are considered most likely. Statistics Norway publishes several projections, but the MMM alternative, which assumes the medium level for each component, is our main alternative. The main alternative is the one we assume to be most plausible. Other terms include ‘plan’, which denotes a desired development, and ‘scenario’, which is used to refer to a description of a possible future development or an action plan based on specific assumptions (de Beer 2011).

2.3. The process

To project the population, we must make assumptions about future fertility, mortality, immigration, and emigration. In addition, we need figures for the baseline population taken from Statistics Norway's population statistics. The projection work is thus organized around four areas:

- Fertility
- Mortality
- Immigration and emigration
- Aggregation

Old time series need to be updated with new data in each of these areas, assumptions need to be calculated in the form of age and sex-specific rates/probabilities, and input data for the models must be quality assured. The aggregation work also includes updating the baseline population and running the BEFINN model to generate the actual projections. For a more technical description of the models and files, as well as the different steps required in the projection work, see Thomas et al. (2020).

2.4. Data

The population projections use aggregated individual-level data on population size, births, deaths and international migration from Statistics Norway’s population statistics (BESTAT), which is retrieved from the Norwegian Tax Administration for the National Population Register. No Norwegian population data are collected specifically for the purpose of developing the population projections.

However, additional data on, for instance, the development in fertility, life expectancy and migration, causes of death, economic development in various parts of the world, as well as international demographic projections are collected and used to help shape the assumptions. This is described in more detail in Chapters 5–7.

The population statistics, on which the projections are based, only include persons who are registered as residents in the National Population Register. This includes persons who reside permanently in Norway, as well as persons who plan to reside in Norway for six months or longer and hold a valid residence permit. Since 1956, Nordic citizens have gained residency automatically. The same now applies to all citizens from the EEA and/or EFTA countries.

However, many individuals work in Norway without being included in the statistics, particularly those on short-term contracts. There are also those who reside in Norway without a permit. Beyond this, the population statistics include persons who have moved abroad but have not registered this move. For more details on criteria for residency and emigration, please refer to the English publication by Zhang (2008) and the English abstract in the report on this topic by Pettersen (2013). Consequently, it is the *de jure* population and not the *de facto* population that is projected.

2.5. Publications and output

Statistics Norway's population projections are published every two years. The main results are presented in a press release at https://www.ssb.no/en/folkfram. In Statistics Norway's StatBank (https://www.ssb.no/en/statbank/list/folkfram), large amounts of data are published about projected population figures and changes in the population based on various demographic characteristics (see Table 2.1). Assumptions about fertility, mortality, immigration and emigration, as well as the results of the projections, are also presented in reports and articles in Norwegian and English.

Table 2.1 Tables from the population projections available online at Statistics Norway's StatBank[1]

Table title	Content	Model
Population projections 1 January, by sex, age, immigration category and country background, in 15 alternatives	Total population	BEFINN
Projected number of immigrants 1 January, by country background and duration of stay, in 5 alternatives	Total population	BEFINN
Projected population changes, by immigration category and country background, in 9 alternatives	Births, deaths, immigration, emigration and net migration	BEFINN
Projected fertility rate, by country background, in 3 alternatives	Total fertility rate	BEFINN
Projected period life expectancy, for men, women and both sexes combined, in 3 alternatives	Life expectancy and remaining life expectancy	Lee-Carter/ARIMA
Projected cohort life expectancy for men and women, in the medium alternative	Life expectancy and remaining life expectancy	Lee-Carter/ARIMA
Projected probability of death (per 1 000), by sex and age, in 3 alternatives	Probability of death	Lee-Carter/ARIMA[2]
Stochastic population projections 1 January, by sex and age, in 5 percentiles	Total population	PEP[3]

[1] The population counts are per 1 January, whereas the component information pertains to the entire year in question. The population on 1 January one year is identical to the population on 31 December in the previous year, except that all individuals' ages will be increased by a year.
[2] ARIMA is short for 'Auto-Regressive Integrated Moving Average'.
[3] PEP is short for 'Program for Error Propagation'.
Source: Statistics Norway

2.6. Users

The main users of Statistics Norway's national population projections are public and private planners, central government, as well as journalists, researchers, politicians and the general public. Every year, there are more than 40 000 downloads of the national population projections from the StatBank on Statistics Norway's official website.

The projections are also used internally at Statistics Norway, for example as input in macroeconomic models such as KVARTS, MODAG, DEMEC and SNOW and in the microsimulation model MOSART. Beyond this, the national projections are used as input in BEFREG, the regional population projection model, and also in the projection models LÆRERMOD and HELSEMOD, which project the future need of teachers of various types as well as health personnel.

Statistics Norway regularly reports their assumptions and projection results to international agencies, including Eurostat, the United Nations, the Nordic Council of Ministers and Nordstat, among others, while helping quality assure nowcasts and projection results from Eurostat.

2.7. Regulations

There is no specific statutory law for the national projections, but the work to produce and publish the projections is founded on the Act on Official Statistics and Statistics Norway (Ministry of Finance 2019). This is a revision of the Norwegian Statistics Act of 1989. The revised Statistics Act mandates that a national statistics program should be implemented. Whether the population projections are to be included in the program is currently being discussed, but has not been determined as of today.

There is no EU regulation in this area, but there is a collaboration between Norway and Eurostat. Eurostat regularly makes population projections for EU and EFTA member countries, including Norway (Eurostat 2020). Eurostat follows the code of practice for European statistics (Eurostat 2017), and has further drawn up guidelines for reporting and communication that the Norwegian national projections adhere to (Eurostat 2018). The United Nations has also drawn up guidelines for communication of population projections (United Nations 2018), and these guidelines are considered when Norwegian population projections are published.

In summary, the population projections are produced and published in accordance with international standards (United Nations 2014, OECD 2015, Eurostat 2017, Sæbø 2019). The Norwegian figures are, however, more detailed (age, year, immigration category, country group and duration of stay) than what is commonly published by most other countries (United Nations 2014, Eurostat 2017).

2.8. History

Previous population projections

Statistics Norway has produced national population projections regularly since the 1950s, with several models having been developed. The BEFREG model was developed during the 1970s and 1980s and is documented in Norwegian by Rideng et al. (1985). The BEFREG model is currently in use, albeit only for projections at the regional level, and has undergone several adjustments over the years (see Thomas et al. 2020). The BEFREG model also provides national level estimates but does not provide separate estimates of the immigrant population. Thus, the original BEFINN model was designed to model the population of immigrants and their Norwegian-born children by country group. This model was employed in the years 2005, 2008, 2009 and 2010. Unlike the current BEFINN model, this previous version did not include the general population. Consequently, the results from BEFINN and BEFREG were not comparable for these years.

Starting in 2011, the entire population by immigration category, country group and duration of stay in Norway has been projected using the BEFINN model. This model remains in use today (see Chapter 3 for details).

During the period 2008–2012, population projections were published annually, but have been published every two years since then.

Projections with specific aims

Some specific projections have been published over the years:

- Regional distribution of immigrants and their Norwegian-born children (REGINN). Used only once (2012)
- Projections by marital status. Used only once (1986)
- Household projections. Used only once (1995)

Documentation of previous projections

The projections were initially published in the Statistical Yearbook of Norway series and portrayed the size of the projected population at the national level. Since 1969, various regional and national projections have been produced and published, see www.ssb.no/en/befolkning/statistikker/folkfram/arkiv?fane=arkiv#content. In the period 1969–2002, thirteen sets of regional and national projections were published in the Official Statistics series.

Since 1996, the projection results have been published in the StatBank, where they can be accessed and downloaded by all users from the Statistics Norway website (https://www.ssb.no/en/statbank/list/folkfram). They have also been documented in various press releases and in Norwegian articles in Statistics Norway's internal journal *Economic Surveys*. In 2016, an online article describing the main results was published in English for the first time.[3] A documentation report in English was first published in 2014 (Aase et al. 2014).

Most of the historical documentation of the population projections is only available in Norwegian, and interested readers are referred to, for instance, Rideng et al. (1985), Hetland (1998), and Texmon and Brunborg (2013). For a description of previous assumptions and results see, for example, Syse et al. (2018a), Tønnessen et al. (2016), Tønnessen et al. (2014), Brunborg et al. (2012), Brunborg and Texmon (2011) and Brunborg and Texmon (2010).

Comparability over time

Broadly speaking, the national population projections may be compared over time from 1996 onwards, although changes to the models and the data have occurred.

As an example, the country groups are not entirely comparable over time, since the definition and the number of groups have varied (from two to five). Over the past decade, three country groups have been used. However, the countries comprising the groups have varied somewhat. Croatia was, for instance, moved from Country Group 3 to Country Group 2 when the country joined the EU in 2013. For an overview of the current grouping of countries, see Appendix A.

2.9. Comparability with the official population statistics

In comparing results from the population projections with the general population statistics at Statistics Norway, two main differences stand out:

- The projection models project the population from 1 January one year to 1 January the following year. This means that individuals who move several times during the year are only recorded with one move. If people move to and from Norway twice, they are not recorded in the modelled estimates of migration. Consequently, somewhat fewer migrations are tallied in the population projections as compared to the numbers that are published in the general population statistics.
- The age definitions differ in the projections and the general population statistics. The projections are made for 120 age groups: 0, 1, 2, ..., 119 years. For age-specific rates for fertility, mortality and migration we define age in completed years at the end of the year. In the general population statistics, on the other hand, it is usually age at the time of the event that is used. This means that the age-specific rates and the probabilities that are used in the projections apply to a population that, on average, is half a year younger than those published in the population statistics. The same applies to life expectancy at birth and remaining life expectancy.

[3] www.ssb.no/en/befolkning/artikler-og-publikasjoner/population-projections-2016-2100-main-results

3. The BEFINN projection model

The cohort-component method is used for the projection of the national population in the BEFINN model. It calculates the next year's population by starting with the population in the current year and adding births, deducting deaths and emigrations, and adding immigrations. This is done for both sexes by one-year age groups. When the following year's population has been calculated, it is used as the basis for calculating the population the year after.

The population is projected in several different alternatives. Each alternative is described using three letters in the following order: fertility, life expectancy and immigration. The alternative MMM indicates that the medium level is used for all the three components, and it denotes our main alternative. The components can also have the levels L = low, H = high, C = constant, E = Equal in- and out-migration or 0 = no migration. In the previous projection rounds, four letters were used as these projections included internal migration, which was defined by the third letter of the four.

3.1. The cohort-component method

The cohort-component method is a common method for projecting populations and is used by most agencies that project populations at a national or international level (Gleditsch and Syse 2020).

Data and methods

We use two types of input when projecting the population using the cohort-component method:

I. Updated figures for the population by sex and one-year age groups for the baseline year
II. Assumptions about the future development of the demographic components:
    - fertility
    - life expectancy
    - immigration
    - emigration

The population projections utilize aggregated individual-level data on population size, births, deaths and migration from Statistics Norway's population statistics (BESTAT), collected from the Norwegian Tax Administration for the National Population Register. We employ data categorized by age, sex, immigrant background and country group for 1 January each year, in addition to the aforementioned figures on births, deaths, immigration and emigration by age and sex. No samples are used. The projections utilize the whole population in estimations.

Table 3.1 shows an example of how we do this. When we have an overview of the number of men and women in each age group in the baseline year, and assumptions about the demographic components for each of these groups, we can work out how many persons there will be in each age group the year after. If, for example, we start with 14-year-old females in a given year and deduct those who are assumed to emigrate or die during the course of a year, and then add the number of 14-year-old females who are assumed to immigrate, we arrive at the number of 15-year-old females the year after. This figure is then used as the basis for calculating the number of 16-year-old females the year after that, and so on. These women are indicated in blue in the table. A cohort can thus be followed through the projection period.[4]

Table 3.1 An illustration of the cohort-component method

	Number of women			
	Registered year	Projected years		
	t	t+1	t+2	t+3
Age 0	26 619	26 649	26 536	26 288
Age 1	27 165	26 870	26 907	26 804
Age 2	28 058	27 314	27 020	27 058
Age 3	29 261	28 154	27 406	27 120
Age 4	29 547	29 322	28 202	27 449
Age 5	29 721	29 601	29 356	28 224
Age 6	30 118	29 780	29 641	29 383
Age 7	30 789	30 161	29 810	29 659
Age 8	31 047	30 843	30 206	29 850
Age 9	32 041	31 099	30 894	30 256
Age 10	32 507	32 099	31 156	30 958
Age 11	32 008	32 563	32 156	31 219
Age 12	31 319	32 067	32 625	32 223
Age 13	31 494	31 377	32 126	32 690
Age 14	30 853	31 551	31 439	32 191
Age 15	30 887	30 908	31 614	31 512
Age 16	30 722	30 972	31 010	31 734
Age 17	30 367	30 789	31 055	31 107
Age 18	30 861	30 442	30 879	31 159
Age 19	32 067	30 959	30 573	31 038
Age 20	32 019	32 208	31 149	30 803
Age 21	32 005	32 193	32 432	31 418
Age 22	32 688	32 207	32 465	32 754
Age 23	33 822	32 952	32 543	32 883
Age 24	33 822	34 116	33 357	33 035
Age 25	34 470	34 163	34 553	33 933
Age 26	35 143	34 789	34 583	35 092
Age 27	36 110	35 417	35 152	35 075
Age 28	37 214	36 333	35 726	35 579
Age 29	38 288	37 399	36 571	36 081
Age 30	37 899	38 420	37 577	36 829

Source: Statistics Norway

This method cannot be used directly for those below age 1. Indeed, to project the number of 0-year-olds, we start with the number of women in each age group between 15-49 years and combine this with the assumptions about fertility for each age group. We then arrive at a figure for new-born boys and girls. To calculate the number of new-born boys, this figure is multiplied by 0.51369, the natural sex ratio at birth which indicates a slight bias towards boys. An example of the children this pertains to is indicated in green in the table.

The assumptions

Most of the assumptions that are used in the cohort-component method are stated as rates, probabilities or proportions by sex and one-year age groups. This applies to the assumptions about future fertility, mortality, and emigration. For immigration, the total assumed number of immigrations is distributed by age and sex based on the age and sex distribution observed in previous years of immigrations.

Future fertility is projected based on observed trends in fertility, differing by immigration background. The fertility of women with a Norwegian background is projected separately, whereas the fertility of immigrant women is projected in 15 alternatives by combinations of country group and duration of stay in Norway (see Chapter 5). Probabilities of death and life expectancy are projected through a combination of Lee-Carter and ARIMA models (see Chapter 6). An econometric

[4] A cohort is a group of people who have experienced something during the same period, such as being born, getting married or being a student. The term is most frequently used with reference to birth cohorts, i.e. men and/or women born in the same year.

model has been used from 2008 onwards to project future immigration (see Chapter 7). In this model, immigration is projected based on factors like income levels, unemployment, population size of sending countries in broad age groups, and prior immigration to Norway from the country groups, see Cappelen et al. (2015) and Tønnessen and Skjerpen (2019).

Multiple events during the course of one year

In principle, our version of the cohort-component method only calculates changes from the turn of one year to the turn of the next. This implies that there is limited possibility for the same person to experience more than one demographic event during the course of a single year. A person cannot, for example, immigrate and then emigrate (or die or have a child) in one and the same year. One result of this is that projected figures for immigration and emigration do not include persons who have both immigrated and emigrated during the same year. This means that the immigration and emigration figures from the population projections are somewhat lower than the corresponding figures from Statistics Norway's population statistics. The figures will, however, be comparable for net migration.

An exception from the rule of only one demographic event during the year concerns new-borns: It is possible to be born and die in the same year, or to be born and emigrate in the same year. This is because of the order in which the components are entered in the model. First, all the births are entered, and the age of all the age groups is increased by one year. This newly projected population (including the births) is then used to calculate the number of deaths and the number of emigrations in each age group. Finally, both the number of deaths and the number of emigrations are deducted, and the number of immigrations added.

Age at the end of the year

In the population projections, age at the end of the year is used in the definition as well as the calculation of demographic events (births, deaths and migrations). In the general population statistics, on the other hand, it is usually age at the time of the event that is used. This means that the age-specific rates and the probabilities that are used in the projections apply to a population that, on average, is half a year younger than those published in the population statistics. The same applies to life expectancy at birth and remaining life expectancy.

3.2. The BEFINN model

The BEFINN model projects the population at the national level, and immigrants, Norwegian-born persons with two immigrant parents and the remaining population are projected as separate groups. Since immigrants and Norwegian-born children with two immigrant parents are separate groups, separate assumptions can also be used about the demographic components for these groups. For fertility, separate birth rates are assumed for immigrant women from three country groups and five duration of stay groups, while the same rates as for other women are assumed for Norwegian-born daughters of two immigrant parents. For mortality, the same age and sex-specific probabilities apply to all groups. For emigration, separate probabilities are used for immigrants, for Norwegian-born persons with two immigrant parents and for the remaining general population. These probabilities differ, in turn, depending on which of the three country groups the immigrants and their Norwegian-born children come from. For immigrants, the probability of emigration also varies with duration of stay.

To be able to calculate the number of Norwegian-born persons with two immigrant parents, assumptions must be formed about how large a proportion of the children who are born to immigrant women also have an immigrant father. These proportions vary between the three country groups. This is discussed in more detail in Chapters 4 and 7.

Results

BEFINN calculates the future population in Norway as of 1 January for each projection year, up to and including 2100, based on the following characteristics:

- One-year age group (0, 1, 2, …, 119 years)
- Sex
- Immigration category
  - Immigrant
  - Norwegian-born children with two immigrant parents
  - The remaining general population
- Country group, i.e. country group of birth for immigrants and mothers' country of birth for Norwegian-born children with two immigrant parents
- Duration since first immigration to Norway (only for immigrants)

The country groups currently in use are described in detail in Appendix A. In short, *Country Group 1* comprises all Western European countries, i.e. countries that were part of the 'old' EU (pre-2004) and/or the EEA and EFTA, as well as the US, Canada, Australia and New Zealand. On average, nationals from these countries display relatively similar demographic behaviour for fertility and emigration. Moreover, few or no restrictions apply for their living and working in Norway. *Country Group 2* comprises the eleven new EU countries in Eastern Europe (who became EU members in 2004 or later): Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bulgaria and Romania. We have merged them to form one group since it is from these countries that immigration to Norway has increased most in recent years. Moreover, of all the EU countries, it is for these eleven countries that the income differences are greatest relative to Norway, while restrictions on immigration from these countries have been largely abolished. The potential for migration to Norway is therefore relatively high. *Country Group 3* comprises the rest of the world, e.g. the rest of Eastern Europe, Africa, Asia (including Turkey), South and Central America and Oceania (excluding Australia and New Zealand). Nationals from these countries must apply for a permit to live and work in Norway. This group is extremely heterogeneous, and we have primarily merged these countries into one group for the sake of simplicity.

In short, the number of people at the beginning of a year (t+1) is derived from the status of the previous year (t) as well as changes in year t in terms of births, deaths, emigrations and immigrations. The components are primarily estimated based on age- and sex-specific rates and probabilities.

For each projection year, BEFINN also calculates the number of births, deaths, emigrations and immigrations based on the same characteristics as above.

3.3. Alternative projections

The results of a population projection depend on the assumptions which are used for the components. Different assumption alternatives are therefore produced for fertility, life expectancy and immigration:

- M – medium
- H – high
- L – low
- C – constant
- E – zero net migration (i.e. equal in- and out-migration)
- 0 – no migration (no in- or out-migration, i.e. closed borders)

Statistics Norway projects the population using a total of 15 combinations of these alternatives (Table 3.2). Each alternative is described using three letters in the following order: Fertility, life expectancy and immigration. The term 'main alternative' is used to designate the MMM alternative, which indicates that the medium level has been used for all components.

Table 3.2 Statistics Norway's projection alternatives[1]

Alternative	Description
MMM[1]	Medium national growth
LLL	Low national growth
HHH	High national growth
HMM	High fertility
LMM	Low fertility
MHM	High life expectancy
MLM	Low life expectancy
MCM	Constant life expectancy
MMH	High immigration
MML	Low immigration
MMC	Constant immigration
LHL	Strong ageing
HLH	Weak ageing
MME	Zero net migration
MM0	No migration (closed borders)

[1] The MMM alternative is Statistics Norway's main alternative, and the one we recommend using unless we explicitly state otherwise, or the users have a particular aim in mind for their analyses.
Source: Statistics Norway

In the MME alternative (zero net migration), immigration and emigration take place, but the difference between them is 0. In other words, there are as many emigrations as immigrations. In the MM0 alternative, on the other hand, there is no international migration at all, i.e. the borders are closed.

One reason why we project the population in so many alternatives is to illustrate the uncertainty associated with the projections. This is discussed in more detail in Chapters 8 and 9. For example, the alternatives with constant life expectancy or immigration, and the alternatives with no migration and/or zero net migration, are relatively unrealistic, but they can nonetheless represent interesting comparisons for analytical work. The same applies to the alternatives for high national growth (HHH) and low national growth (LLL). It is not very probable that we will see a combination of high fertility, high life expectancy and high immigration, or of low fertility, low life expectancy and low immigration throughout the projection period.

This year, we also provide a stochastic population projection of the Norwegian population by one-year age group and sex, with the methods and results presented in Chapter 9. The median is similar to the deterministic main alternative (MMM). Prediction intervals around this median (67 and 80 percent prediction intervals) are available in the StatBank, but intervals with other coverage probabilities or results for larger age groups are available on request.

4. Summary of assumptions

This chapter provides details of the specific assumptions used in the current national projection, as well as the data and underlying methods used to produce the assumptions. An excerpt of the key assumptions is shown in Table 4.1. In the following chapters (Chapters 5–7) we discuss both the assumptions and the results in greater detail and provide more substantial background information.

Table 4.1 A brief summary of the key assumptions[1]

	2019 Registered	M Medium assumption	H High assumption	L Low assumption
Total fertility rate, children per woman	**1.53**			
2025		1.53	1.71	1.33
2040		1.74	1.94	1.33
2060		1.74	1.94	1.33
2100		1.73	1.93	1.34
Life expectancy at birth, men	**81.2**			
2025		82.6	83.5	81.7
2040		85.6	87.3	83.7
2060		88.9	91.3	86.0
2100		93.4	96.6	89.7
Life expectancy at birth, women	**84.7**			
2025		85.7	86.4	84.9
2040		88.1	89.7	86.4
2060		90.9	93.2	88.4
2100		94.9	98.0	91.4
Yearly immigrations	**50 868**			
2025		43 500	51 200	36 900
2040		40 100	55 400	32 200
2060		37 200	64 600	25 900
2100		36 900	84 300	18 300
Yearly emigrations[2]	**25 547**			
2025		29 800	31 800	28 200
2040		29 000	34 100	26 200
2060		26 700	38 400	21 800
2100		24 800	49 900	15 200

[1] The figures for registered life expectancy are calculated slightly differently than those published in the official statistics. The figures on yearly immigrations and emigrations do not include persons who have moved to and from Norway (or vice versa) during the same calendar year. As such, these figures are not fully comparable with those presented in the population statistics.
[2] The M, H and L figures for projected emigrations are obtained from the MMM, MMH and MML alternatives, respectively.
Source: Statistics Norway

4.1. Fertility

Projected age-specific fertility rates (ASFRs) are used as assumptions for future fertility in BEFINN (see Box 4.1). The ASFRs vary depending on country group of origin, duration of stay, one-year age group and calendar year. The assumptions are produced in three alternatives: High (H), medium (M) and low (L) fertility.

BEFINN projects the fertility for 16 different groups of women. In addition to calculating fertility for Norwegian-born women (i.e. non-immigrants), we also factor in the fertility disparities between immigrant women in 15 combinations of country group of origin and duration of stay in Norway. First, we ascertain the output levels for the different groups in the empirical, historical data. Next, we make assumptions about how fertility will develop in the future, based on observed fertility. Currently, no formal model is employed (Gleditsch and Syse 2020).

Data

We use observed data to calculate the baseline level for fertility in the different subgroups of women. We take the number of women aged 15–49 years from Statistics Norway's population statistics. The data source, which is Statistics Norway's version of the National Population Register, also contains information about the women's backgrounds, i.e. whether they are immigrants or not, and how long they have lived in Norway. Data about births are also obtained from Statistics Norway's population statistics, which contain information about live-born children.

Box 4.1. 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. The mid-year population is the average number of women of the age in question residing in the country in a given calendar year. Women are divided into one-year age groups from 15 to 49 years. Moreover, immigrant women are divided by country background and duration of stay in Norway.

The formula for age-specific fertility rates can be written as follows:

$ASFR(x,t) = f(x,t)/k(x,t)$,

where $f(x,t)$ is the number of live births to women age x in year t, and $k(x,t)$ is the mid-year population of women age x in year t.

Total fertility rate (TFR) is the sum of the age-specific fertility rates for 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.

Baseline fertility

BEFINN projects the population at the national level. To do this, we need estimates of future birth rates. This is done separately for immigrant women and for the remaining population. We first find the baseline level for the different groups and then make assumptions about how we believe fertility will develop for these groups in the future.

Fertility among immigrant women

To calculate how many children will be born to immigrant women in future, we create groups based on country group and duration of stay.

We use three country groups (see Appendix A for a detailed list):

- Country Group 1: Western Europe, the US, Canada, Australia and New Zealand
- Country Group 2: Eastern EU member countries (Bulgaria, Estonia, Croatia, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, Czech Republic and Hungary)
- Country Group 3: The rest of the world, e.g. the rest of Eastern Europe, Africa, Asia (including Turkey), South and Central America and Oceania (excluding Australia and New Zealand)

Duration of stay is calculated as the number of whole years since first-time immigration to Norway. We divide duration of stay into five groups:

- 1 year or less
- 2–3 years
- 4–6 years
- 7–11 years
- 12 years or more

Together, this amounts to 3 x 5=15 combinations of country group and duration of stay. To find the baseline level for fertility in the 15 different groups of immigrant women, age-specific fertility rates are calculated for each group as an average of the last ten years. This is a weighted average where the last year with available data counts most.

Fertility among the remaining women

Once we have calculated the baseline level for fertility among immigrant women, we are left with the rest. Norwegian-born women with two immigrant parents are also part of this group. To calculate the baseline level for fertility among the remaining women, ASFRs are calculated for the last year.

Fertility assumptions

For each year in the projection period, we use a factor that adjusts the baseline ASFRs up or down based on how we assume fertility will develop in future. The annual factor is created in three alternatives: low, medium and high, and is applied to all the ASFRs in the given year. As such, we do not account for changing age schedules. The factors are set by Statistics Norway after discussions with an advisory reference group consisting of fertility researchers.[5]

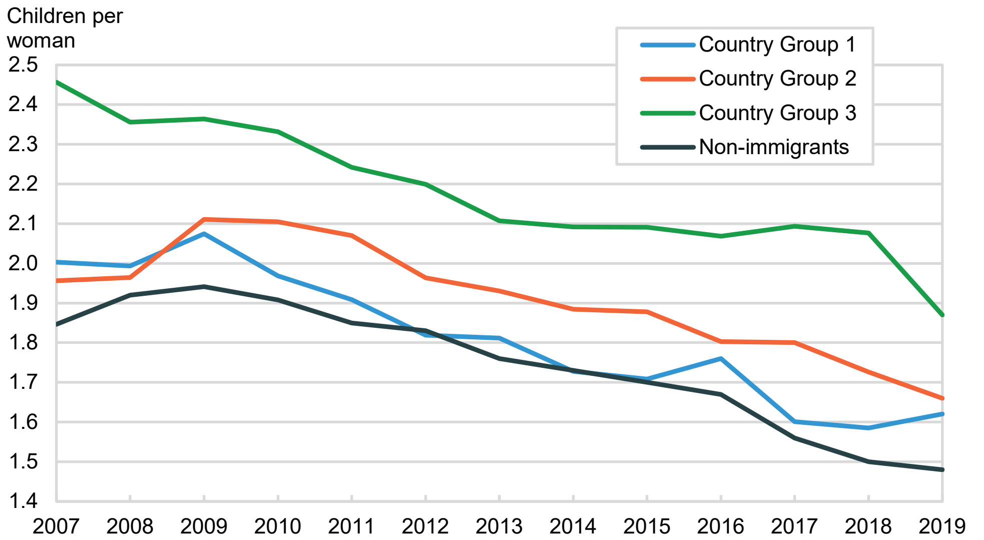
When we set the factors, the fertility of women with a Norwegian background (i.e. non-immigrant women, including those who are Norwegian born with two immigrant parents) are used as the point of departure. For example, we can envisage the total fertility rate being 1.7 in 2040 – i.e. 15 percent higher than in 2019, when these women gave birth to 1.48 children on average. The factor will then upwardly adjust the age-specific fertility rates for all groups of women, so that they are 15 percent higher in the year 2040 than in 2019. This means if women from Country Group 3 with a 4-6 years duration of stay had a TFR of 2.43 in 2019, the projected TFR of that group would be 2.79 in 2040, corresponding to a 15 percent increase.

Since the same factor is used for everyone, it is conceivable that the differences in fertility between the immigrant women from each of the three country groups and the remaining women could be constant throughout the projection period. They are not, however. This is because immigrant women's fertility varies with their duration of stay, and because the number of immigrant women in different groups varies over time. During the projection period, most immigrant women will switch duration of stay groups several times, so that the composition of the 15 groups of immigrant women changes. This has consequences for how many women can potentially give birth in each duration of stay group – and thereby for how fertility will develop among immigrant women overall. This means that the projected total fertility rate will not be constant as the composition of the different groups of women will change over time.

The recent development of the total fertility rate for immigrants from each country group is shown in Figure 4.1. The observed patterns are projected to continue in the future, since all groups are multiplied by the same factor. However, Tønnessen (2019) finds that immigrant fertility declines as the duration of stay in Norway increases, and this is accounted for.

[5] For the 2020 population projections, the reference group consisted of the following members (listed alphabetically with associated organization in parentheses): Kjersti N. Aase (Vestfold and Telemark county municipality), Espen Andersen (Statistics Norway, population statistics), Janna Bergsvik (Statistics Norway, social and demographic research), Lars Dommermuth (Statistics Norway, social and demographic research), Rannveig Kaldager Hart (FHI), Øystein Kravdal (UiO/FHI), Sturla Løkken (Statistics Norway, public economy and population models), Johan Tollebrant (Statistics Sweden, demographics) and Marianne Tønnesen (NIBR).

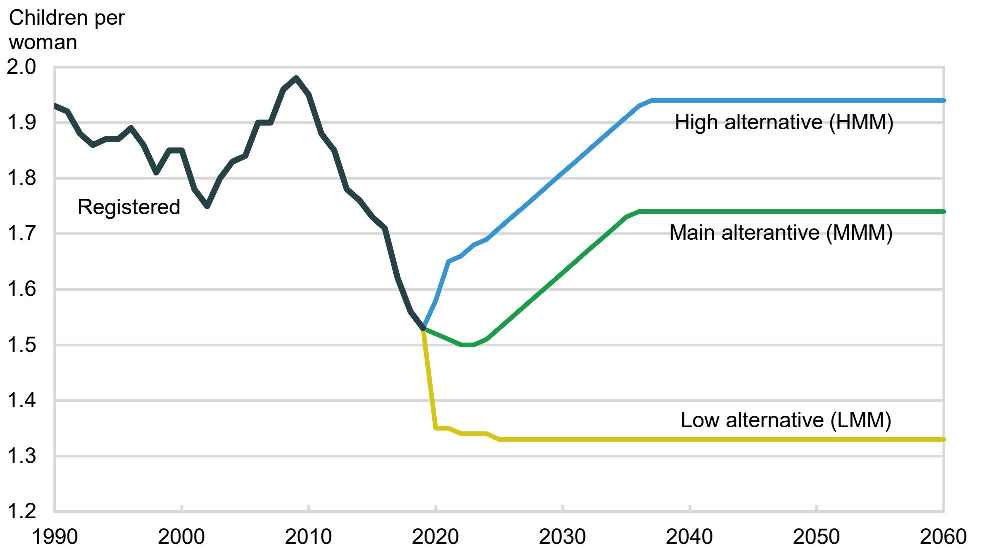
Figure 4.1 Total fertility rate in Norway by country group, 2009-2019



Source: Statistics Norway

Based on a summary of empirical knowledge of fertility trends and the current COVID-19 pandemic and its aftermath, we assume that the decline in fertility that we have seen since 2009 will continue, but at a slower pace, for the next five years. In the medium assumption, we assume that the fertility decline will slowly level off, at approximately 1.5 children per woman thereafter return to the current level in 2025. Thereafter, we expect a gradual increase to approximately 1.6 in 2030 and a continued rise to around 1.74 in 2036. From this point onwards, the fertility is held fairly constant (1.73-1.74). This is portrayed in Figure 4.2. As mentioned earlier, we apply the same assumptions of percentage change to fertility for all 16 groups of women. The reason why the projected overall TFR changes somewhat over time is that the composition of women, with different immigrant backgrounds and durations of stay, will not be constant. As the fertility of all women depends on the size and composition of the groups of immigrant women by country group and duration of stay, the TFR of all women will change somewhat throughout the projection period. It is also dependent on the assumptions about future immigration, as discussed later in this chapter.

Figure 4.2 Total fertility rate in Norway, registered 1990-2019 and projected 2020-2060 in three alternatives[1]



[1] High refers to the high fertility alternative, whereas low refers to the low fertility alternative.
Source: Statistics Norway

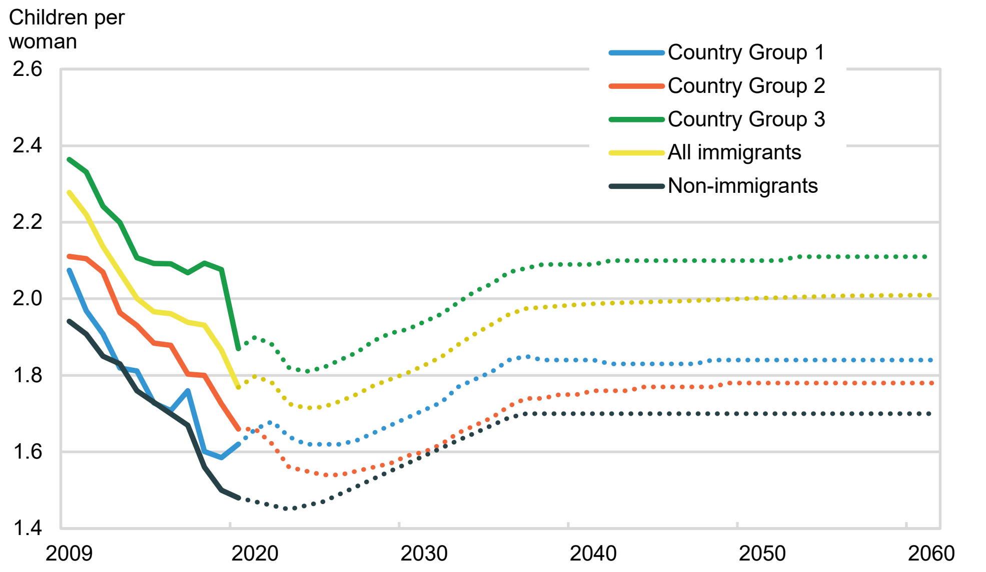
In the low assumption, the TFR will reach a low point of 1.33 in 2025, which is close to the current levels seen in Finland. Finland has the lowest fertility among Norway's neighbouring countries and has also had a lower TFR than Norway almost every year since 1960. In both the short and long run, the low assumption is kept constant at this level. In the short-term, to account for all economic and health uncertainties associated with the COVID-19 pandemics and its aftermath. In the long-term, to account also for the postponement of childbirths among Norwegian women and fewer women with three or more children. This long-term low assumption is 24 percent below the long-term level of the medium assumption and is also shown in Figure 4.2.

The high assumption for the TFR is expected to reach a level of 1.71 in the short run, which is similar to the level registered in Norway in 2016. In the long run, the high alternative is assumed to gradually approach a TFR of 1.94. This long-term high level is 12 percent above the long-term level of the medium and is portrayed in Figure 4.2.

Figure 4.3 shows registered and projected TFR for immigrant women from each of the three country groups as well as the non-immigrant women, from 2009–2060 in the main alternative (MMM). In the short-run, the fertility levels will decrease for all three groups, with Country Group 3 having the steepest decline. After the initial first years, the fertility levels will increase for all three groups until they become stable from approximately 2036 onwards. For Country Group 1, TFR will become stable at approximately 1.84, compared to 1.78 for Country Group 2 and 2.10-2.11 for Country Group 3.

This is in accordance with the assumptions for gradual phasing-in of long-term levels of TFR discussed earlier. For Country Group 2, however, there is a relatively large decrease in fertility in the short term, stabilizing in the long term at a level that is well below today's level. One explanation for this pattern is that we expect lower immigration from this group throughout the projection period, and that more women will thus end up in groups with a long duration of stay, which gives a lower fertility level. Overall, long-term fertility for women with immigrant backgrounds will stabilize at a level of approximately two children per woman (2.00-2.02).

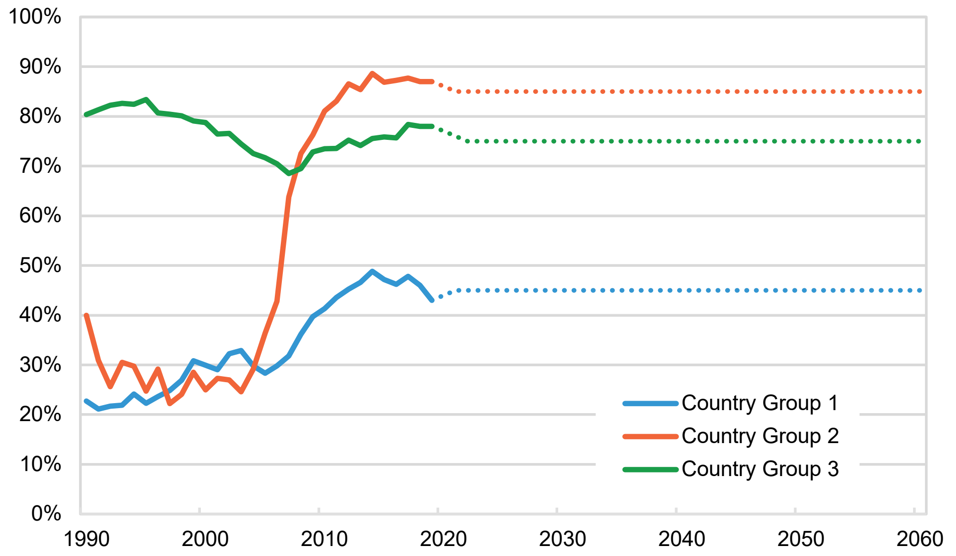
Figure 4.3 Total fertility rate in Norway by country group, registered 2009-2019 and projected 2020-2060, main alternative (MMM)



Source: Statistics Norway

In order to calculate the number of Norwegian-born children to two immigrant parents we also make assumptions about the proportion of immigrant women who will have children with immigrant men. This is discussed more in the chapter on immigration (Chapter 7). Figure 4.4 portrays the assumptions used for this year's projections.

Figure 4.4 Share of immigrant women who have children with immigrant men, by country group, registered 1990-2019 and projected 2020-2060



Source: Statistics Norway

4.2. Life expectancy and mortality

Statistics Norway uses recognised models to project mortality in Norway. In these models, future mortality is largely determined by the historical empirical development in the mortality rate.

We use the product-ratio variant of a Lee-Carter model, where the trend in mortality for a selected time period, represented by two estimated time series, is extended using an auto regressive integrated moving average (ARIMA) model. The period of registered data used as input is determined prior to each projection.

This method gives us mortality rates by age in years and sex up to and including the year 2100, which are subsequently used in the BEFINN model. The projected mortality rates are also used to calculate life expectancy at birth and the remaining life expectancy at every age up to and including 105 years. Calculations are made for men and women separately, as well as for men and women combined.

Data

The figures for the number of deaths and the size of the population are taken from Statistics Norway's population statistics. In the current projection, we use an input-period from 2000-2019 in the modelling work. We calculate age-specific death rates for men and women, and the total for both sexes, for all ages 0-110, and allow for the fact that deaths do not occur linearly throughout the year (see Box 4.2). Age is defined as the age in whole years at the end of the year. When the mortality rates are calculated, an adjustment is made for extreme values.

Once we have calculated the mortality rates in the input period, and made adjustments for extreme values, the actual modelling of projected rates can begin.

Box 4.2. Mortality rates

We calculate age-specific mortality rates for men, women and combined for both sexes by one-year age groups from 0 to 110 years for each calendar year in the period from 2000 up to and including the last year for which data are available. Age at death is defined as age in whole years at the end of the year. Once the mortality rates have been calculated, they are corrected for extreme values. Mortality rates with the value 0 are set to the average of the rates for the age groups before and after for ages up to and including 100 years. This happens relatively rarely, but there are cases where deaths have not occurred in a certain year, sex and age group. For example, deaths are rare among females aged between 10 and 15 years.

There are large fluctuations from year to year for older ages (101-110 years). Therefore, to estimate projected death rates for these age groups, a logistic model has been used to extrapolate and smooth the estimated rates for ages 101-110 years. Input in this model is mortality rates for the age groups 70-100 in the period years 2000-2019. This reduces the noise in the estimates at high ages and provides stable projected death rates for the entire age range. For ages 110-119 years, the probability of death is set at 0.5 for both men and women throughout the period.

Modelling mortality

Initially, we use the 'product-ratio method' (Hyndman et al. 2013). The purpose of this method is to reduce the correlation between the mortality rates for men ($_M$) and women ($_W$). The method can be formally described as follows:

$$p(x,t) = \sqrt{(m_M(x,t) * m_W(x,t))}$$
$$r(x,t) = \sqrt{(m_M(x,t)/m_W(x,t))}$$

where $p(x,t)$ is defined as the square root of the product of the mortality rate of men ($m_M(x,t)$) and women ($m_W(x,t)$), respectively, at age x in year t, and $r(x,t)$ corresponds to the square root of male mortality rate divided by the female mortality rate. Even if $p(x,t)$ and $r(x,t)$ are not completely uncorrelated, the correlation is significantly reduced.

A model based on the Lee-Carter model (Lee and Carter 1992, Li and Lee 2005, Lee 2000) is then applied to the observed mortality data in our sample. This model was originally developed by Lee and Carter (1992), but has subsequently been further developed by others. The method estimates parameters for changes in the mortality level over time and by sex and age. It can be expressed as follows:

$$\log m(x,t) = a(x) + \sum b_i (x)k_i (t) + u(x,t),$$

where $\log m(x,t)$ is the logarithm of the mortality rate in year t for age x, $a(x)$ is the general age pattern, $b_i(x)$ is the age-dependent correction in the time index, $k_i(t)$ is the time index and $u(x,t)$ is a stochastic error term that is assumed to be normally distributed.

Given that we have already reworked the mortality rates $m(x,t)$ for men and women using the product-ratio method, we use a Lee-Carter model in which the mortality rates $m(x,t)$ for men and women are replaced by $p(x,t)$ and $r(x,t)$, respectively. We thereby model mortality for men and women in the same process. The sum of the age-dependent correction in the time index $b_i(x)$ multiplied by the time index $k_i(t)$ can consist of one or more components. Our data prove to be well adapted using the following Lee-Carter model with two components (Keilman and Pham 2005).

$$\log p(x,t) = a_p(x) + b_{p1}(x)k_{p1}(t) + b_{p2}(x)k_{p2}(t) + u_p(x,t)$$
$$\log r(x,t) = a_r(x) + b_{r1}(x)k_{r1}(t) + b_{r2}(x)k_{r2}(t) + u_r(x,t)$$

So far, we have only modelled the observed mortality rates, i.e. mortality from and including the year 2000 until the last year for which data are available (i.e. 2019). In order to make assumptions about how mortality will develop in the future, we use what is referred to as an ARIMA model (Wei 2006). In this model, we include what is called a 'random walk with drift' (RWD), which means that we take account of a trend in mortality that we expect to continue into the future. The formula we use is as follows:

$$k_i(t) = \theta_i + k_i(t-1) + v_i(t),\ i=1,2,$$

where θ_i is the trend (drift), $k_i(t)$ is the time index and $v_i(t)$ is a stochastic error term that is assumed to be normally distributed.

When we enter the predicted values for $k_1(t)$ and $k_2(t)$ in the Lee-Carter model, together with the estimated values for the age profiles, $a_i(x)$ and $b_i(x)$ (i=1,2), we obtain predicted values for $p(x,t)$ and $r(x,t)$. These are transformed back into the projected mortality rates $m(x,t)$ for men and women, respectively.

Once we have calculated the age-specific mortality rates for the whole projection period using the models presented above, uncertainty from the RWD model is estimated by simulating 5 000 alternatives by means of bootstrapping. This yields different paths for a possible development in future life expectancy.

Before the age and sex-specific mortality rates in the four alternatives can be used in BEFINN, the mortality rates are converted into probabilities using the following formula:

$$q(x,t) = 1-(\exp(-m(x,t)))$$

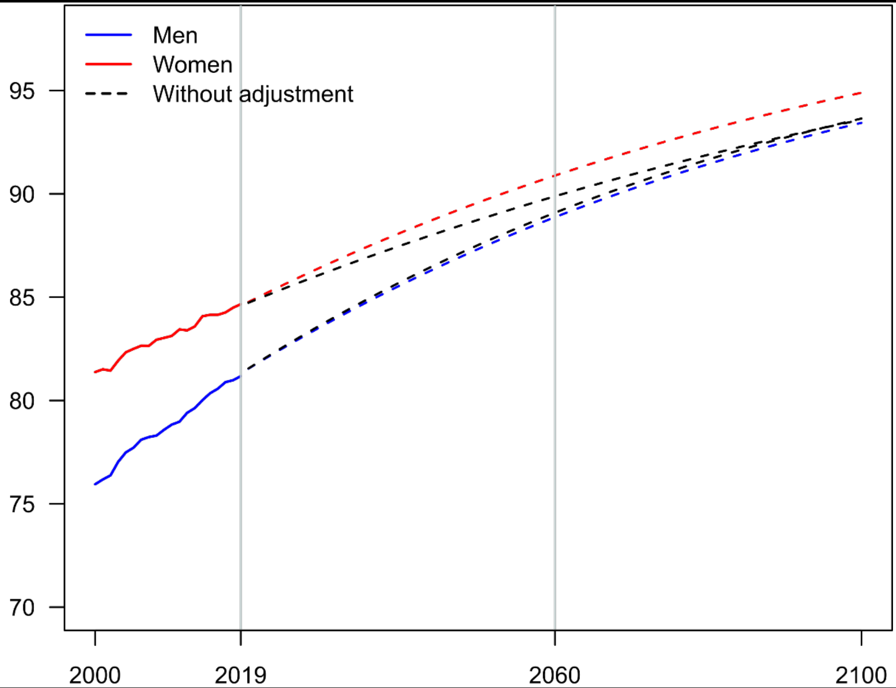
Discretionary adjustments

The period used as input is determined prior to each projection. After assessing the plausibility of the projected mortality rates resulting from the model, we also make other discretionary assessments. If adjustments seem appropriate, we make these in consultation with an advisory reference group, consisting of mortality experts from medical and research institutions in Norway and abroad.[6]

While there are certain well-known issues with the estimated mortality rates, such as a slightly poor fit of infant mortality and too large a reduction in young age mortality, we argue that these discrepancies are tolerable in a population projection perspective. However, since male mortality has declined very rapidly in recent decades, an extrapolation leads to higher life expectancies for men than women for a number of ages in the range 50-80 years. We have therefore chosen to add some constraints that, throughout the projection period, reduce the mortality rates and increase life expectancy somewhat more than the model estimates indicate for women. The effect of this adjustment is shown in Figure 4.5.

[6] The advisory group for mortality consisted of the following members: Inger Ariansen (Norwegian Institute of Public Health), Christian Lycke Ellingsen (Stavanger University Hospital), Örjan Hemström (Statistics Sweden), Nico Keilman (University of Oslo), Bjørn Møller (Cancer Registry of Norway), Siri Rostoft (Oslo University Hospital) and Anders Sønstebø (Statistics Norway). Members are listed in alphabetical order with institutional association in parentheses. We thank the reference group for their useful input in the formation of our assumptions.

Figure 4.5 Projected life expectancy at birth for men and women, with and without discretionary adjustment, registered 2000-2019 and projected 2020-2100[1]



[1] Dashed lines represent the medium alternative in each instance.
Source: Statistics Norway

Life expectancy at birth and remaining life expectancy

Once we have estimated age-specific mortality rates for the projection period, we calculate period life expectancy at birth and remaining life expectancy for each age group in each projection year. We calculate this for the national population in three alternatives. We do this for men and women separately as well as for men and women combined. The latter is based on mortality rates for both sexes combined. We also calculate life expectancy at birth and remaining life expectancy from a cohort perspective, for men and women separately. Variations between projected period and cohort-based life expectancy estimates are discussed in more detail in Chapter 6. Here, we will briefly outline the approaches used to produce the two life expectancy metrics.

Period life expectancy

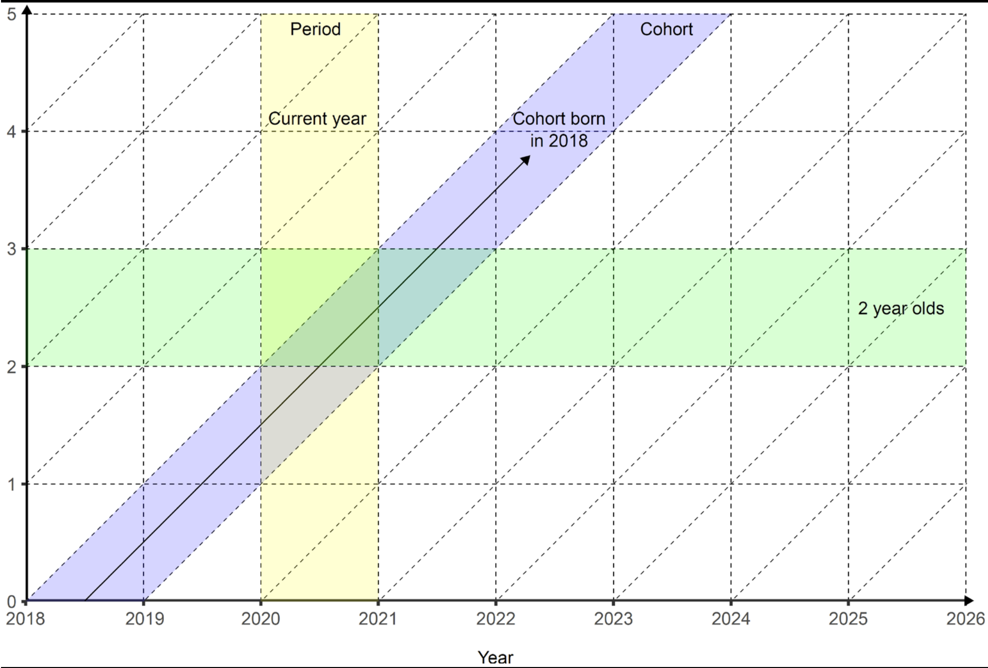
Period life expectancy is the expected number of years a person can expect to live according to the age-specific death rates in a given period, usually a calendar year. It is usually estimated at birth but can also be estimated for other ages, in which case it is termed remaining life expectancy.

Life expectancy at birth refers to the number of years a new-born baby will live if the relevant age-specific mortality probabilities for a period (normally a calendar year) persist. Remaining life expectancy is defined as the remaining number of years a person at a given age will live if the age-specific mortality probabilities for the remaining ages in the period persist. As is shown in Figure 4.6, for a period life expectancy at age 2 in 2020 we would use projected mortality rates in 2020 for ages 2, 3, 4 and so on. Statistics Norway calculates the remaining period life expectancy for each age up to and including 105 years.

Cohort life expectancy

Cohort life expectancy estimates the average number of additional years a person can be expected to live according to the assumed future changes in mortality for their cohort over the remainder of their life. These estimates are calculated using registered and projected age-specific death rates for the same cohort throughout their life (see diagonal in Figure 4.6). These estimates therefore require mortality rates based on larger observed and projected time series. Statistics Norway calculates the cohort life expectancy at birth and remaining life expectancy at birth for 2020-2100, up to and including 100 years.

Figure 4.6 Lexis diagram for period and cohort life expectancy[1]



[1] Adapted from https://obr.uk/box/period-cohort-measures-of-fertility-and-mortality/.
Source: Statistics Norway

Mortality assumptions

It is the projected probabilities of death that are used as assumptions about mortality in BEFINN. Probabilities of death are used by sex, one-year age group and calendar year in four alternatives: Medium (M), low (L), high (H) and constant (C) life expectancy.

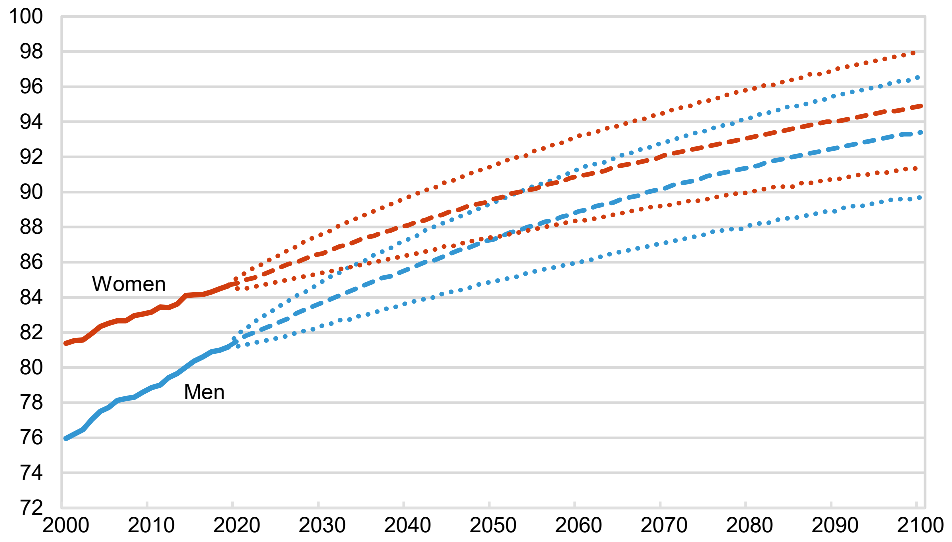
The estimated projected alternative is called the medium alternative. We assign to it an 80 percent prediction interval, in line with standard practice (Savelli and Joslyn 2013). We name the upper limit of the prediction interval for mortality rates the low alternative (referring to low life expectancy), while the lower limit is called the high alternative (referring to high life expectancy). In addition, we have a constant alternative (C), where the mortality rates in the medium alternative from the first projection year are held constant throughout the projection period.

At the national level, probabilities of death are applied by sex, age and calendar year. The same mortality level is assumed for immigrants as for the general population, since the disparities on average are below ten percent and decline further for immigrants with a long duration of stay in Norway (Syse et al. 2016, Syse et al. 2018).

To calculate the number of deaths, the probabilities of death are entered into BEFINN. The number of deaths is necessary to calculate the overall population figures.

This year's projections are based on developments in mortality during the period 2000–2019. We assume that mortality will continue to decline. In our medium alternative, period life expectancy at birth for men increases from 81.2 years in 2019 to almost 89 years in 2060, i.e. an increase of almost eight years. This is shown in Figure 4.7. For women, we have assumed a slightly less pronounced increase from 84.7 years in 2019 to 91 years in 2060, i.e. an increase of about 6 years. In the low alternative, the increase will be weaker – around four years for men and five years for women – over the same period. In stark contrast, life expectancy in the high alternative will increase sharply, by just over 10 years for men and nine years for women.

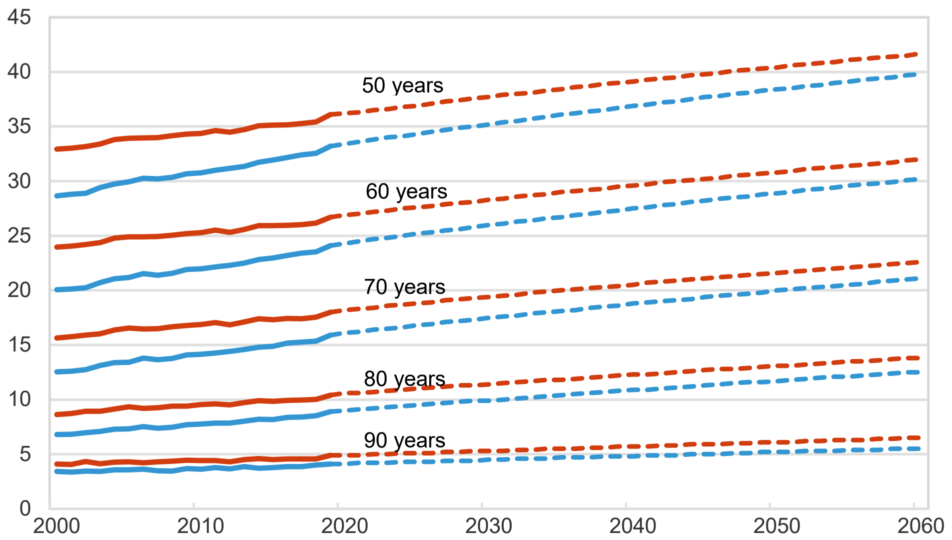
Figure 4.7 Life expectancy at birth for men (blue) and women (red), registered 2000-2019 and projected 2020-2100 in three alternatives[1]



[1] Dotted lines refer to high and low life expectancy alternatives, dashed lines to medium alternative.
Source: Statistics Norway

One of the main reasons for the projected increase in life expectancy at birth is the expected increase in remaining life expectancy in older age groups, as shown in Figure 4.8. According to the medium alternative, the remaining life expectancy for 70-year-olds will be around 4-5 years higher in 2060 compared to today. The increase is also pronounced for the 80-year-olds, who can expect to live 3 years longer on average in 2060. This is also reflected in the mean age of death, which, according to the main alternative, is expected to increase from around 80 years today to around 89 years in 2060.

Figure 4.8 Remaining life expectancy at ages 50, 60, 70, 80 and 90 for men (blue) and women (red), registered 2000-2019 and projected 2020-2060, medium alternative (M)



Source: Statistics Norway

To summarise, we assume a pronounced increase in life expectancy at birth and remaining life expectancy in this year's projections. Consequently, older people will constitute an increasing share of the population in the years to come. At the same time, the mean age of older people will continue to rise.

The mortality gap between men and women is expected to narrow, and there will only be around a two-year difference between male and female life expectancy at birth by 2060, according to our medium alternative.

4.3. Immigration and emigration

In the population projections, immigrations and emigrations are calculated separately. Net migration constitutes the difference between the two. Whereas future immigration is estimated using a model, future emigration probabilities are based on observed emigration during the past decade.

For both immigration and emigration, the world outside Norway is divided into three country groups of origin (see also Box 4.3 and Appendix A):

1. Western Europe, the US, Canada, Australia and New Zealand
2. Eastern EU member countries
3. The rest of the world

Immigrants and their Norwegian-born children are grouped according to their own (immigrants) or their mothers' country of origin (Norwegian-born children to two immigrant parents), see Box 4.4.

Data

Data on immigration to Norway and emigration from Norway are derived from Statistics Norway's population statistics. If someone moves both to and from Norway (or vice versa) during the same calendar year, this is neither registered as an immigration nor an emigration in this context, since the population projections are based on a change taking place from the turn of one year to the turn of the next. This does not affect the figures for net migration, but both the immigration and emigration figures will be a little lower than those that are published by Statistics Norway. This applies in particular to persons from EU countries (i.e. Country Groups 1 and 2), who can move freely between the EU/EFTA/EEA countries.

For the immigration model, data are needed also from other sources, and more details are available in Chapter 7, Section 7.3. In short, the population of the three country groups in broad age groups (0-14, 15-39 and 40+ years) is used as the denominators in the emigration rates. The figures are obtained from the latest version of the United Nations World Population Prospects.[7] The purchasing power-adjusted GDP per capita in Norway and in the three country groups are obtained from the World Bank and the OECD. The unemployment rate for Norway is based on Statistics Norway's labour market surveys, which are available in the OECD's database dating back to 1970. For the unemployment rate in Country Group 1, we use unemployment figures from the OECD. For the unemployment rate in Country Group 2 (the new Eastern European EU countries), we have used figures from both the OECD and Eurostat. They contain unemployment rates in each of the countries from the end of the 1990s. We have calculated a weighted average of the figures from both sources, and further weighted them by the countries' respective populations. For Country Group 3 (the rest of the world), there are no figures for the unemployment rate that give a satisfactory picture of the labour market situation. When the model is estimated for this group, this variable is therefore not

[7] The United Nations global demographic estimates and projections are updated every other year, see http://esa.un.org/unpd/wpp/index.htm. This year's figures are taken from the World Population Prospects 2019.

included. Lastly, we have calculated a measure of the network effect using the number of immigrants from each country group who are resident in Norway. These figures are taken from Statistics Norway's population statistics. This is used only for Country Group 3.

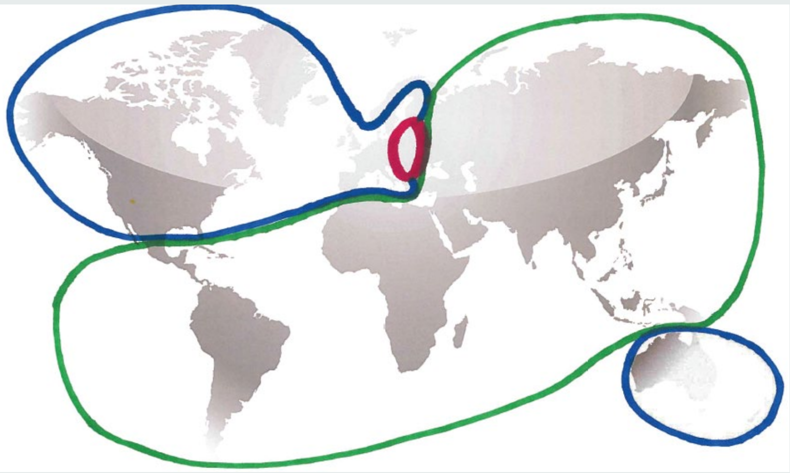
Box 4.3. The country groups

We have divided the countries of the world into three groups. Even though there are pronounced differences within the country groups, there are also certain similarities. It is a person's country of origin that decides which group he or she belongs to. For persons born abroad, this is (with a few exceptions) their country of birth. For persons born in Norway, it is their mother's country of birth.

Country Group 1 comprises all the Western European countries, i.e. countries that were part of the 'old' EU (pre-2004) and/or the EEA and EFTA, as well as the US, Canada, Australia and New Zealand. On average, nationals from these countries display relatively similar demographic behaviour as regards fertility and emigration. Moreover, few or no restrictions apply as regards their living and working in Norway.

Country Group 2 comprises the eleven new EU countries in Eastern Europe (EU members in 2004 or later): Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bulgaria and Romania. Migration from these countries was a major contributor to the immigration peak in Norway from 2007 to 2016. Moreover, of all the EU countries, it is these 11 countries where the income differences are greatest relative to Norway, while the expected demographic development in these countries also differs from other parts of the EU. As with all EU citizens, persons from this country group have the right to live, work and study in Norway.

Country Group 3 comprises the rest of the world, e.g. the rest of Eastern Europe, Africa, Asia (including Turkey), South and Central America and Oceania (excluding Australia and New Zealand). Nationals from these countries must apply for a permit to live and work in Norway. This group is quite heterogeneous, and we have primarily grouped these countries for the sake of simplicity.



Box 4.4. Commonly used terminology

In the population projections – and in Statistics Norway's other statistics – an *immigrant* is defined as a person born abroad with two foreign-born parents and four foreign-born grandparents, and who are registered as resident in Norway.

Immigration is defined as the number of migrations to Norway during a single-year period, irrespective of the immigrants' country of birth or citizenship. For example, during a calendar year, immigration to Norway includes 8 000-10 000 Norwegian citizens, most of whom are born in Norway and are thus not considered immigrants.

Emigration is defined as the number of migrations out of Norway during a period, irrespective of the country of birth or citizenship.

Net migration corresponds to the difference between the number of immigrations to and emigrations from Norway during a single-year.

In the population projections, we project the population from one year-end to the next. This means that people who move in and out of the country – or vice versa – within a year are not included in the population projections figures for immigration and emigration. We call these *multiple migrants*. As such, the immigration and emigration figures from the population projections are somewhat lower than the corresponding figures from Statistics Norway's population statistics, as explained in Chapters 2 and 3. Net migration figures are, however, comparable.

Norwegian-born with two immigrant parents are defined as persons born in Norway to two parents born abroad, and who also have four grandparents who were born abroad.

When we divide immigrants and Norwegian-born with immigrants according to the three country groups, we use 'country background' and not, for example, citizenship or which country they emigrated to Norway from. *Country background* is constructed based on information on country of birth. For immigrants, this is (with a few exceptions) their own country of birth. For Norwegian-born to two immigrant parents, the mother's country of birth is used.

Econometric models for three country groups and three age groups

Our modelling approach follows to a large extent Cappelen and Skjerpen (2014) and the references therein. In Chapter 7.3 we provide some theoretical underpinnings for the econometric models employed for forecasting, cf. Equations (1)-(5) and the interpretation of them in our empirical context.

In contrast to what had been the case in the previous projections, undertaken in 2018 and earlier, we now use a disaggregated approach when it comes to age composition of the immigrants. We now split the population in each country group into three different age groups. Group 1 consists of persons aged 0 to 14 years, group 2 consists of those aged 15 to 39 years and group 3 consists of those aged 40 years or older. Thus, the emigration rate, which is the immigration rate to Norway, is disaggregated into three different variables. This is the same age-disaggregation as employed by Tønnessen and Skjerpen (2019) using almost the same population data. However, we do not have data for incomes, unemployment and migration costs that are disaggregated by age, so we continue to use aggregated series for these variables. One motivation behind the disaggregation of the immigration rate is the fact that most migrants tend to be young, typically belonging to age group 2. We also expect future changes in the age composition of the origin countries, with such changes likely to be important when projecting immigration to Norway over the coming decades. According to the United Nations population projections, a larger share of the population in Country Groups 1 and 2 will consist of people in the oldest age group, an age group with traditionally low migration propensities. It is reasonable to assume that the immigration rate of the youngest age group is linked to the rate of the other two age groups because most child migrants arrive with their parents. Since we use annual data, we encounter a simultaneity issue when estimating the immigration rate of the youngest age group, given its dependence on the migration rate for the other two age groups. This is handled in the modelling approach.

The most common variables, excluding dummies, used in the models are:

M_{ijt}	The number of individuals in age group i that emigrate to Norway from country group j in year t. i=0-14,15-39,40+; j=1,2,3.
P_{ijt}	The mean population (in 1000s) in age group i in country group j in year t. i=0-14, 15-39, 40+; j=1,2,3.
RY_{jt}	Nominal GDP in Norway per capita (in PPPs) in year t divided by nominal GDP per capita in country group j in year t.
U_{kt}	The unemployment rate in year t measured in percentage terms for country group k. k=NOR,1,2.
$STOCK_t$	The stock of immigrants living in Norway at the start of year t. This variable is used only for Country Group 3.

In Chapter 7.3 we provide the explicit numerical models used for forecasting immigration from the three country groups. Altogether there are 9 equations, three for each country group. For each country it is one equation for each of the age group. All the equations are specified in logarithmic variables. The left-hand side variable is the log of the emigration rate for a specific age group in a specific country group in a given year, where the emigration rate is given by the emigration to Norway divided by the mean population (measured in 1 000s) of the age group in the country group. The equations for Country Group 1 are in (7), the equations for Country Group 2 are in (8) and the equations for Country Group 3 are in (9). The equations for Country Groups 1 and 2 are estimated by instrumental variables (IV) or by ordinary least squares (OLS) whereas the parameters for Country Group 3 are either calibrated or estimated by full information maximum likelihood (FIML). Besides providing the estimated or calibrated values we also provide some diagnostics for the different empirical models. Below, we give some comments to the results obtained for each of the country groups.

Country Group 1

In the equation for the youngest age group in Country Group 1 the emigration rate for 'parents' ($M/P_{15\text{-}39}$) enters twice both with and without a lag. This is also the case for the relative income ratio. In the long run the emigration rate for children increases by 0.76 percent when the 'parent' emigration rate increases by one percent, and by 0.40 percent when per capita income in Norway increases relative to that in Country Group 1. For the second age group, i.e., for those between 15 and 39 years, the emigration rate increases by 1.54 percent when relative incomes in Norway increase by one percent. An increase in the unemployment rate in Norway from 4 to 5 percent lowers the long-run emigration rate by 6 percent, while a similar increase in the unemployment rate in Country Group 1 increases the emigration rate by roughly 7.5 percent. The equation for the oldest age group, i.e. for those aged 40 years and older, has a long-run income effect of 1.31 percent, quite similar to that of the younger group. The unemployment effects are much stronger for the older group. An increase in the unemployment rate from 4 to 5 percent in Norway will reduce the emigration rate and thus immigration to Norway by 18 percent while a similar increase in the unemployment rate in Country Group 1 increases immigration to Norway by nearly 13 percent.

Country Group 2
Initially it was difficult for citizens of these countries to move to countries in Western Europe, except when employed in seasonal work. However, when a number of these countries became members of the EU, in May 2004 and some later in 2007, the restrictions on migration were gradually lifted. When formulating our econometric equations for this country group, later to be used for forecasting, we have included a step-dummy that has the value of one up to 2003, 0.33 for 2004 (as the change took place in May) and 0 after that. Because the models are specified in logarithms it implies that the percentage changes of the explanatory variables are unaffected by the policy change in 2004, but since there is a positive shift in the intercept the absolute effects of changes in the explanatory variables become much larger. We have also included some impulse dummies to achieve a reasonably stable model.

For the youngest age group for Country Group 2, the 'parent' effect is almost unity in the long run. There are no long-run effects of the unemployment rate in Norway, only short-run effects, but the long-run effect of a change in relative incomes is quite strong, 1.45. For the age group 15-39 years, the long-run income effect is nearly 2 showing that this age group is highly mobile across borders. There is also a very high long-run response to changes in the Norwegian unemployment rate, where the elasticity is also close to 2 in absolute value. As such, a permanent increase in the Norwegian unemployment rate from 4 to 5 percentage points will, in the long-run, reduce immigration by 40 percent. For the oldest age group, the income effect is 1.33 and the unemployment effect is -1.74. Both effects are somewhat smaller than for the 15-39 age group, but still quite large. In contrast to Country Group 1, the own unemployment rate has no long-run effect on migration to Norway

Country Group 3
When it comes to the estimation of the model for this country group, we include a couple of impulse dummies to capture marked changes in immigration, capturing the effects of certain shocks that cannot be explained by the other variables included in the model.[8] Of course, similar shocks will probably take place also during the projection period. The size and sign of future shocks are very difficult to predict. The same is true for their timing and effects. Furthermore, it is also hard to foresee what the response of Norwegian authorities will be according to these potential shocks. For instance, with respect to the high immigration alternative outlined below, the government could choose to tighten regulations on immigration in response to positive supply shocks relating to a potentially large influx of immigrants from Country Group 3.

The emigration rates for this country group depend on the income ratio lagged two years. For the two oldest age group there is an effect of the Norwegian unemployment rate. The Norwegian unemployment rate lagged one year enters for the middle age group, and the relative change in this variable enters for the oldest age group. A network effect, operationalized by using the total stock of immigrants from Country Group 3 at the beginning of the year, is present for all the age groups. Two impulse dummies related to large influxes of immigrants to Norway

[8] $DUM1999_t$ An impulse dummy being 1 in 1999 and 0 in all other years. It is related to a large influx of immigrants from Balkan in 1999.
$DUM2016_t$ An impulse dummy being 1 in 2016 and 0 in all other years. It is related to a large influx of immigrants from Syria in 2016.

in 1996 and 2016, respectively, are also present for all three age groups in Country Group 3.

For the iterations (in the projections, to be commented on later) to converge also in the high alternative, it has been necessary to monitor some of the parameters in the model given in (9) in Chapter 7.3. We have set the income effect equal to a common value, 0.317, which is the same as the one used for the aggregate approach in 2018 (see Section 3.4 in Syse et al. 2018a). The derived value of the long-run relative income effect is 0.6, which is much smaller than for the other country groups. The size of the parameter of the network variable is important when it comes to convergence. If it is too high, one encounters problems with convergence in the high alternative. We have calibrated it such that it is one third of the size of the coefficient of the income ratio variable. The derived value is thus 0.095. None of the parameters of the lagged endogenous variables (one for each age group) should be too high. We have set them to a common value of 0.474, which is the same value that was employed in conjunction with the official projections in 2018. An alternative procedure would have been to allow for age-group-specific responses related to the three right-hand side variables mentioned above. However, it is hard to know a priori how one should rank the groups with respect to the size of different parameters for the right-hand side variables. Thus, we have chosen a simple and practical solution. Conditional on the values of the three calibrated parameters, we have estimated the remaining parameters by full information maximum likelihood (FIML). Only for the middle age group there is a long-run effect of a change in the Norwegian unemployment rate with an estimated effect of about 0.7.

Forecasts of the variables

Once the parameters have been estimated (and with respect to Country Group 3 partially calibrated) for each of the nine equations, they are used to calculate how immigration to Norway will develop in future. To be able to do this, we need forecasts of how the economic and demographic variables will develop in the projection period (the explanatory or forcing variables). These forecasts are taken partly from international sources and partly from Norwegian sources and our own estimates.

The figures for the future development of the world's population in the three country groups are taken from the United Nations most recent population projections, made in 2019. In our medium alternative, we use the United Nations medium-variant. In our high and low alternatives, we use United Nations high- and low-fertility variants, respectively. In the high and low alternatives from the United Nations we have only access to data for each fifth year, i.e. the years 2020, 2025, …, 2100. To obtain values for each of the remaining years, we use piecewise linear interpolation to impute values.

Figures 7.10-7.15 in Section 7.3 in Chapter 7 show the (mean) population by age for the three age groups in the three country groups. For Country Group 1 there is substantial change in the expected age distribution both in recent decades and going forward (Figure 7.10). While the number of children has roughly been constant at 137 million from the early 1980s, the number of people aged 40 + years has been increasing, and it is expected to reach 500 million during the 2040s. The size of the most mobile age group, 15-39, is roughly constant and is expected to remain around 250 million people in Country Group 1. The total population in Country Group 1 in the three United Nations alternatives are shown in Figure 7.11. As can be seen from the figure, there is marked uncertainty as to whether the total population will remain stable, decrease or increase.

Figure 7.12 shows the age distribution for Country Group 2, which is expected to change considerably. The number of inhabitants in the most mobile age groups began to decline at the time most of these countries became EU-members. This is to a large extent a result of the fact that many people in this age group have already migrated to Northern and Western European countries, including Norway. It is expected that the population in Country Group 2 will decline over the coming decades, with the most rapid decline among the most mobile age group likely to occur during the 2020s. The total population of Country Group 2 is currently around 100 million, see Figure 7.13. It is expected to fall below 70 million by 2100 according to the United Nations medium alternative. If the aggregate immigration rate for Norway should stay constant, the decline in the population of Country Group 2 would lead to a reduction in annual immigration from this group of 30 percent from 2020 to 2100.

Country Group 3 has by far the largest population among the three country groups. Figure 7.14 in Chapter 7, Section 7.3, shows the historical development as well as the projected trends according to the size of the three age groups, whereas the total population is shown in Figure 7.15. According to the latest United Nations forecast the population in this country group will reach 10 billion by 2100. In the low alternative it will reach a maximum of around 8 billion sometime during the 2050s, while in the high alternative the trend in population growth over the last 30 years or so will simply continue for another 80 years. As is clear from Figure 7.14, a significant ageing process will accompany this total growth.

The estimates of the future number of immigrants residing in Norway (which are used to calculate the network effect) are based on figures from the previous population projection. Once the number of immigrations has been predicted, the whole projection model (that is BEFINN) is run using the updated figures. The model produces new estimates of the number of resident immigrants from each country group. These figures are then used to forecast immigration again. Such iteration rounds are repeated several times until convergence is obtained. As mentioned earlier, the network effect is only present for Country Group 3.

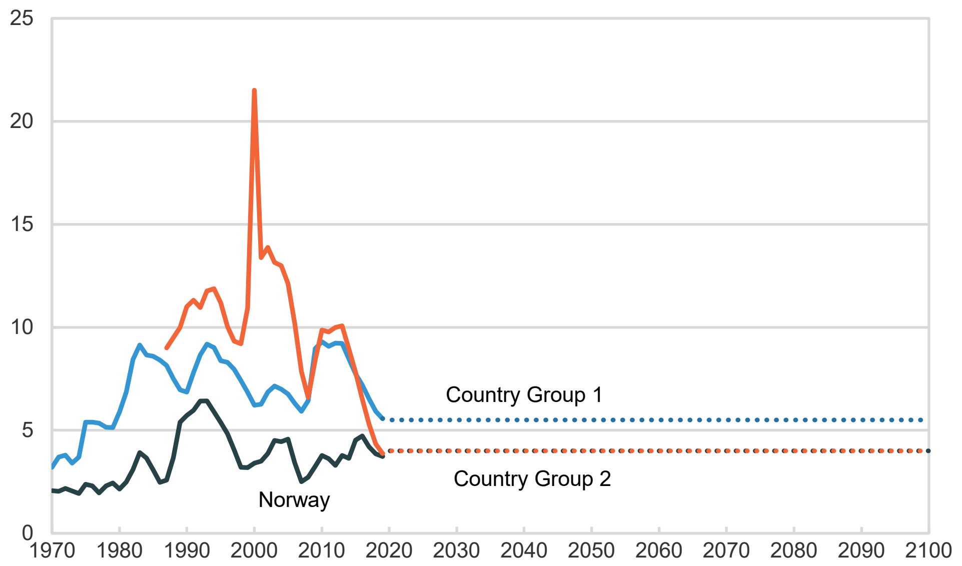
In the past, political decisions and wars have influenced immigration to Norway. When estimating the model, we have therefore included indicators for years when important political changes have taken place. We are not able to predict when new political changes might occur and how these would influence immigration.[9] The same applies to natural disasters or armed conflicts that lead to new flows of refugees. We do however control for the effects of these changes in the estimation.

Forecasts of the unemployment rate in Norway are taken from Statistics Norway's macroeconomic projections. In the long term, the unemployment rate has been levelled off to a historically 'normal' level around the average of the last three decades (4 percent). In recent years the unemployment rate in Country Group 2 has been significantly reduced, and more than we expected in our forecasts two years ago. We assume that it will stay at a low level, similar to the Norwegian level in the long run. For Country Group 1, the unemployment rate has also been reduced. Due to the COVID-19 pandemic, unemployment will increase dramatically in 2020 in most countries. Due to the uncertainty regarding the short run economic effects of the pandemic, we have adjusted the modelled forecasts for 2020 and 2021 in an *ad hoc* way as explained below. In the long term, however, the unemployment rate is expected to stay at a fairly low level when compared to previous decades. The

[9]From 1 January 2020 Norway allows dual citizenships, provided that the country one already is a citizen of allows this. If this is not the case, one may lose the original citizenship when one becomes a Norwegian citizen (UDI 2020c). The new law may lead to both higher immigration and emigration, but it is hard to know whether the effects will be sizeable. We have not attempted to account for the effects in this more flexible law.

changing demographic structure in both Country Groups 1 and 2 is one reason why we think this is a reasonable assumption in the long run. The Norwegian unemployment rate is assumed to be the same in all three scenarios. It is set to 4 percent in all years in the period 2022-2100, as shown in Figure 4.9.

Figure 4.9 Unemployment rates in Norway and Country Groups 1 and 2, registered 1970-2019 and assumed future values 2020-2100. Percent



Source: OECD, Eurostat and Statistics Norway

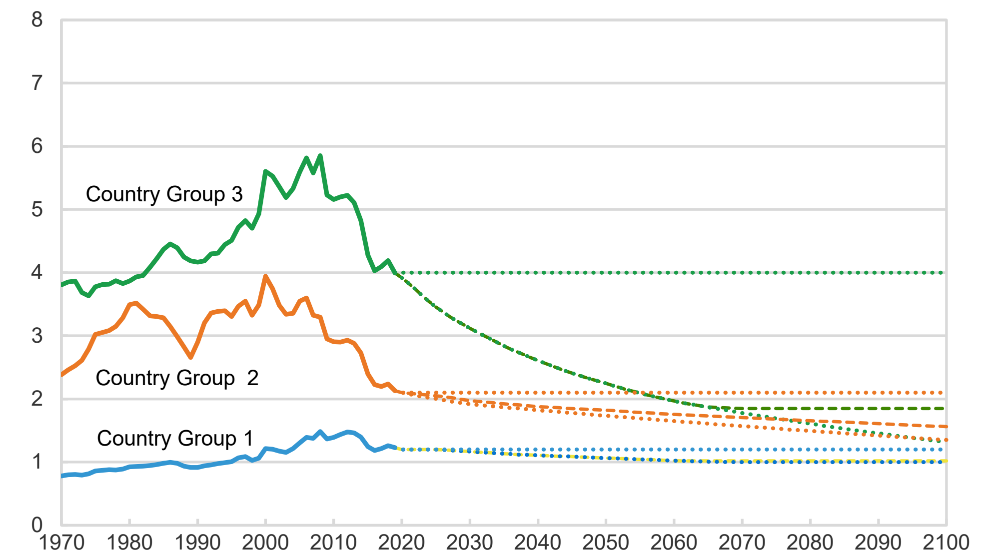
Three alternative paths have been made for future income development (low, medium and high alternatives). They reflect three different alternatives with respect to future economic development. The high alternative assumes the greatest income differences between Norway and the rest of the world in the years ahead. In this case the last observed relative income levels have simply been extended until 2100. The medium alternative assumes that non-oil GDP per capita in Norway follows that of Country Group 1, while the gradual phasing out of oil and natural gas exploration in Norway takes place according to the most recent figures available. In the low alternative there is more absolute convergence in relative incomes between Norway and the three country groups, also in the very long run. The effects of the COVID-19 pandemic that is currently affecting the world economy have been difficult to account for in these forecasts. We base our forecasts on relative incomes per capita, and as long as all countries are negatively affected in roughly a similar fashion, there will be little change in relative incomes due to the pandemic.

It is reasonable to assume that the large increase in unemployment in most OECD countries will reduce migration significantly. Other factors, such as closing of borders, quarantine rules and general uncertainty due to the pandemic may also have large effects on immigration to Norway. The COVID-19 pandemic is therefore accounted for in the following way: Initially, we make projections as if the pandemic had not taken place. Based on these projections we reduce the projected immigration by 50 percent in 2020, and by 25 percent in 2021. The resulting values for 2020-2021 are then fixed. We then restart the dynamic simulations in 2022.

Since the lagged age-group-specific immigration variables enter with a one-year lag, we need to fix also the value for the assumed 'normal' year 2022. This procedure is necessary in particular for Country Group 3 where the low immigration in the years 2020 and 2021 will impact the number of immigrants living in Norway, which is itself as an explanatory variable in the econometric equations employed in the forecasting.

Figure 4.10 shows the historical relative income per capita ratios for each country group and for the three scenarios. For Country Group 1 relative incomes are not expected to change much compared to the historical data in any of the three alternatives. For all country groups the high alternative is constructed by extra-polating the 2018/19 relative income level until 2100. The middle alternative is constructed assuming that a gradual decline in Norwegian oil revenues will lead to a reduction in Norwegian GDP per capita in relative terms. For Country Group 2 we expect a catch up in incomes to continue in the middle and low alternative but to different degrees. For Country Group 3, the income ratio declines from about 4 in 2019 to about 1.85 in 2070 and are thereafter it remains constant for the remaining part of the projection period in the medium alternative. This develop-ment is related to phasing-out the petroleum activity in Norway but more importantly with a continuation of economic growth in Country Group 3. In the low scenario there is no difference in the income ratio until 2064 when compared to the development in the medium alternative. In this year the income ratio is set to about 1.9. From this level the income ratio decreases further, to around 1.3 in 2100. Thus, according to the low scenario (PPP-adjusted) GDP per capita in Norway is only 30 percent higher than the corresponding level in Country Group 3. In the high scenario the income ratio is set to the constant value of 4 for the entire projection period.

Figure 4.10 Relative GDP per capita, registered 1970–2019 and assumed paths 2020-2100 in three alternatives



Source: OECD, the World Bank and Statistics Norway

Immigration forecasts for the three country groups

The estimated equations corresponding to (7)-(9) are utilized for dynamic projections. First, the unknown parameters are replaced by their estimates and the errors are set to zero. Second, the estimated equations are transformed such that it is the log of immigration of the age groups that occur as left-hand side variables. After having predicted the log emigration for the three age groups by performing iterated forecasting, one may derive the prediction for emigration in levels. Note that we have time series for the exogenous variables on the right-hand side for the period 2020-2100. Values for the lagged right-hand side variables are obtained recursively ('dynamic forecasts'). In Chapter 7, we show the forecast for the three country groups in the medium, high and low alternatives based on the various assumptions for relative incomes and the projected populations.

Projected immigration

Based on these different demographic and economic estimates, the immigration model yields three different paths (low, medium and high alternatives) for immigration from each of the three country groups. Some unevenness generated by the econometric model at the start of the paths is usually smoothed based on a discretionary assessment. In addition, the estimated standard error of the forecasts is used to allow for model uncertainty in the calculations.[10] This is done by adding the standard deviation of the prediction error to the forecast for immigration in the high alternative and correspondingly deducting the standard deviation from the low alternative. This is done for each of the three country groups. Due to the current COVID-19 pandemic, discussed in more detail in Chapter 1, some constraints were added to the estimates before they were used in the BEFINN model for 2020 and 2021. More specifically, we opted to half the modelled estimates in the medium alternative for immigration from Country Groups 1-3 for 2020. For 2021, we reduced the modelled estimates with 25 percent. While we know that international migration has, and will continue, to be greatly affected in the short term, the unprecedented scale of the pandemic means we have little information from which to inform our assumptions in the medium and long term. As such, they were kept as they were modelled.

Every year a number of people with a Norwegian background who have been living abroad migrate back to Norway. This group also includes persons born in Norway to two foreign-born parents. Assumptions about the future immigration of this group are based on registered immigration patterns over the past decade, but also account for an expected increase in the trend towards 2100. The trend is assumed to increase because, as emigrations occur, the stock of people with a Norwegian background (who could potentially return) will also increase. In this year's medium assumption, we except the immigration of 'non-immigrants' to increase linearly, from around 6 750 today to 8 300 in 2100. No COVID-19 *ad hoc* adjustments were made in the medium assumption, even in the short-term. The reasoning behind this is discussed in Section 7.1. Under the high assumption, the increase in immigration for 'non-immigrants' is projected to reach 9 900 in 2100, and in the low assumption it is projected to reach 6 600 in 2100. The high and low assumptions have, however, been spanned out from 2020, due to the pronounced uncertainties related to the COVID-19 pandemic, also in the shorter term.

Immigration from the three country groups (projected in three alternatives), as well as immigration by persons with a Norwegian background, is entered into the national projection model BEFINN.

Emigration

Emigration is calculated using emigration probabilities. These probabilities are based on observed emigration during the last ten years, and only one (medium) assumption is made, i.e. no low or high assumptions are made. However, an additional assumption (zero emigration) is made to produce the no migration (MM0) alternative.

The probability of emigrating is significantly higher for immigrants than for their children born in Norway. Persons who belong to the remaining general population have the lowest tendency to emigrate. For the three country groups, the probability of emigrating is greatest for persons with a background from Country Group 1 and

[10] When calculating the standard error of the forecast error at a specific horizon, we only pay attention to the errors in the econometric models and neglect the contribution from estimation uncertainty.

lowest for Country Group 3. Emigration is greatest in the first years after immigration to Norway, and it decreases as the duration of stay increases.

In the population projections, separate emigration probabilities are used for immigrants, Norwegian-born children to two immigrant parents and the remaining general population. The probabilities are calculated by sex, one-year age groups (0–69 years), country groups and durations of stay (for immigrants), with a few exceptions:

- For persons under the age of 15, the same probability of emigration is used for boys and girls
- For persons aged 55–69, the probabilities are calculated for five-year age groups for each sex

Five duration of stay groups are used:

- 0 years
- 1 year
- 2–4 years
- 5–9 years
- 10+ years

One group – immigrants from Country Group 2 with the longest duration of stay – consists of too few persons for the observed figures to be used to produce good emigration probabilities. An average of the emigration probabilities for persons with the longest duration of stay in Country Groups 1 and 3 is used instead. For persons who are 70 years old or more, the population projections do not assume any immigration or emigration.

Since high immigration one year will entail higher emigration in the ensuing years, the estimates of the number of emigrations are largely dependent on the figures for immigration. Separate high and low assumption alternatives for emigration are thus not currently produced.

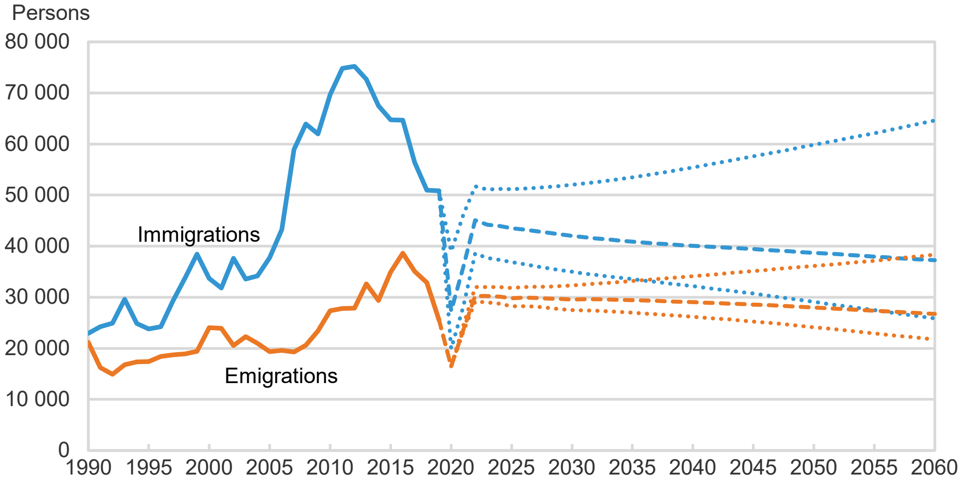
Due to the COVID-19 pandemic, emigration from Norway has been lowered by 50 percent for 2020 and 25 percent for 2021. The reductions were applied uniformly across all emigration groups, i.e. applied to all the emigration probabilities.

A summary of main assumptions

A more detailed account of this year's immigration and emigration assumptions is provided in Chapter 7. Figure 4.11 portrays a summary of the projected total immigration and emigration. In short, we assume a decline in the immigration to Norway from around 45 000 to 37 000 in 2060 in our medium assumption. Under the low assumption, we assume a more pronounced decline, to around 26 000 in 2060, whereas we assume an increase to around 65 000 over the same time period in our high assumption.

For emigration, we project a fairly stable emigration, albeit gradually declining, from around 30 000 yearly to around 27 000 per year in 2060, in our main alternative. In the low immigration alternative, we project a more pronounced decline in the emigration, to around 22 000 in 2060. In contrast, around 38 000 are projected to emigrate in 2060 in our high immigration alternative.

Figure 4.11 Immigrations and emigrations, registered 1990–2019 and projected 2020–2060 in three alternatives[1]



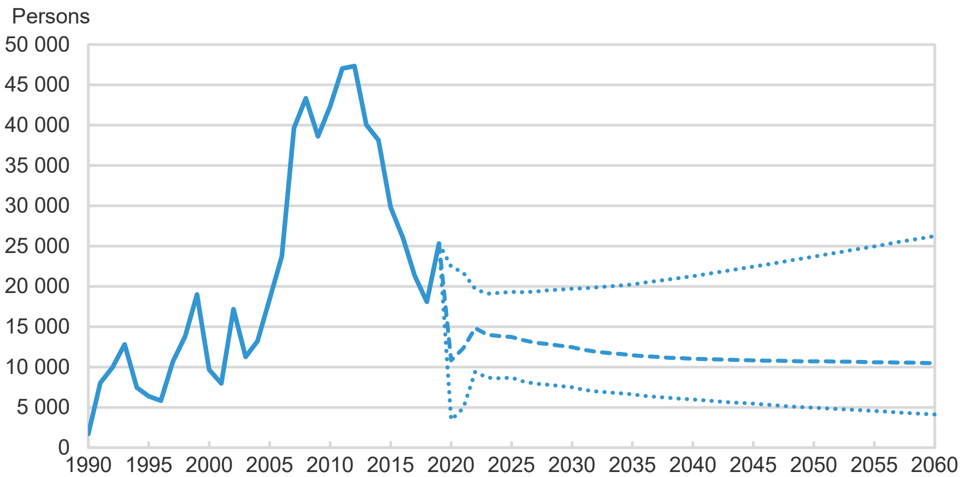
[1] Excludes persons who have both immigrated and emigrated during the same year. The three alternatives are MMM (main), MMH (high immigration) and MML (low immigration).
Source: Statistics Norway

Net migration

Net migration is calculated by deducting annual emigration from annual immigration.[11] Previously, that is until 2011, assumptions were made about future net migration, but this is now just the result of the assumptions about gross immigration and emigration. For the stochastic projections presented in Chapter 9, the projected net migration in the main alternative was delivered as input, by sex and one-year age groups.

Figure 4.12 shows the projected net migration in the main alternative, as well as in the low and high immigration alternatives. Net migration remains positive until 2060 in all these alternatives, although the magnitudes vary considerably. In the main alternative, we project a yearly net migration of around 15 000 from 2022 onwards, declining gradually to around 10 000 in 2060. In the low immigration alternative, we project a more pronounced relative decline, from around 9 000 to around 4 000. In the high immigration alternative, the net migration is projected to increase, from around 20 000 per year to around 26 000 in 2060.

Figure 4.12 Net migration, registered 1990–2019 and projected 2020–2060 in three alternatives[1]



[1] The three alternatives are MMM (main), MMH (high immigration) and MML (low immigration).
Source: Statistics Norway

[11] Net migration corresponds to the difference between the number of immigrations to and emigrations from the country during a period. It is net migration that constitutes the contribution of immigration and emigration to population change in Norway.

Distribution by age, sex etc.

The projections of immigration and emigration are also used to estimate the future number of immigrants and Norwegian-born children with two immigrant parents who will live in Norway. This is done in the national population projection model BEFINN. For this we need an additional assumption: Which proportion of the children born to immigrant women will have a father who is also an immigrant? This assumption is based on a projection of observed trends for each of the country groups (see Figure 4.4).

In BEFINN, the assumed number of immigrations from each of the three country groups is distributed by sex, one-year age groups (0–69 years) and one-year duration of stay groups (0–30 years). This distribution is based on the breakdown of immigration the last ten years: How has it differed by age, sex and duration of stay? Some may have lived in Norway before, and this is also accounted for. People with a Norwegian background who move back to Norway are distributed by sex, one-year age groups (0–69 years) and whether they are Norwegian-born to two immigrant parents or belong to the remaining general population (i.e. without an immigration background). If they are Norwegian-born to two immigrant parents, they are distributed by their mothers' country group of origin.

5. Fertility – Assumptions and results

Rebecca F. Gleditsch[12]

Fertility levels in Norway have decreased since 2009. The main fertility assumption in this year's population projection is a continued decline in fertility over the next couple of years, followed by an increase that will continue until it stabilizes after 2025 at around 1.7 children per woman. The low fertility assumption is set to 1.3 children per woman from 2020 forward, while the high fertility assumption is set to 1.9 children per woman from the mid-2030s onwards.

Assumptions about fertility are necessary to project the number of children born, the total population, as well as the age structure of the population. In our model, we use the total fertility rate (TFR, see explanation in Box 5.1) to make these assumptions. In 2009, the TFR in Norway was 1.98 – almost two children per woman – but it has persistently declined over the past decade. In 2019, TFR was 1.53, the lowest ever registered in Norway. As such, Norway has witnessed a decrease of almost half a child per women (0.45) over the last 10 years. The observed decline in fertility has two main causes: First, women are postponing having their first child and, second, fewer women are having three or more children. While there remains uncertainty over to the extent to which the postponed births may be 'recovered', we are more confident that the downward trend in third and higher order births will continue.

A primary aim of this chapter is to provide a detailed overview of how the fertility assumptions for this year's projections were formed. Currently, Statistics Norway does not use a formal statistical model for fertility (Gleditsch and Syse, 2020), but instead examines observed trends in the TFR over recent years, changes in age at first and higher order births (see Box 5.1), shifts in cohort fertility, as well as differences between immigrant and non-immigrant women in their fertility outcomes. We examine these trends for Norway, but also examine changing patterns in other European countries, especially the Nordic countries. After detailing the patterns and trends that inform our fertility assumptions, the latter half of the chapter provides a discussion of the consequences of these assumptions for future fertility in Norway, with particular emphasis placed on the developments until 2060.

[12] We thank the advisory reference group for fertility, which consisted of the following members: Kjersti N. Aase (Vestfold and Telemark county municipality), Espen Andersen (Statistics Norway), Janna Bergsvik (Statistics Norway), Lars Dommermuth (Statistics Norway), Rannveig Kaldager Hart (Norwegian Institute of Public Health), Øystein Kravdal (University of Oslo/Norwegian Institute of Public Health), Sturla Løkken (Statistics Norway), Johan Tollebrant (Statistics Sweden, demographics) and Marianne Tønnessen (NIBR, OsloMet). Members are listed in alphabetical order with institutional association in parentheses. We are especially grateful for their useful input in the formation of our assumptions.

Box 5.1. Age-specific fertility rates (ASFR), total fertility rate (TFR) and cohort fertility

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. The mid-year population is the average number of women of the age in question residing in the country in a given calendar year. Women are divided into one-year age groups from 15 to 49 years. Moreover, immigrant women are divided by country background and duration of stay in Norway.

The formula for age-specific fertility rates can be written as follows:
$ASFR\ (x,t) = f(x,t)/k(x,t)$

where $f(x,t)$ is the number of live births to women age x in year t, and $k(x,t)$ is the mid-year population of women age x in year t.

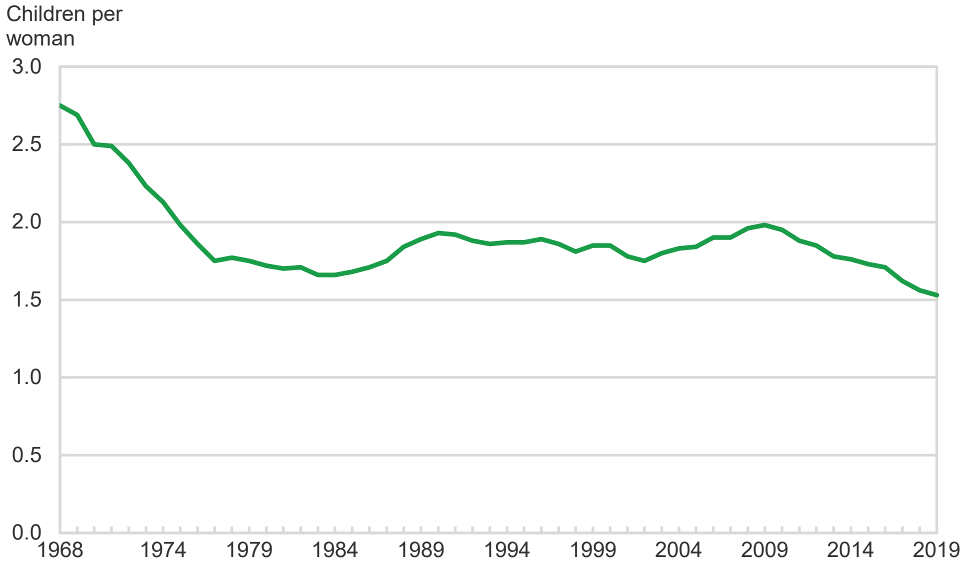
Total fertility rate (TFR) is the sum of the age-specific fertility rates for women aged 15–49 years in a given period, normally a calendar year. TFR can be interpreted as the average number of children each woman will give birth to, provided that the period-specific fertility pattern in the calendar year will persist and that no deaths occur before age 50.TFR is often also called period fertility, as it reflects the situation in a specific year or period.

In contrast to this, cohort fertility reflects the average number of births given by all women born in the same calendar year. Cohort fertility can only be calculated when women born in the same year have finished their fertile period. If we assume that women are finished having children when they are 45 years old, this means that by 2019 we can only calculate cohort fertility for women born in 1974 and earlier. Although a few women have children after age 45, it has a minor impact on the cohort fertility. Cohort fertility varies less over time than TFR (period fertility) as births can be postponed or recovered over the life course without having major consequences for the final number of children.

5.1. Fertility development in Norway

Since the beginning of the 1970s, TFR (period fertility) in Norway has ranged between 1.5 and 2.0 children per woman (Figure 5.1). In the 2000s, Norway experienced a steady increase in TFR from 1.75 in 2002 to 1.98 – almost two children per woman – in 2009. At that point in time, the fertility level in Norway was among the highest in Europe and we have to go all the way back to 1975 to find similarly high levels in the Norwegian context. However, in the years since 2009, a persistent decline in the TFR has been observed. The most recent registered data, covering 2019, suggests the TFR has now reached an all-time low in Norway, at 1.53 children per woman. This is equivalent to a decline of almost half a child per woman, in just 10 years.

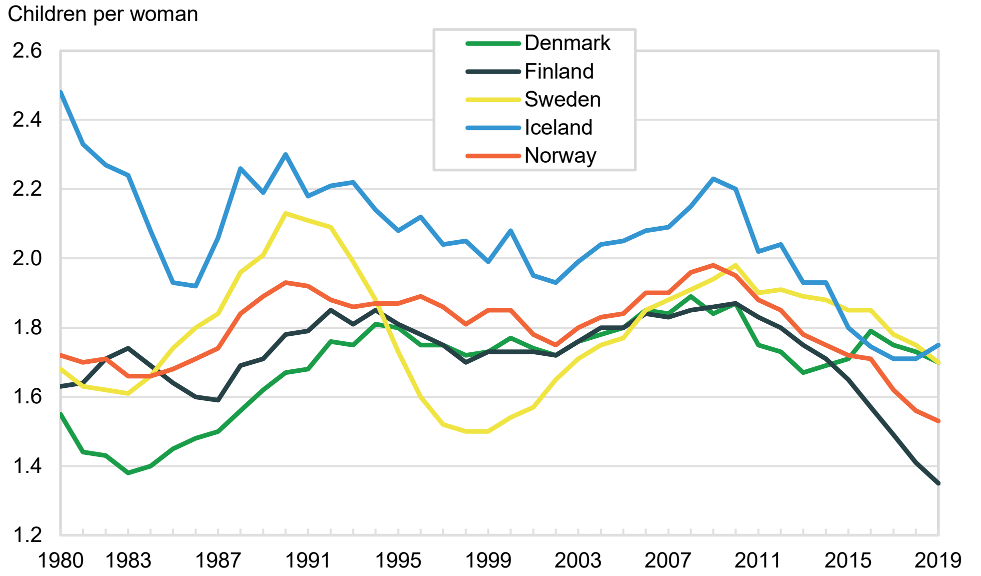
Figure 5.1 Total fertility rate, 1968-2019



Source: Statistics Norway

Declining fertility is not only a Norwegian phenomenon. As Figure 5.2 illustrates, most other Nordic countries have also seen a fall in fertility over the last ten years. The decrease has been greatest in Finland and Iceland, with fertility rates dropping by an equivalent of 0.51 and 0.48 children per woman, respectively. The decline in Finland was large enough to reach a record-low TFR of 1.35 in 2019. The TFR in Denmark and Sweden is somewhat higher, at 1.70 for both countries. The development in fertility has been more varied in the rest of Europe. In Germany, for instance, TFR was as low as 1.33 in 2006, but by 2018 it had risen to 1.57 (Population Reference Bureau 2019) – slightly higher than we currently experience in Norway. Yet, when compared to countries like Italy and Spain, fertility levels in Norway are still relatively high. More broadly, the TFR for the entire EU increased from 1.54 to 1.60 over the period 2006-2016, before declining again to 1.56 in 2018 (Eurostat 2020).

Figure 5.2 Total fertility rate in the Nordic countries, 1980-2019



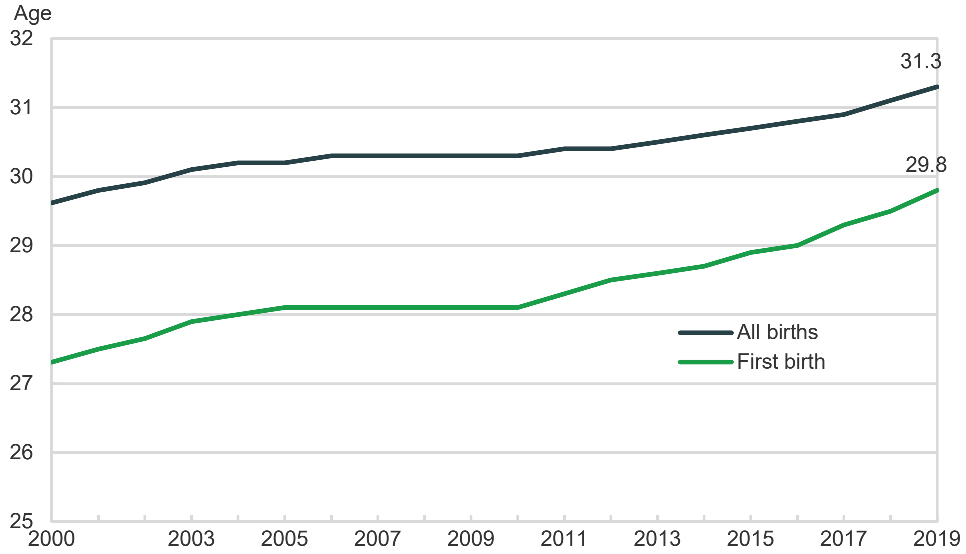
Source: Statistics Norway and the national statistical agency for each country

The impact of maternal age on fertility

TFR, which is a summarised measure of age-specific period fertility, is influenced by the ratio of the number of children born by women in the different fertile age groups (between 15-49 years), and the number of women in these age groups. Between 2018 and 2019, the total size of the female population aged 15-49 increased by almost 2 500 in Norway. When we break this down and focus more specifically on the age group with the highest levels of fertility, women aged 35-39 (as shown later in Figure 5.5), we see a growth in the population of almost 4 500. However, despite the increase in the number of women in fertile ages, there were approximately 600 fewer births in 2019 than in 2018, which resulted in a drop in the TFR.

Because TFR summarizes age-specific period fertility rates, it is highly sensitive to changes in birth timing. Observing a fall in TFR alongside an increase in the population of women in fertile ages could indicate a postponement of childbearing. In periods during which the TFR increases, the average age at birth tends to remain stable or increase only slowly, whereas at times when the TFR declines, the average age at birth tends to increase at a more rapid pace, indicating a postponement of births. Women's average age at birth increased to 31.3 in 2019, from 30.3 in the period 2006-2010 (see Figure 5.3). This is the highest mean age at birth ever registered in Norway. As shown in Figure 5.3, the most pronounced increase is observed for first births, where it has increased from 28.1 years in 2010 to 29.8 years in 2019. As a longer-term comparison, 30 years ago the average age of women at first birth was approximately 25.

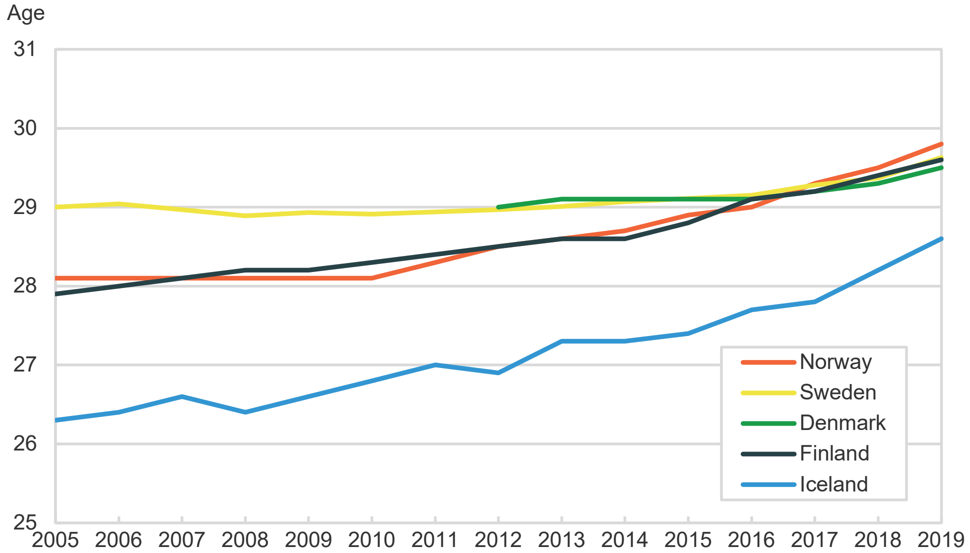
Figure 5.3 Mean age of women at first and all births, 2000-2019



Source: Statistics Norway

This trend towards higher mean age at first birth for women is also present in the other Nordic countries, though to varying degrees. Figure 5.4 shows maternal age at first birth in the Nordic countries from 2005-2019, although numbers for Denmark start in 2012. While Sweden and Denmark had the highest mean ages in the years 2005-2015, they have seen only modest increases in recent years. More rapid increases have been witnessed in Norway, Finland and Iceland. While Iceland started from a relatively young age at first birth, where the average age remains below 29 years, the upward trends in Norway and Finland mean these two countries now have the highest mean age at first birth. Indeed, the mean age at first birth in now above 29 for all countries in the Nordic region, except Iceland. If Iceland continues at its current rate, it too should reach an average age of 29 within a couple of years.

Figure 5.4 Mean age of women at first birth in the Nordic countries, 2005-2019

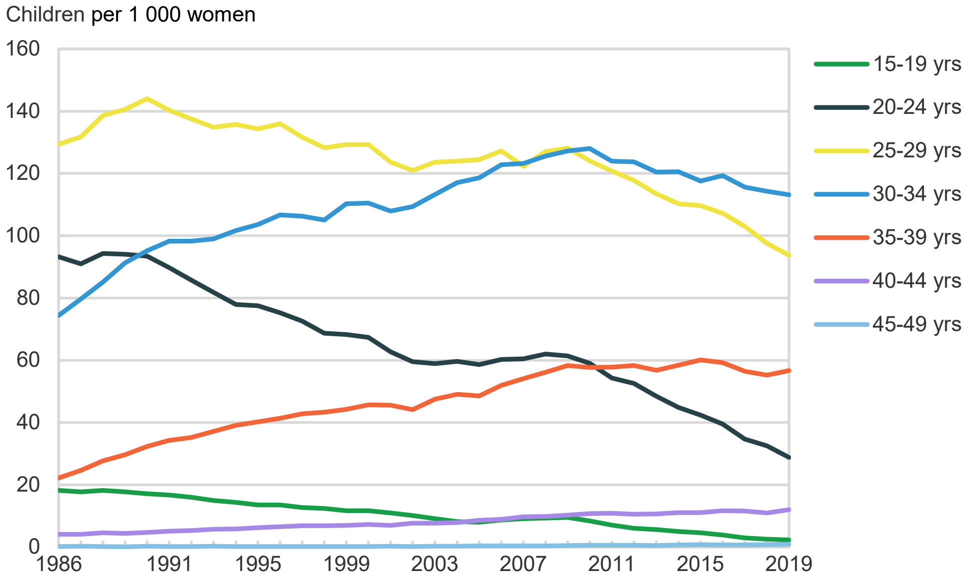


Source: Statistics Norway and the national statistical agency for each country

Age-specific fertility rates (ASFRs, see Box 5.1) provide a more detailed understanding of the change in the timing of births over recent years. This measure indicates how many children are born per 1 000 women in a given age group. As can be seen in Figure 5.5, over the past 20 years, fertility has decreased among women aged 15-29, but increased among women in older age groups. In more recent years, the rates for women aged 30-34 have also started to decline. These changing trends mean there has been a change in which age groups can be considered to matter the most for fertility in Norway. Indeed, while women aged 25-29 have been the most important group in terms of birth rates, from 2009 the highest birth propensities have been associated with women aged 30-34. Accompanying this has been a steady decrease in the contribution of women aged 20-24 years, with women aged 35-39 years having higher birth rates for the last decade.

Postponement of first birth and no significant increase in the age-specific rates for women aged 30 or over, suggests that there are few signs of a recovery in births yet. When an increasing number of women postpone having their first child and ASFRs decrease, TFR will also decrease. However, the decrease in TFR can also be a temporary trend, meaning that TFR can increase if postponed births are recovered at a later date.

Figure 5.5 Children per 1 000 women, by age group, 1986-2019

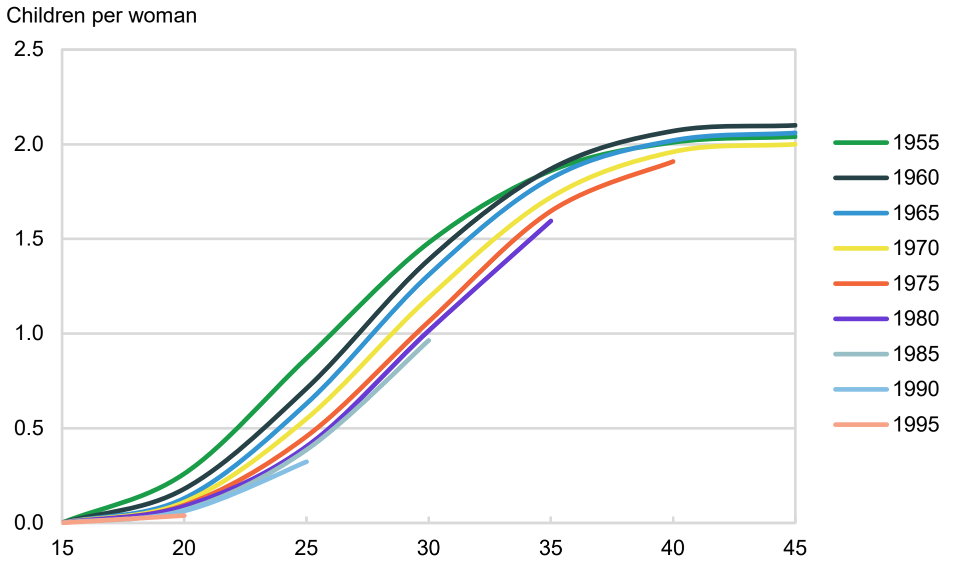


Source: Statistics Norway

Cohort fertility

When measuring period fertility (by TFR), there can be large fluctuations from year to year. Cohort fertility, meaning the average number of children born to a specific cohort of women, is a more stable measure of fertility. Completed cohort fertility can only be measured when the cohort of women has surpassed childbearing age. By age 45, most women in Norway are finished having children and completed cohort fertility is therefore often measured at this age. With that said, cohort fertility for non-completed cohorts can also be useful in providing some idea of the degree to which women are increasingly choosing to delay fertility. Figure 5.6 illustrates the average number of children born to selected cohorts of women (1955-1995). Although many of these cohorts have not yet finished their childbearing careers, the figure illustrates important differences between younger and older cohorts. Indeed, the average number of children is lower at each age for younger cohorts, as compared to older cohorts. The postponement of births seen in the younger cohorts, that have not yet reached 45 years of age, may still be recovered, but overall this suggests that the cohort fertility will be lower in the future.

Figure 5.6 Cohort fertility by age, selected cohorts, 1955-1995



Source: Statistics Norway

Table 5.1 provides more detailed information on cohort fertility at different ages. The general trend is for lower completed cohort fertility, and when we compare the fertility rates for ages under 45, achieved family size declines as we move down the table towards ever younger birth cohorts.[13] A pattern of postponement is also visible in Table 5.1. If we compare cohort fertility at age 20 for the 1940 and 1970 birth cohorts, we find that the 1940 birth cohort has an average number of children (0.24) that is more than two times higher than that of the 1970 birth cohort (0.11). However, as these two cohorts age, the difference between them declines, such that by age 45, the 1940 birth cohort has a completed cohort fertility of 2.35 while the 1970 birth cohort has a completed cohort fertility of 2.00. Despite this clear evidence of postponement, completed cohort fertility has steadily declined: Women born in 1974, who turned 45 in 2019, had on average 1.96 children, while those born in 1965, for instance, had on average 2.06 children.

Table 5.1 Cohort fertility at exact ages, selected cohorts, 1935-1995

Year of birth	20	25	30	35	40	45	Completed
1935	0.200	1.040	1.860	2.290	2.410	2.420	2.42
1940	0.240	1.140	1.920	2.260	2.340	2.350	2.35
1945	0.260	1.160	1.820	2.090	2.180	2.190	2.19
1950	0.280	1.060	1.650	1.950	2.060	2.080	2.08
1955	0.260	0.870	1.480	1.860	2.010	2.040	2.04
1960	0.180	0.710	1.390	1.870	2.070	2.100	2.10
1965	0.130	0.630	1.310	1.820	2.020	2.060	2.06
1970	0.110	0.550	1.190	1.720	1.960	2.000	2.00
1975	0.094	0.457	1.063	1.647	1.909		
1980	0.088	0.404	1.015	1.595			
1985	0.068	0.386	0.964				
1990	0.063	0.323					
1995	0.039						

Source: Statistics Norway

As is clear from Table 5.2, this fall in cohort fertility is, to a large extent, due to the decrease in women having three or more children and the slight increase in women having no children. Indeed, childlessness has increased from 9 percent among the 1945 birth cohort to almost 14 percent for the 1974 birth cohort. The two-child

[13] Some exceptions to this trend do occur, such as the relatively high fertility among the 1960 birth cohort age 35 and over, and the relatively low fertility among the 1935 birth cohort aged 20-35.

norm has been consistent since the 1945 birth cohort, with around 4 out of 10 women having two children for all cohorts born between 1945 and 1974.

Table 5.2 Parities in female birth cohorts (percentages) and completed cohort fertility, selected cohorts, 1935-1974

Cohort	0 children	1 child	2 children	3 children	4+ children	Total number of children (cohort fertility)
1935	9.6	10.4	30.4	27.4	22.2	2.42
1940	9.5	10.1	33.7	29.1	17.6	2.35
1945	9.0	11.8	41.5	26.4	11.3	2.19
1950	9.4	11.3	45.4	23.5	8.4	2.08
1955	11.2	14.3	42.1	24.2	8.1	2.04
1960	11.9	13.8	39.7	25.6	9.2	2.10
1965	12.5	14.2	40.2	24.7	8.4	2.06
1970	13.4	14.7	41.2	23.1	7.6	2.00
1971	13.3	14.9	41.8	22.7	7.3	1.99
1972	13.4	15.0	42.1	22.2	7.4	1.98
1973	13.3	15.4	42.0	22.2	7.2	1.98
1974	13.8	15.4	41.8	22.0	7.0	1.96

Source: Statistics Norway

Childlessness

The gradual trend towards increasing childlessness among women has been evident for many years, and comparing the two most recent completed cohorts, it remains that way today. Indeed, childlessness was 0.5 percentage points higher for the 1974 cohort (13.8 percent) as compared to the 1973 cohort (13.3 percent). This pattern is not restricted to Norway, with childlessness among men and women aged 45 having risen over recent decades among all the Nordic countries, though to varying degrees. Finland has witnessed a relatively rapid rise, while in recent years the trends in Sweden have started to decline again (Andersson 2009, Jalovaara et al. 2019, Hellstrand et al. 2020). If we compare childlessness among women who have only recently completed their fertile ages, 13.5 percent of Swedish women born in 1973 did not have children (Statistics Sweden 2020), a similar number as Norway (13.3 percent). In Denmark, this was slightly lower at approximately 12 percent among women aged 50 in 2018 (Statistics Denmark 2018). In Finland, the proportion is considerably higher with almost 19 percent of Finish women born in 1973 remaining childless (Statistics Finland 2020). As such, Finland has among the highest levels of childlessness for cohorts who have completed their fertile years (Kreyenfeld and Konietzka 2017).

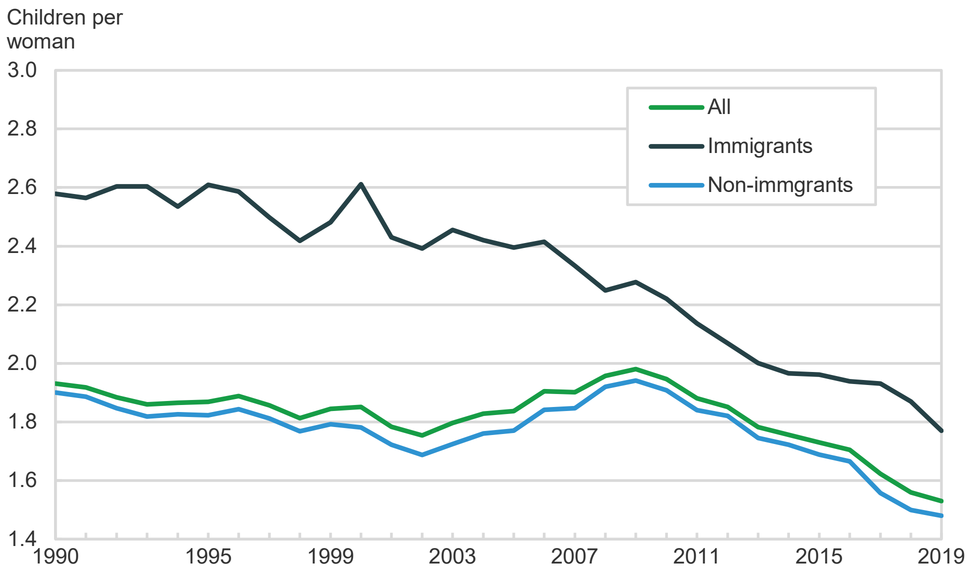
Historically, the proportion of childless women in Norway has fluctuated, though as noted above there has been a gradual increase from 9 percent among women born in 1945 to almost 14 percent in 2019 among women born in 1974. To get an idea about future childlessness, it can be useful to examine changes in patterns among women who have not yet completed their fertile years. Indeed, the share of childless women by age 35 in Norway has seen a gradual increase from less than 20 percent among women born in 1970, to 24 percent among women born in 1982. Although a reasonably large share of women aged 35 may want to have children in the future, it is still likely that the share of childless women will increase as births are postponed to such an extent that fecundity (i.e. the ability to conceive and carry a child to term) might be negatively affected. However, it has been suggested that it should be possible to allow non-partnered individuals access to IVF and that donation of eggs should become legal (Norwegian Biotechnology Advisory Board 2020). However, this is currently under debate. If the Norwegian law in this area is changed, it will become increasingly similar to that of Denmark, where childlessness is lower (12 percent). The overall impact of these changes on TFR is nevertheless likely to be minor, as currently only around 3-4 percent of children are born using IVF (Norwegian Biotechnology Advisory Board 2019). However, for involuntary childless women and couples, this might still be important.

The impact of immigration on fertility

Despite a decrease in fertility levels among immigrant women over the past years, their levels of fertility remain higher than those of the rest of the population (see Figure 5.7). However, the impact of immigrants childbearing behaviour on the overall level of TFR in Norway is minor and has been stable for many years. The TFR for non-immigrant women in 2019 was 1.48 and thus, by comparing to the TFR for the entire population (1.53), the impact from the immigrant women on the overall TFR was just 0.05 children per woman. Since 1990, the impact of immigrants on fertility has ranged between 0.03 and 0.07. Thus, neither the increase in TFR at the beginning of the 21th century, nor the decrease seen in the years after 2009, may be attributed to changes in fertility among immigrant women. However, since 2009, the decrease in fertility has been more pronounced among immigrant women than among non-immigrant women. The decrease corresponds to around 0.51 children (22,8 percent) among immigrant women and 0.46 children (22,3 percent) among non-immigrant women.

Since there are many immigrant women in Norway in prime childbearing ages, immigrant women do contribute significantly to the total number of births. In 2019, around 28 percent of all new-borns had an immigrant mother. Thus, although the impact on the level of the TFR is minor, immigrant women's contribution to births and population growth is substantial.

Figure 5.7 Total fertility rate by immigrant background, 1990-2019



Source: Statistics Norway

In the population projections, immigrant women are grouped into three groups according to their country group of origin (see Box 5.2). Figure 5.8 illustrates the development in TFR among immigrant women from the different country groups. In the years 1990-2019 there were marked differences in the development of fertility according to these groups. Immigrant women from Country Group 1 (Western Europe, the US, Canada, Australia and New Zealand) had a relatively stable fertility level of approximately two children, though a fall has been witnessed since 2009. The fluctuations in the fertility levels among women from Country Group 2 (Eastern EU member countries) were comparatively large, with an average of about 1.8 children per woman, but with annual values fluctuating between a TFR of 1.4 and 2.4 over the 19-year period. The fertility trends among immigrant women from this group appear to be closely linked to EU accession, wherein the rates were in relatively sharp decline prior to most countries joining the EU in 2004, before TFR then sharply increased, peaking at around 2.1 children per woman in 2009. Since 2009, the TFR for immigrant women from Country Group 2 has again started on a downward trend. Immigrant women from Country Group 3 have seen a persistent decline in TFR throughout the period, though they did start from a relatively high TFR of 3.0 in 1990. From previous analyses we know that fertility declines with duration of stay in a country (Andersen 2019, Tønnessen 2019, Tønnessen and Mussino 2019). In Norway, this is particularly the case for immigrants from Country Group 3, where an increasing proportion of women from this country group have experienced longer duration of stays, and for whom fertility rates have indeed been found to be lower. Yet, the fertility level among newly arrived immigrant women from Country Group 3 is also lower today as compared to what it was in previous years (Andersen 2019).

Box 5.2. Country groups

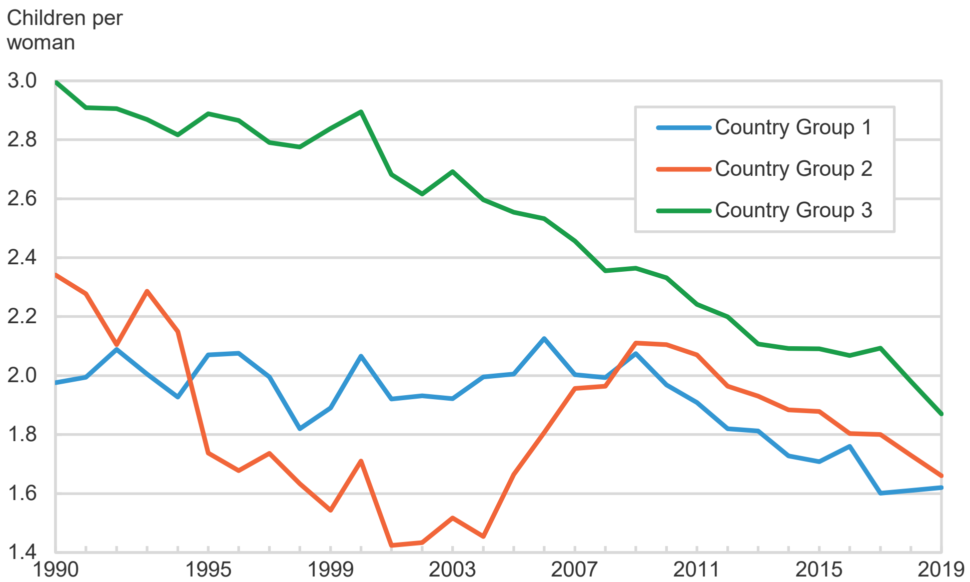
In the population projections, immigrants are grouped by country background (country of birth), in three country groups (see Appendix A for a detailed list):

Country Group 1: Western Europe, the US, Canada, Australia and New Zealand.

Country Group 2: Eastern EU member countries (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

Country Group 3: The rest of the world, e.g., the rest of Eastern Europe, Africa, Asia (including Turkey), South and Central America and Oceania (excluding Australia and New Zealand).

Figure 5.8 Total fertility rate of immigrant women by country group, 1990-2019



Source: Statistics Norway

5.2. Assumptions of future fertility patterns in Norway

The following section will provide a more detailed discussion surrounding the reasoning behind this year's assumptions when determining future fertility development for the national population projections. We have seen a significant decline in period fertility, especially since 2009. Fertility has declined among both immigrant and non-immigrant women, and among almost all ages. The question is, if this downward trend will continue, or if fertility levels will stabilize or increase again. We make an assessment of this utilizing the widely used framework made by Easterlin and Crimmins (1985) who distinguished between changes in supply, regulation costs and demand. Supply refers to the ability to conceive and carry a baby to term. This means that one is sexually active and physically able to have children. Regulation costs refer to access to, and acceptance of, the use of contraceptives and abortion. Demand refers to the desire for having children. This can in turn be influenced by purchasing power, expected costs of having children (both direct costs such as food and clothing, and indirect costs such as loss of income if one parent stays home to care for children), preferences of having children compared to spending time on money or on other things, as well as norms related to the ideal number of children. Below is a brief discussion of potential changes in supply, regulation costs and demand over the past years. A more detailed and nuanced overview of the Norwegian fertility development in a theoretical perspective is provided by Kravdal (2016).

Supply

As the biological ability to have children decreases with increasing age, the supply decreases with age. Thus, the postponement of childbirths can result in an increasing proportion of women being unable to biologically have the children they want at the time in their life when they wish to have them. At the same time, it is important to note that we do not know whether Norwegian women begin family formation at a later age because they want to have fewer children than in the past. However, modern medical treatment makes it possible to assist women who have postponed having children. New figures show that 3-4 percent of Norwegian children are born with the help of assisted reproductive technology each year (Norwegian Biotechnology Advisory Board 2019). This is twice as many as 20 years ago. Although this assistance is very important for the families who utilize it, the contribution to the overall number of children born in Norway is small. There are currently discussions as to whether laws surrounding provision of assistance should be expanded and, if implemented, the law will allow single women the use of assisted reproductive technology. Furthermore, the law is opening for allowing also the donation of eggs, which currently is illegal in Norway (Norwegian Biotechnology Advisory Board 2020). The overall impact on TFR is nevertheless likely to be minor, as only around 3-4 percent of children are born as a result of IVF, as stated above. Overall, we therefore expect few changes to the supply side in the future.

Regulation costs

Regulation costs indicate access to and acceptance of the use of contraceptives, emergency contraception and abortion. The first two are far more widespread in Norway than the latter. Over the past 15 years, the abortion rate has been declining and in 2019 Norway had a record low number with less than 10 abortions per 1 000 women (NIPH 2020b). The numbers are declining for all age groups. At the same time as abortion rates are declining, sales of emergency contraception (morning after pill) have also declined. This might indicate that the number of women who experience unwanted pregnancies is declining as well. This might be a consequence of the widespread access to and use of a variety of contraceptives. The use of contraceptive birth control has increased for all age groups throughout the period. The decline in the number of aborted pregnancies is primarily due to fewer abortions among women 25 years and younger, one of the main reasons being improved use of birth control among younger cohorts compared to older cohorts (NIPH 2020b). To the extent that unwanted or unplanned pregnancies contribute to Norwegian fertility, this contribution may have decreased somewhat over time. In summary, regulation costs have been stable and possibly declining, which we believe will be a future trend as well. Thus, it is considered unlikely that changes in regulation costs will impact markedly on future fertility.

Demand

The demand for children is influenced by purchasing power, direct and indirect costs of raising children, preferences and norms. Explanations of demand are linked to income and direct and indirect costs (Becker 1991). Higher (hourly) wages make it easier to cover the direct costs of having children. At the same time, men and women who earn more have more to lose if they choose to reduce their work hours to care for children. This could mean that (especially) women who work more are more likely to choose to have fewer children or remain childless. Welfare schemes can reduce both the indirect and direct costs of raising children. Norway provides a large array of general welfare schemes supporting families, including subsidized public day-care and paid parental leave. Paid parental leave is directly linked to previous labour market participation.

According to Kravdal (2002), fertility levels in Norway have historically been little affected by the purchasing power of individuals. At the same time, we know that income is linked to a higher probability of having children in Norway (as in the rest of the Nordic countries), and that this relationship has become somewhat stronger in recent years (Hart 2015, Hart et al. 2015). Dommermuth and Lappegård (2017) draw similar conclusions, when analysing the impact of individual employment on first births. They compare the period prior to the financial crisis, when TFR increased (2000-2009), with the years after the crisis, when TFR went down (2010-2015). Overall, they find a positive association between being employed and having a certain experience in the labour market (length of employment) and first births. This positive association is even stronger after 2009. In addition, the negative impact of local unemployment rates on first births increased. Taken together, these findings indicate that the transition to first birth is particularly sensitive to individual economic insecurity and more general economic uncertainty.

Changes in family or welfare policies may also led to a change in fertility. Since the beginning of the 21th century a couple of notable extensions to family policy have emerged in Norway. For instance, subsidised day-care, which has been linked to the relatively high fertility rate in Norway (Rindfuss et al. 2010), was greatly improved after a political settlement in 2003 resulted in increased availability and lower parental payments. Meanwhile, the already extensive paternity quotas have also seen a number of small adjustments, such that there has been an overall increase of 7 weeks over the past 25 years, with coverage now ranging between 49 and 59 weeks. Today, the overall leave is divided into three, 15 weeks for each parent with the remaining weeks able to be shared as the parents choose. However, outside of these notable extensions, there have been relatively minor changes in the family policy area over the last 15 years (Syse 2020).

The improvements in family policies certainly does not fit with the considerable decline observed in the TFR in recent years. It can be assumed that welfare schemes that facilitate the combination of work and family will remain at least at the current level in the future, and there may be room for expansions of the policies if fertility continues to decline. The question remains however, whether any future policies will actually increase fertility in Norway. A systematic literature review by Bergsvik et al. (2020) found that improvements in day-care (availability and prices) increases fertility. However, in Norway children already have a right to day-care at a subsidized price and the day-care coverage is already comparatively high (Hart and Kravdal 2020). Thus, the impact of implementing further expansion and price reductions to the day-care sector is uncertain, although respondents of a recent survey in Norway state that free day-care and even longer parental leave would encourage them to have more children (Hart and Kravdal 2020).

Impact of COVID-19 on fertility development in Norway

The 2020 national population projections were produced during the onset of the COVID-19 pandemic. As such, there is particularly high uncertainty pertaining to our assumptions about how the population will develop in the years to come. In terms of fertility development, speculations have been made about whether the associated 'lockdown' might lead to a baby boom. However, we view this as an unlikely scenario in Norway, as research indicates that a health crisis such as COVID-19, especially when coupled with increased mortality rates, tends to reduce fertility levels, as least in the short-term (Mamelund 2004). A comparative analysis of different health crises and other disruptive shocks show a decline in birth rates nine months after such an event (Richmond and Roehner 2018). As mentioned in the sections on supply, regulation costs and demand, the financial and employment situation currently seen might also be a contributing factor to a potential decline in fertility on a short-term basis (Sobotka et al. 2011, Yuhas 2020).

The COVID-19 pandemic has placed an abrupt break on the Norwegian economy and estimates indicate that the financial repercussions are likely to continue for several years (Statistics Norway 2020a). This is a stark contrast to the reports from the end of 2019, in which the assumption was for the Norwegian economy to remain stable for the years to come, with increasing wages and a decline in unemployment (Statistics Norway 2019). As a result of the current situation, oil prices have fallen significantly, and investments have slowed. Figures from the Norwegian Labor and Welfare Administration (NAV 2020b) show that the number of registered unemployment increased from approximately 65 000 to more than 400 000 between the beginning of March and May. If being a full-time employee and having job security is important for women who are planning on having children in the future, this recent development could conceivably impact fertility development in Norway in the coming years. As of now, the economic situation in Norway is greatly impacted by COVID-19 and it is uncertain as to how long this impact will last. However, the Norwegian economy is likely to recover faster than the economies of many other countries as a result of 'Norway's greater scope for manoeuvrability in fiscal and monetary policy and the depreciation of the krone against most currencies' (Statistics Norway 2020a).

Beside this, Norway has implemented several restrictions in the provision of fertility treatments during COVID-19, with cancelled treatments and reduced capacity. Thus, despite Norway currently having the lowest fertility levels ever registered, and while the impact of the current pandemic on fertility is unknown, we view it as more likely to have a negative impact than a positive one. This has been accounted for in the-short term development in the medium fertility alternative, and potential long-term impacts have been accounted for in our low fertility assumptions alternative (see box 5.3 for more information about calculation of fertility in the population projections). The low fertility assumption has been reduced to a considerably lower level in this year's projection as compared to earlier projections, both in the short- and longer-term. Although it is unknown how long the current crisis will last, we have assumed that the fertility levels will stay fairly low until approximately 2025.

Box 5.3. Calculation of fertility in the population projections

In the model that projects the population at the national level (BEFINN), we project fertility for different groups of women. We project the fertility for non-immigrant women, but also account for fertility differences between immigrant women in 15 combinations of country background and duration of stay in Norway. First, we find the starting level for the different groups, then we make assumptions about how we think fertility will develop in the future. The assumptions are primarily made based on considerations of the development in fertility for the non-immigrant women.

Fertility among non-immigrant women
First, we calculate the fertility of non-immigrant women. Norwegian-born with one or two immigrant parents are also included in this group. In order to determine the starting level of fertility among non-immigrant women, ASFRs for only the last year are calculated.

The fertility of immigrants
Second, we project the fertility of immigrant women. They are divided into three country groups (see Box 5.2) and five groups based on duration of stay (1 year or less, 2-3 years, 4-6 years, 7-11 years and 12 years or more). In total, this amounts to 15 combinations of country group and duration of stay. To find the baseline fertility level in the 15 different groups, age-specific fertility rates (ASFRs) for each group are calculated as an average of the last ten years. This is a weighted average where last year with available data counts the most. We also make assumptions about the proportion of immigrant women who will have children with men who are immigrants – to be able to calculate the number of Norwegian-born with two immigrant parents. These assumptions usually amount to a continuation of the current situation and are described in more detail in Section 4.1.

Fertility assumptions
Once we have calculated the baseline level of fertility in the 16 groups (i.e. non-immigrant women and 15 groups of immigrant women), we must make assumptions about how fertility will develop in the future. For each year of the projection period, we use a factor that adjusts the age-specific fertility rates up or down based on how we assume fertility will develop in the future. The annual factor is made in the three alternatives: low, medium and high and is applied to all the ASFRs in the given year. As such, we do not account for changing age schedules. The factors are set by Statistics Norway after discussions with an advisory reference group consisting of fertility researchers.[1]

When determining the factor, the factor is based on the fertility among the non-immigrant women, i.e. Norwegian-born women. For example, we can envisage the total fertility rate being 1.70 in 2040 – i.e. 15 percent higher than in 2019, when these women gave birth to 1.48 children on average. The factor will then upwardly adjust the age-specific fertility rates for all groups of women, so that they are 15 percent higher in the year 2040 than in 2019. Since the same factor is applied to all groups for a specific year, this means that if women from Country Group 3 with a 4-6 years duration of stay had a TFR of 2.43 in 2019, the projected TFR of that group would be 2.79 in 2040, also corresponding to a 15 percent increase.

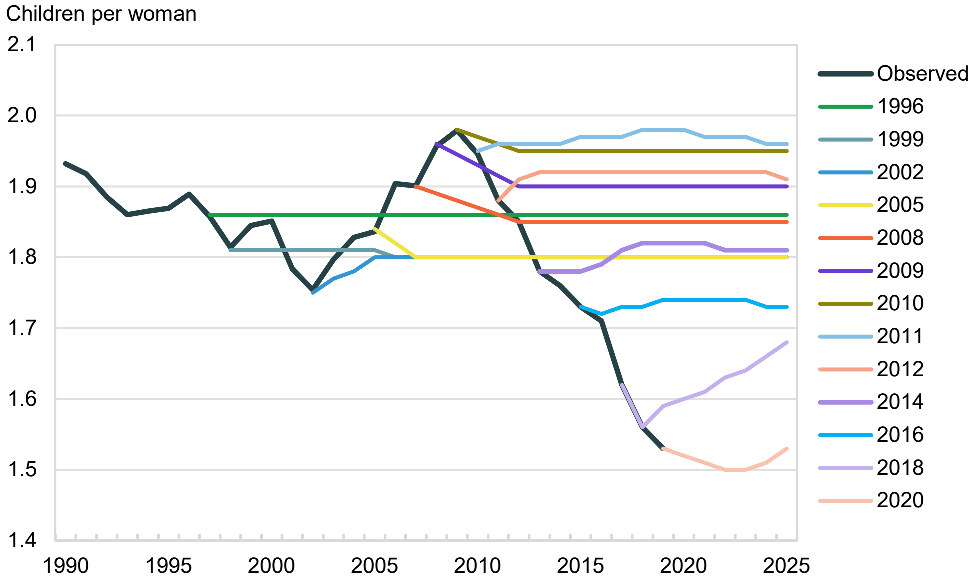
Since the same factor is used for all women, one could assume that differences in fertility between the three country groups and the non-immigrant women would remain constant throughout the projection period. However, they do not. This is because the immigrant women's fertility varies with duration of stay, and the number of immigrant women varies over time. During the projection period, duration of stay will change several times for most immigrant women, thus, the composition of the 15 groups of immigrant women changes. This has consequences for how many women are at risk of having children in each group – and thus how the fertility of immigrant women in total will develop. For example, if we assume that the TFR among non-immigrant women will be constant until the year 2100, the TFR among all women – including both immigrant and non-immigrant women – will not necessarily be constant. This is because the total number and the distribution across country groups and duration of stay among immigrant women will change over time.

[1]For the 2020 population projections, the reference group consisted of the following members: Kjersti N. Aase (Vestfold and Telemark county municipality), Espen Andersen (Statistics Norway, population statistics), Janna Bergsvik (Statistics Norway, social and demographic research), Lars Dommermuth (Statistics Norway, social and demographic research), Rannveig Kaldager Hart (Norwegian Institute of Public Health), Øystein Kravdal (University of Oslo/ Norwegian Institute of Public Health), Sturla Løkken (Statistics Norway, public economy and population models), Johan Tollebrant (Statistics Sweden, demographics) and Marianne Tønnessen (NIBR, OsloMet). Members are listed in alphabetical order with institutional association in parentheses. We are especially grateful for their useful input in the formation of our assumptions.

The accuracy of past fertility projections

Since 2009, the total fertility rate in Norway has decreased from 1.98 to 1.53. The degree to which past projections have accurately portrayed realised fertility is clear from Figure 5.9. Indeed, it appears that there has been a strong tendency to project fertility at similar levels as the levels observed the year prior to the production of the fertility projections. Thus, past main alternatives have projected a too low fertility during periods with high and/or increasing fertility, while the projected fertility during years with lower and/or declining fertility has been too high. This year's projection continues the decreasing trend seen in the years since 2009, before we expect a recovery from around 2025 forward.

Figure 5.9 Registered and projected overall total fertility rate, 1990-2025, main alternatives



Source: Statistics Norway

Box 5.4. Changes from last projection

In the main alternative for the 2018-projections, the long-term fertility level was set at approximately 1.77 children per woman. The long-term level was based on the assumption that women's preference of having more than two children has changed over the past years and is less likely than for previous cohorts. For the short-term levels, the assumption was that there would be a rather sharp increase in fertility after an initial (modest) decline. Over the past two years, the fertility level in Norway has had a sharper decline than projected in 2018, which consequently led to an over-estimation of the number of births in the past two years. For 2018, there was a deviation of approximately 1 000 children, while 2019 saw a deviation of approximately 2 000 children. For both years, the deviation was within the high and low fertility alternatives.

As fertility is the only component for which we do not employ a model in our assumption work, we have undertaken a survey to explore potential models for possible future projections rounds (Gleditsch & Syse 2020). This research shows that the majority of European countries rely on a formal statistical model in their assumption work. However, at the same time around half rely on expert opinion or a mix of expert opinion and formal statistical models. We plan to examine the potential for whether a model-based approach might yield benefits for future projections rounds at Statistics Norway.

For this year's projections, our medium assumption project a continued decline in fertility over the next five years, before a gradual increase begins. We assume that it will be slightly lower than in the last projection in the long-term, ending up at approximately 1.74 children per woman. This is around 0.03 less than in the 2018 projections. Compared to the main alternative in the last projections, this year projects approximately 2 800 fewer children in 2020 and 9 200 fewer children in 2060. For more information on changes from the 2018 projection to the 2020 projection, see Chapter 1. Figure 5.16 compares the overall projected TFR from the 2018 and the 2020 projection in the main, high and low fertility alternatives.

Fertility assumptions

Future fertility development in Norway is expected to primarily be driven by changes in factors on the demand side, as we do not expect changes in supply and regulation costs in Norway that are likely to markedly influence fertility in the years to come. Summaries of research on effects of policy changes have furthermore shown that it is generally more effective policies directed to reduce high fertility, in contrast to policies directed at increasing fertility in low-fertility settings (Hellstrand et al. 2020). Norway is likely to continue to have generous work-family policies and the preference for having two children is still strong and is expected to remain so at least among the majority of families (see e.g. Cools and Strøm 2020). Taken together, this indicates that future fertility levels in Norway will rise from today's historically low level. However, fertility levels can continue to decline if men and women want to spend less time raising children. This might be because an increasing number of women want to participate in the paid labour force, and pursue careers, to a larger extent than in the past. Indeed, in 2019, 43.5 percent of women age 19-24 were currently enrolled in higher education, this compares to 37 percent of women aged 19-24 in 2009 (Statistics Norway 2020b). Beyond this, the increased unemployment resulting from the COVID-19 pandemic might also be expected to contribute to the postponement of births, especially first births, both as an immediate consequence of the health crisis (Mamelund 2004, Richmond and Roehner 2018), but also in the longer term if economic uncertainty and unemployment persists in the aftermath of the current pandemic (Dommermuth and Lappegård 2017).

The combination of potential changes in preferences (such as fewer women opting to have three or more children and a slight increase in childlessness), a tendency to postpone childbirths among the younger cohorts, as well as the unstable labour market due to COVID-19, seems to indicate a continued decrease in fertility in the short-term, and as such this is what we have assumed for this year's fertility projection.

To illustrate the uncertain nature associated with population projections, we create fertility assumptions in three different alternatives: Low, medium and high. Although it is unlikely that fertility levels will remain at a set level throughout the projected period, the span between the low and high alternatives illustrates the potential degree of uncertainty surrounding the fertility projections and that the results are largely dependent on the assumptions used to project future fertility.

Fertility in the short-term

In the short-term, fertility assumptions are informed by expert opinions about how future TFR will develop in Norway. These opinions are informed by research of historical trends, previous empirical studies on changes in fertility determinants and international comparisons. This includes a recognition that TFR is affected by changes in the age pattern of fertility. The decrease in TFR seen in the years after 2009 has coincided with an increase in maternal age, especially in the maternal age at first birth. When examining patterns of fertility decline, there has been a sharper decline in fertility among female students (often younger women). The combination of participating in higher education and lower fertility among female students is likely to contribute to the postponement of fertility over the life course in the future. So far, females who gain higher education have 'recovered' almost all of the postponement in fertility related to educational attainment. However, we assume that this might become more challenging in the future as the average age for first birth is increasing, as shown in Figure 5.3. With increasing age at first birth, the likelihood for a complete recovery of previous fertility rates declines. This suggest that fertility will not increase, but either remain stable or decrease even further in the future. Next, labour participation among women seems to be especially important for the timing of first births. Thus, longer periods of unemployment, which may increase in the near future due to the COVID-19 pandemic, might decrease fertility in the short run. The likelihood of a further decrease in TFR is perhaps also suggested by the number of births in the first quarter of 2020 (13 036), which is almost 400 below that of the first quarter in 2019 (13 407), corresponding to a three percent decrease.

On the other hand, it is likely that the increase in maternal age observed in the past decade will slow down. As a consequence, TFR would increase again. However, the current trends in both period fertility (TFR) and cohort fertility, in combination with an unstable labour market due to the COVID-19 pandemic, makes it likely that fertility among Norwegian women will continue to decrease in the next couple of years. As such, this is our medium assumption, whereas we allow for a faster recovery in fertility in our high assumption and a continued decline in our low assumption.

Fertility in the long-term

Cohort fertility is a more stable measure of fertility than TFR. By age 45, when most women in Norway have completed their childbearing years, cohort fertility has gradually declined from 2.42 children per woman for the cohort born in 1935, to 1.96 children per woman for the cohort born in 1974. The changes seen in cohort fertility over the past decades are, to a large extent, due to the decrease in women having three or more children and the slight increase in women having no children. At the same time, the norm of having two children continues to be strong in Norway (Figure 5.8) and research indicates that this is one of the reasons for why fertility continues to be relatively high. Although we see changes in age-specific fertility rates, the decrease in fertility continues to be more pronounced among women aged under 30 and among women with three or more children. Whether this indicates that younger women prefer fewer children or only reflects a postponement of childbirths, i.e. that they have children at a later stage in life, is yet to be seen. The decrease in women who have three or more children might indicate a decrease in the levels of fertility in the years to come.

Although we assume a continued decrease in short-term fertility, our medium alternative assumes a recovery in fertility within the next 5 years. Although trends in cohort fertility indicate that it is unlikely that women in Norway will reach levels of more than two children per woman, as seen in the past, we assume that the fertility will increase at a slow rate before stabilizing at a higher level than we see today. When period fertility remains stable over most of a woman's fertile life, period fertility and cohort fertility will be quite similar. In our main assumption, we propose that the future cohort fertility will be around 1.74. This figure is clearly higher than today's period fertility of 1.53, but at the same time clearly lower than the current cohort fertility of 1.96. This assumption is both due to the changes seen in fertility over the past decade resulting from the steep increase in maternal age, as well as the potential for women to 'recover' the births they had to that point postponed.

5.3. Consequences of the assumptions for future fertility

In this section we will summarize the consequences of this year's assumptions for the future level of fertility, total number of births and the population. Figure 5.10 gives an overview of registered TFR for all resident women for the years 1990-2019 and projected TFR up until the year 2060 in the medium alternative (MMM) as well as the low (LMM) and high (HMM)[14] fertility alternative. As mentioned in Box 5.3, the same percentage of change in fertility is used for all 16 groups of

[14] Each alternative is described using three letters in the following order: fertility, life expectancy and immigration. M = medium, L = low, H = high.

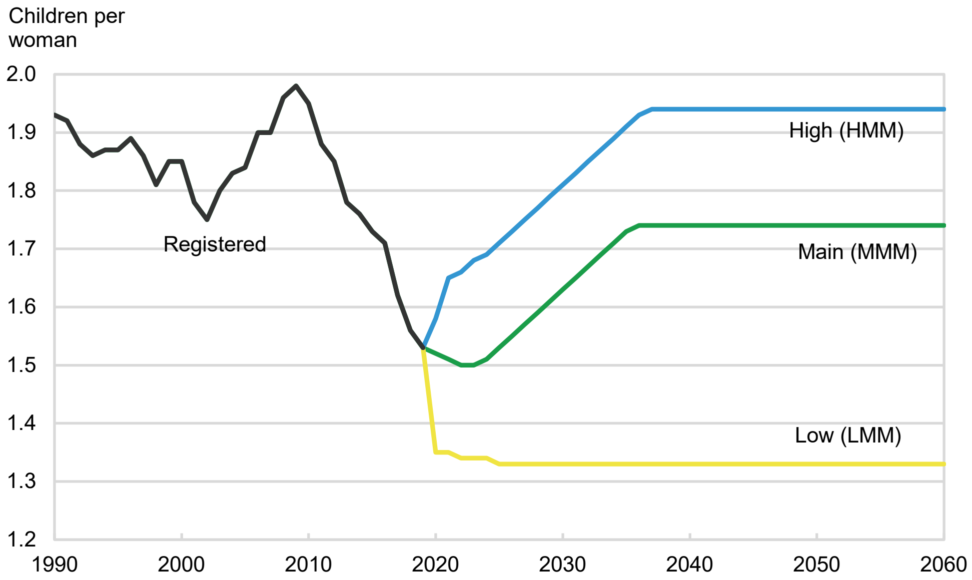
women (non-immigrant women and immigrant women in 15 combinations of duration of stay and country group). However, the difference in TFR between all women and non-immigrant women will not be constant, as fertility among all women depends on the size and composition of the groups of immigrant women by country group of origin and duration of stay. This changes to some extent during the projection period and depends on the assumptions of the future immigration (see Chapter 7 for details on immigration assumptions).

For the medium alterative, we assume that the TFR for non-immigrant women will decrease over the next couple of years to approximately 1.45 children per woman. For all women, this results in a TFR of approximately 1.50. After the initial decrease, we assume that the fertility levels will slowly increase to approximately 1.60 for all resident women by 2030 and continue to increase until reaching 1.74 in 2036 and remaining constant at approximately 1.73-1.74 children per woman on average. For non-immigrant women, this corresponds to a constant level from 2036 at approximately 1.70 children per woman. This is significantly lower compared to the cohorts of women who have finished their childbearing years, but we believe that postponed childbirths and changing preferences will contribute to this development.

A high assumption of a TFR of 1.90 for non-immigrant women corresponds to a TFR of 1.94 for all women in the long-term (to 2060). This is quite similar to the level seen in Norway in 2009 (TFR: 1.98). This corresponds to a change of 27 percent, as compared to today's level. The combination of the current pandemic, the continued postponement of childbirth, the slight decline in cohort fertility, as well as fewer women having three or more children, makes it less likely to see numbers approaching two children per woman. However, there is great uncertainty with the continuation of such trends, and the high alternative is thus set at this high level. Demographers have observed a strong recovery of fertility after a crisis, as was seen in the Norwegian context following the Spanish-influenza (Mamelund 2004), or the baby-boom following World War II. Given the strong two-child norm and the potential of the Norwegian economy to recover relatively fast from the ongoing crisis, the high assumption for fertility is still within a reasonable bound.

In the low assumption, we reduce the fertility from 2020 forward, to a TFR of 1.30 for non-immigrant women, which corresponds to a TFR of 1.34 for all women in the long-term (to 2060). This is 12 percent lower than the TFR observed for 2019 and is close to the current levels observed in Finland. Finland has the lowest fertility among Norway's neighbouring countries and has also had a lower TFR than Norway almost every year since the 1960s. Because of the increased uncertainty related to the current COVID-19 pandemic, coupled with postponed childbirths and fewer women with more than three children, we do not view it as impossible that Norway could reach similar levels as Finland, also in the longer term. As such, the low assumption in this year's projection is much lower than that produced in the 2018 projection round. However, although Norway and Finland share similarities in educational systems and culture, there are differences in immigrant background and age groups among immigrant women, which mean we view it as more likely to see the levels of fertility defined by our medium alternative.

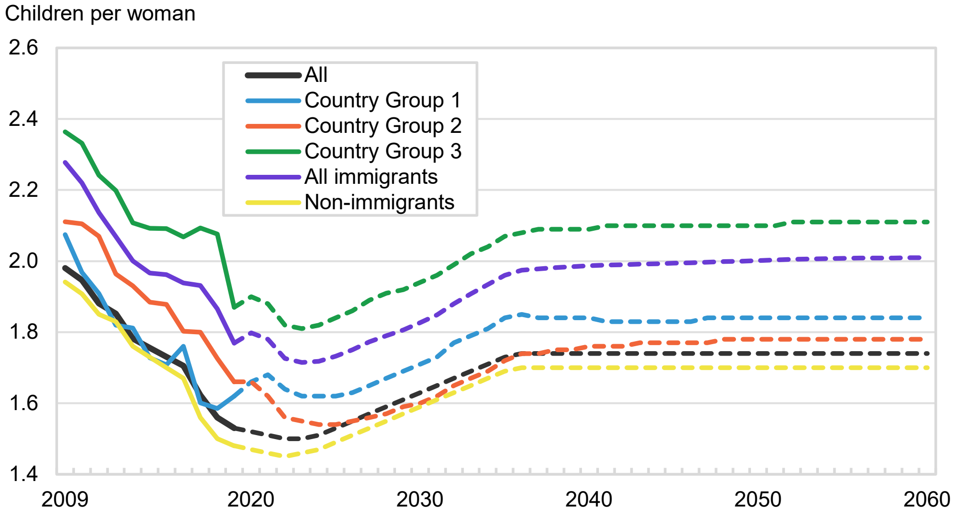
Figure 5.10 Total fertility rate, registered 1990-2019 and projected 2020-2060 in three alternatives



Source: Statistics Norway

Figure 5.11 illustrates the registered and projected TFR for all women, all non-immigrant women, all immigrant women, as well as TFRs for immigrant women from each country group separately for the years 1990-2060. For the first couple of years of the projection period, the fertility level will decrease for Country Group 2, while Country Group 1 and 3 will see an immediate increase before their TFR also starts to decline. Country Group 2 having the steepest decline at 0.12 children per woman – from 1.66 in 2020 to 1.54 in 2024 (compared to 0.04 for Country Group 1 and 0.08 for Country Group 3). After the initial first years, the fertility levels will increase for all three groups starting around 2024 until they become stable from approximately 2036 forward. For Country Group 1, TFR will increase from 1.62 in 2024 and become stable at approximately 1.84, compared to 1.78 for Country Group 2 (from 1.54 in 2024), and 2.10-2.11 for Country Group 3 (from 1.81 in 2023). For all women, the TFR will increase from 1.50 in 2023 and become stable at approximately 1.74 from 2036 forward. Thus, we assume that the country group with the lowest levels of fertility will be Country Group 2 (Eastern EU member countries) and not Country Group 1 (Western Europe, US, Canada, Australia and New Zealand), as previously projected. An important reason for the fertility decline among immigrants from Country Group 2 is our assumption that fewer immigrants will arrive in Norway from these countries in the future (see Chapter 7). Thus, a larger share of women will move to the group with longer duration of stay, a group who tend to have overall lower levels of fertility as compared to women with shorter duration of stay. Put together, long-term fertility for immigrant women will become stable at approximately two children per woman (2.0-2.02)

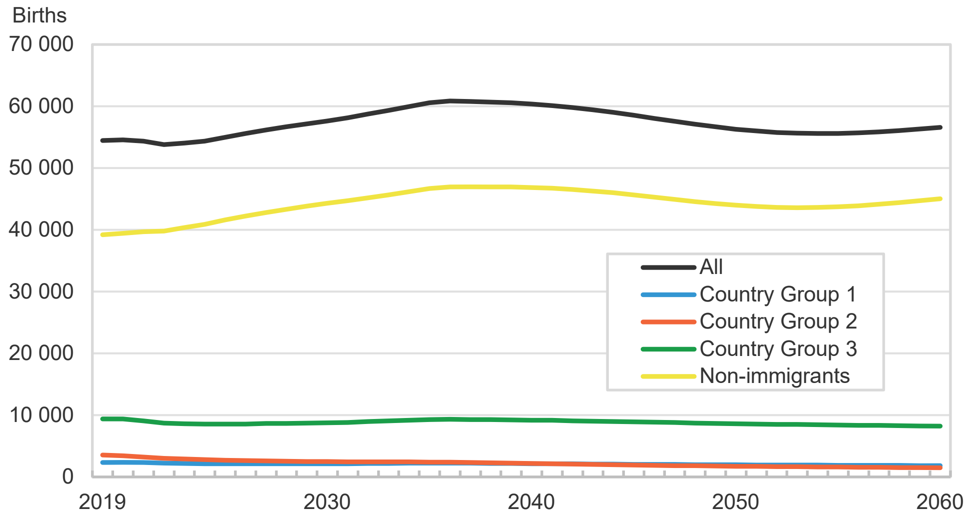
Figure 5.11 Total fertility rate for different groups of women, registered 2009-2019 and projected 2020-2060, main alternative (MMM)[1]



[1] Dashed line shows the medium alternative projection.
Source: Statistics Norway

Figure 5.12 illustrates the development in the main alternative (MMM) in number of births throughout the projection period. The number of future births is determined by both the assumed fertility levels, as well as by the number and age composition of women of childbearing age (15-49 years old). According to our main alternative, the number of births in Norway will increase from 54 481 in 2019 to approximately 60 000 in 2040 followed by a slight decrease to 56 500 in 2060. In the alternative with low fertility, the number of births will decline to approximately 46 000 by 2040 and 38 000 by 2060. In the alternative with high fertility, the number of births will increase to approximately 67 400 by 2040 and 68 000 by 2060. In 2019, approximately 72 percent of all children were born by non-immigrant women, and according to our main alternative, this proportion is expected to slowly increase to approximately 81-82 percent by 2065 and remain constant thereafter. The proportion that are born to women from Country Group 3 decreases slightly throughout the period, from 17 percent in 2019 to 15 percent in 2060. Although the contributions from women in Country Groups 1 and 2 are small, it is worth noting that women in Country Group 1 will contribute more births than women in Country Group 2 by 2041.

Figure 5.12 Number of births for different groups of women, registered 2019 and projected 2020-2060, main alternative (MMM)

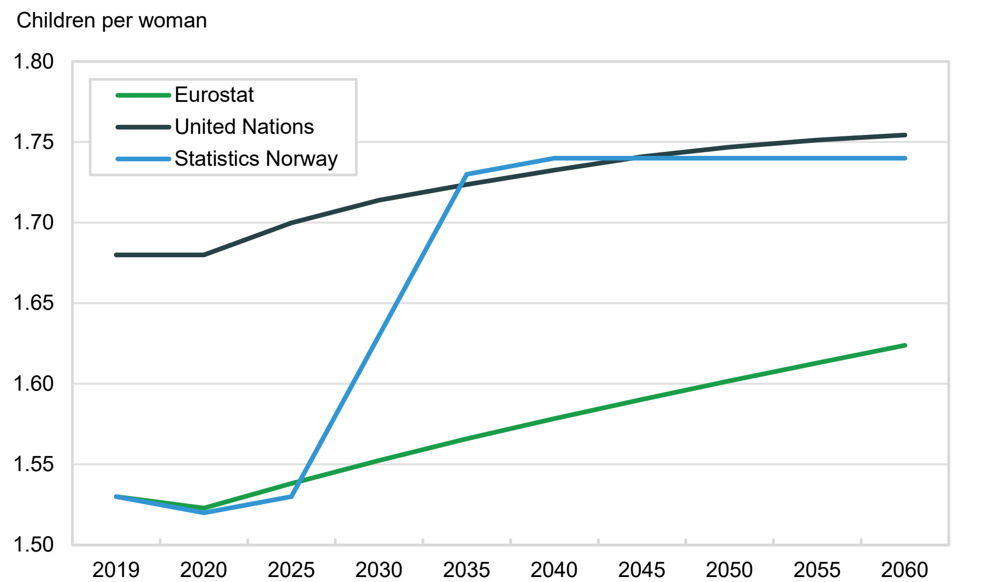


Source: Statistics Norway

5.4. The fertility projections from an international perspective

Both Eurostat (2020) and the United Nations (2019) publish fertility projections for Norway. The United Nations publishes estimates for five-year periods, while Eurostat and Statistics Norway publish estimates for one-year periods. Whereas Statistics Norway and Eurostat use the registered TFR in 2019 as their basis for the future fertility development, the United Nations makes estimates based on historic data, as well as their estimates for Norway in 2015-2020 (TFR: 1.68). There are also differences in the projected age composition across the three projections, as well as in terms of population size, which both impact the future TFR. Figure 5.13 shows a comparison of the medium fertility assumptions for Norway produced by Statistics Norway, Eurostat, the United Nations. As the figure illustrates, all three projections have a different pattern in fertility development. Although the differences in estimated TFR between the three agencies decrease over time, the United Nations projection is most similar to our own, whereas the Eurostat estimates are considerably lower. Indeed, while Eurostat estimates 1.58 children per woman in 2040, the United Nations estimates 1.73 and Statistics Norway 1.74. This pattern continues in 2060, with approximately 1.62 children per woman according to Eurostat, while for the United Nations and Statistics Norway the estimates are 1.75 and 1.74, respectively.

Figure 5.13 A comparison of fertility medium assumptions for Norway made by the United Nations, Eurostat and Statistics Norway, 2019-2060

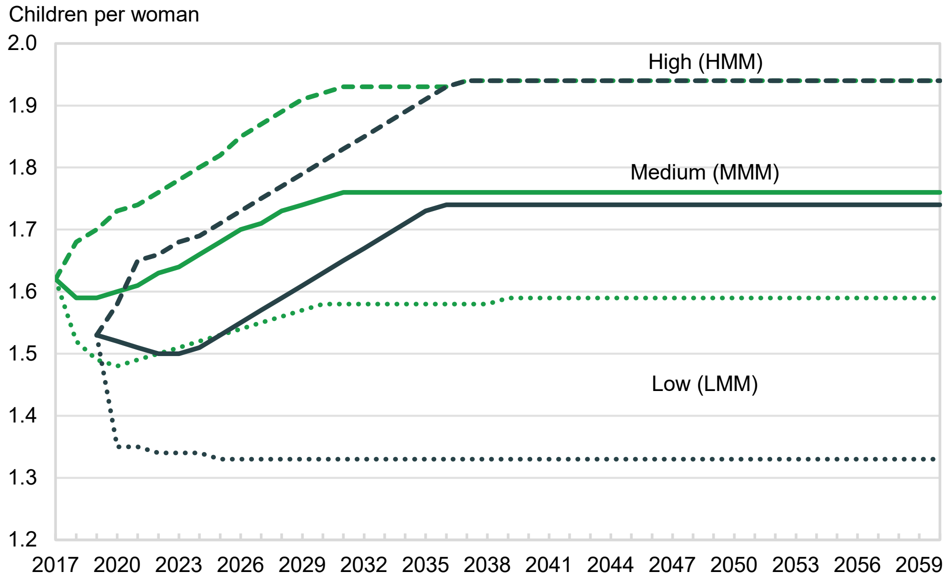


Source: Eurostat, United Nations and Statistics Norway

5.5. Changes in the fertility assumptions from 2018 to 2020

The medium assumption in the long-term is a bit lower in 2020 than it was in 2018, as is shown in Figure 5.14. However, we expect a continued low fertility until around 2025 this year, in part due the observed continued fertility decline in 2018 and 2019, and in part due to repercussions relating to the COIVD-19 pandemic. The high assumption is very similar in the short-run to what was set in 2018, and in the long-run it is identical. However, we have opted to lower the low assumption significantly in 2020, when compared to what it was in 2018. In 2018, we believed that fertility would begin to increase even in the low alternative. This year, both due to the COVID-19 pandemic but also since we are yet to see a trend towards an increased fertility, we have opted to allow for a continued decrease in fertility and stabilized the low assumption at 1.3 in the long-run.

Figure 5.14 A comparison of fertility assumptions in the 2018 (green) and 2020 (black) projections in three alternatives, 2017-2060



Source: Statistics Norway

5.6. Summary

The period fertility (measured by TFR) in Norway has ranged from 1.6 to 2.0 for almost 40 years, i.e. until 2017. Since then it has been below 1.6. In 2019, the TFR was 1.53 after having declined for the past decade from a level of 1.98 in 2009. The decline in fertility is mainly due to two conditions: Women have been postponing births, and a smaller share of women are choosing to have three or more children. The average number of children among women who have completed their childbearing years (cohort fertility) has been fairly stable for the last 15 year at approximately two children per woman. However, younger cohorts get their first child later and thus have to recover these births faster than previously if they are to end up with similarly high levels in the future. Although fertility levels among immigrant women are higher than among non-immigrant women, these groups have also seen a decline in the past decade. Furthermore, the fertility rates of immigrants decline with increased durations of stay, and in the years to come we expect a larger proportion of immigrant women with longer durations of stay in Norway. As such, the contribution of immigrant women's fertility to the overall TFR for all women in Norway is minor. While there is great uncertainty associated with the extent to which postponed births will be recovered in the future, we view it as highly unlikely that the downward trend in third births and higher order parities will change. At the time of writing, COVID-19 has had a substantial impact on Norway and much of the rest of the world. There is great uncertainty as to how this might impact fertility development in Norway in the years to come. The current fertility projection is based on the historical development of fertility and in our medium assumption we have projected a TFR of approximately 1.7 children per woman among non-immigrant women. As a low assumption, we project that the TFR will decline with around 0.2 children to approximately 1.3 children per woman. As a high assumption, we project that TFR gradually increases to approximately 1.9 children per woman.

6. Life expectancy and mortality – Assumptions and results

Michael J. Thomas and Dinh Q. Pham[15]

Since 1990 life expectancy at birth has risen by 7.8 years for men and 4.9 years for women. According to the medium alternative projection, male life expectancy at birth is assumed to rise by a further 7.7 years – from 81.2 years in 2019 to 88.9 years in 2060. For women, an increase of around 6.2 years is assumed, from 84.7 in 2019 to 90.9 in 2060. In the high alternative for life expectancy, the increase is clearly stronger – 10.1 years for men and 8.5 years for women – while the low alternative assumes a weaker growth of 4.8 years for men and around 3.7 years for women. Statistics Norway places most confidence on the medium alternative, wherein we consider an 80 percent likelihood that the future value will lie within the low and high alternative bounds.

Given the assumed rise in life expectancy, the oldest members of society will live to be even older in the future. According to the medium alternative, life expectancy among 70-year-old men and women is projected to increase by around 4-5 years up to 2060. Even for 80-year-old men and women, life expectancy is expected to increase by around 3.5 years over this same period. As a consequence, the elderly are expected to constitute an increasingly significant share of the population, with strong growth even in the very oldest age groups. Those aged 70 and over represent just over 12 percent of the population today, whereas by 2060 we expect this share to rise to 22 percent. The growth in the number of people aged 80 and over is expected to be particularly strong – increasing from around 4 percent today to around 12 percent by 2060.

In this chapter we describe trends in mortality patterns from 1990 to the present day and explain how changes over this period work to inform our assumptions for future mortality. Following the description of observed trends, we detail our mortality assumptions before describing and discussing the results of the mortality projections.

6.1. Trends in life expectancy and mortality

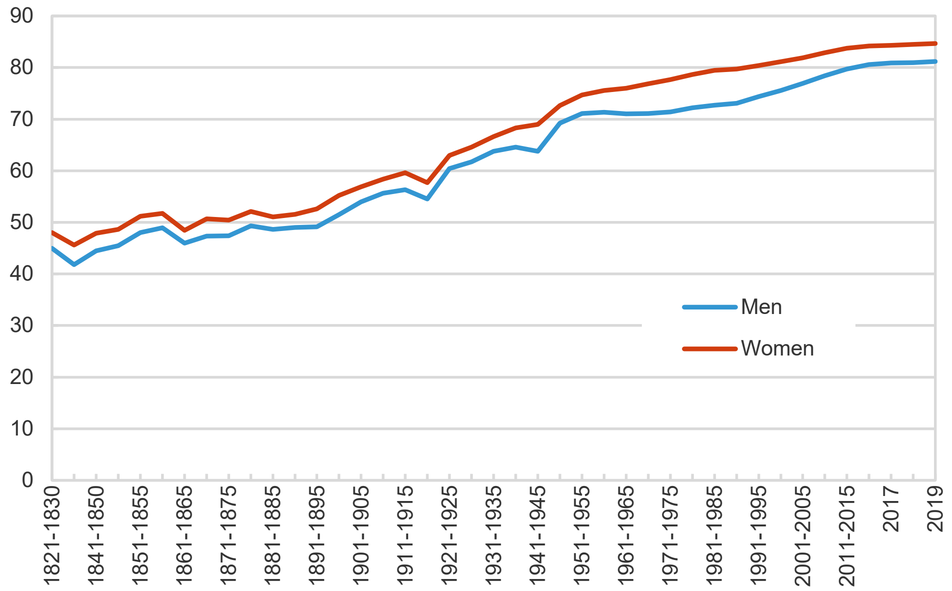
Period life expectancy and sex differences

Period life expectancy at birth (see Box 6.1) is now the highest it has ever been in Norway, with data for 2019 revealing life expectancy at birth to be 81.2 years for men and 84.7 years for women (see Figure 6.1). For both men and women, this represents an increase of 0.19 years compared to the previous year, 2018.

The life expectancy differences between men and women have been decreasing in recent decades. In 2019 the difference in period life expectancy at birth was 3.5 years. As Figure 6.1 shows, other than in 2017 when male life expectancy at birth was 3.4 years lower, this difference is the smallest we have observed since the late 1940s. In 1990, the difference between the sexes stood at 6.4 years. Nevertheless, there still exists a relatively large gap between the sexes in terms of life expectancy. In 2019, new-born boys had a life expectancy at birth equivalent to that of new-born girls in 1998, that is, more than 20 years earlier.

[15] We thank the advisory reference group for mortality, which consisted of the following members: Inger Ariansen (Norwegian Institute of Public Health), Christian Lycke Ellingsen (Stavanger University Hospital), Örjan Hemström (Statistics Sweden), Nico Keilman (University of Oslo), Bjørn Møller (Cancer Registry of Norway), Siri Rostoft (Oslo University Hospital) and Anders Sønstebø (Statistics Norway). Members are listed in alphabetical order with institutional association in parentheses. We are especially grateful for their useful input in the formation of our assumptions.

Figure 6.1 Life expectancy at birth for men and women, 1821-2019[1]



[1] Life expectancy at birth is presented in 10-year groupings for 1821-1850, five-year groupings for 1851-2015 and in single years for 2016-2019.
Source: Statistics Norway

Box 6.1. Period life expectancy at birth and remaining life expectancy

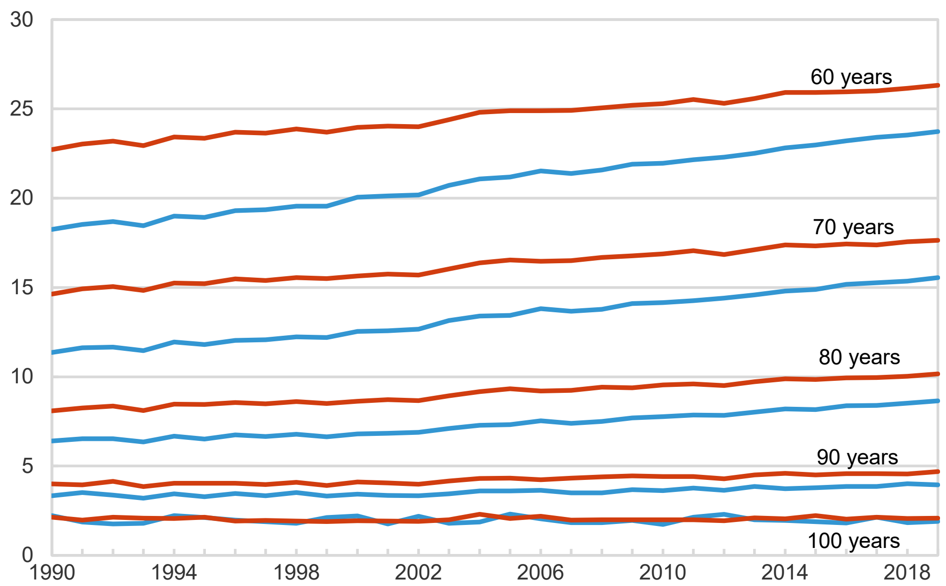
Period life expectancy at birth (e0) is a hypothetical period measure and represents the average number of years a person can be expected to live according to the mortality experience of the entire population in a single year. For each year in the projection period, we calculate life expectancy at birth for men and women separately, as well as for men and women combined.

As with life expectancy at birth (e0), remaining life expectancy (ex) is calculated using age-specific death rates covering a single calendar year (e.g. for a period life expectancy at age 70 in 2025, we would use projected mortality rates in 2025 for ages 70, 71, 72, …, 105). We calculate the expected remaining years of life for each single-year age group up to and including 105 years.

In the projections, the estimates of period life expectancy are based on age at the end of the year and not at time of death, as they are in the general population statistics, with a resulting deviation of just under half a year.

In this year's projection we also produce cohort life expectancy (see Section 6.4).

Figure 6.2 Life expectancy at selected ages for men (blue) and women (red), 1990-2019



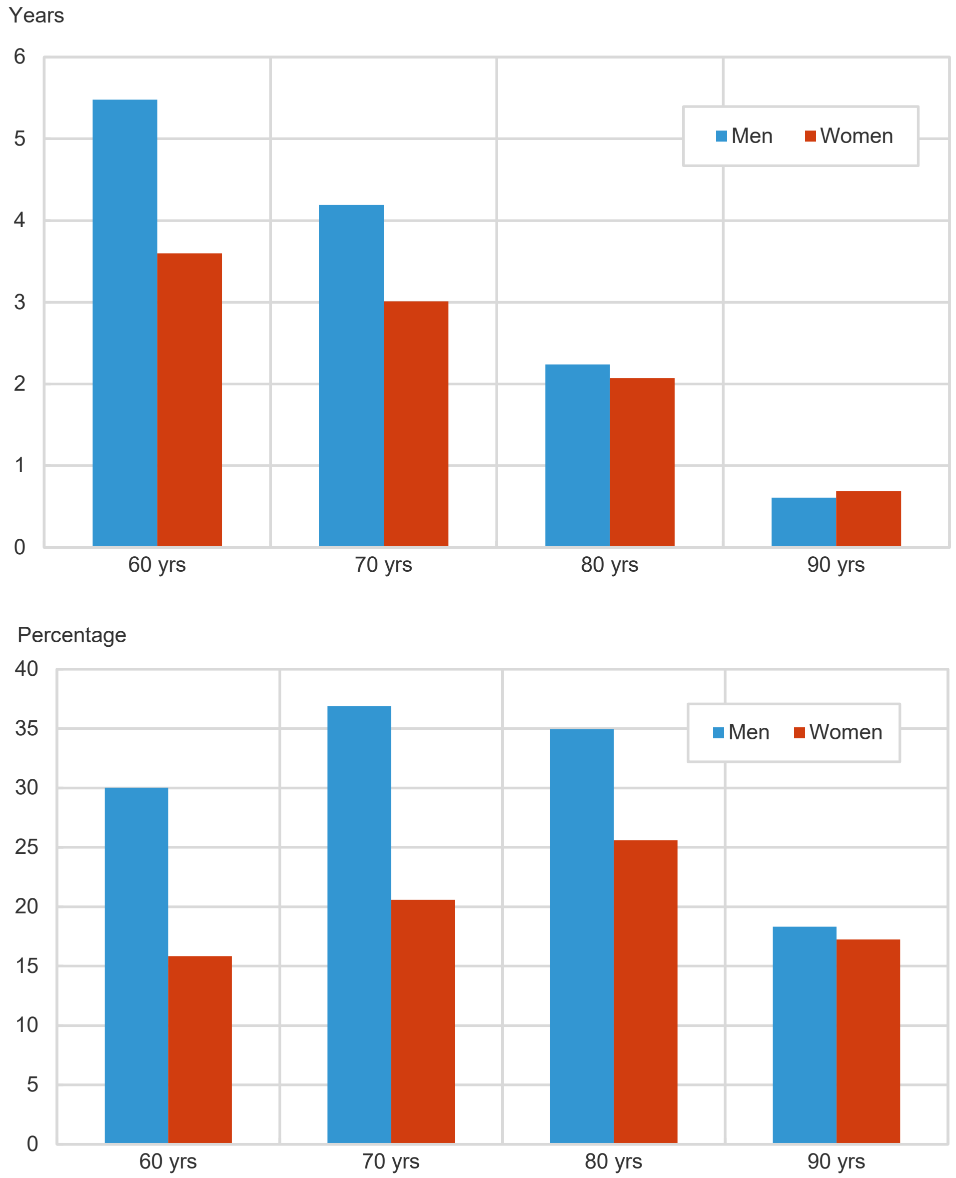
Source: Statistics Norway

Along with life expectancy at birth, remaining life expectancy is calculated for all ages up to and including 105 years (see Box 6.1). As is clear from Figure 6.2, the difference between men and women in remaining life expectancy decreases with age, reaching fewer than 0.2 years for the very oldest age groups (100 years or older). As such, men who reach 100 years of age appear to have at least as good remaining life expectancy prospects as women at this age – though the limited number of people aged 100 or older means these estimates are particularly uncertain.

For age groups under 40, the difference in remaining life expectancy between men and women remains above three years, and above two years for those in their early seventies. It is only in the late eighties that estimated sex differences fall below one year.

Both in terms of years of life and as a percentage increase, the period 1990-2019 has witnessed a stronger rise in life expectancy among men than women (Figure 6.3). The only exception to this trend was among 90-year-olds, wherein women received a slightly higher increase in terms of years gained (Figure 6.3, top), though in percentage terms men still received the greatest increase (Figure 6.3, bottom).

Figure 6.3 Changes in remaining life expectancy by sex from 1990 to 2019 for selected age groups, years (top) and percentage (bottom)



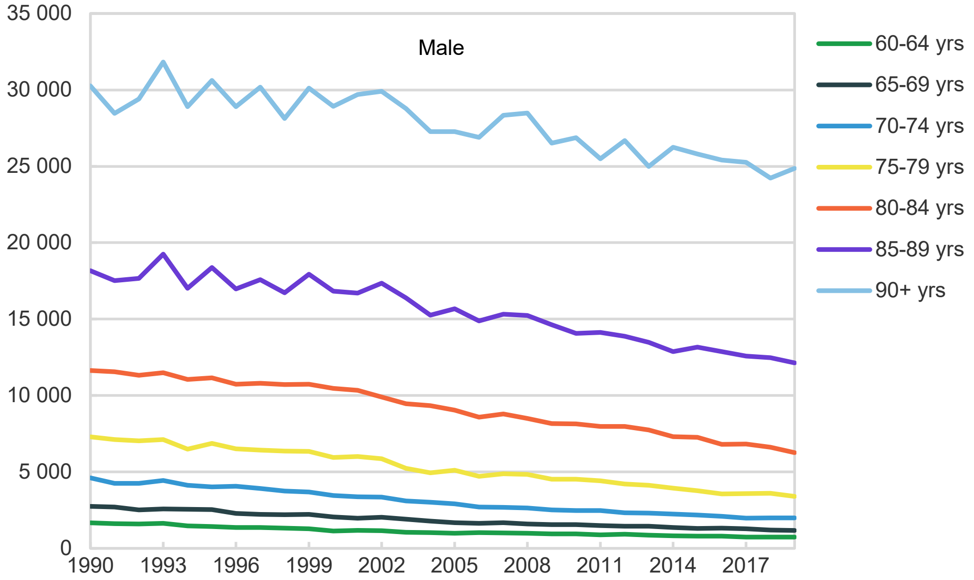
Source: Statistics Norway

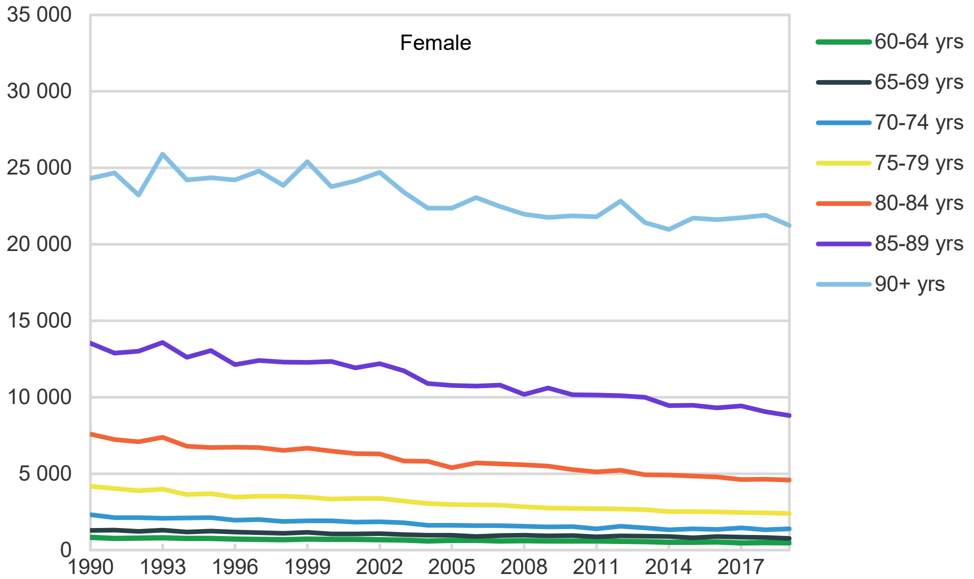
Trends in deaths and causes of death

Up to 1997, more men than women died in Norway. However, with Norway now having far more elderly women than men, the pattern has since reversed. In 2019, 40 684 people died in Norway, comprising 19 979 men and 20 705 women. This was 109 more men and 265 fewer women than in the previous year, and 3 887 fewer men and 1 450 fewer women than in 1990.

Since the year 2000, the fall in mortality has been especially strong among the oldest age groups, and particularly among the oldest men (Figure 6.4, top). For women, while mortality has still declined, it has been a somewhat more gradual process (Figure 6.4, bottom). Because mortality rates in younger age groups are very low, the increase in life expectancy in recent decades is mainly a consequence of older people living longer. Much of this is due to significant changes in lifestyle and other underlying risk factors associated with the most common causes of death in Norway, as well as treatment-side developments associated with medical and technological advances discussed later in this chapter.

Figure 6.4 The number of male (top) and female (bottom) deaths per 100 000 of the mid-year population by age, 1990-2019

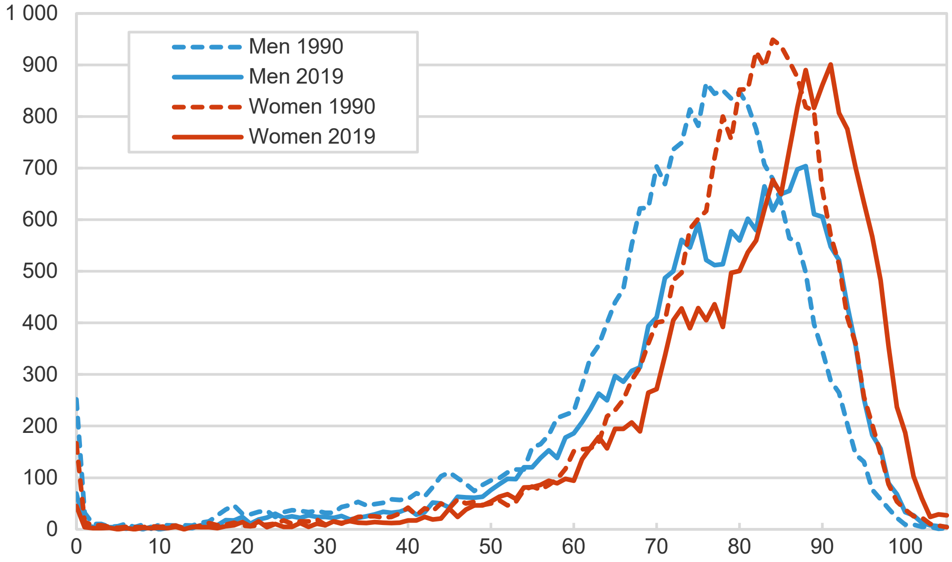




Source: Statistics Norway

As with life expectancy, the average age at death also differs between the sexes. In 2019, the average age at death was 82.2 years for women, while for men it was just 76.5 years. This compares to 1990 where the average age at death was 72.0 and 78.2 years for men and women, respectively. The change in the modal age at death, which reflects the most common age at death (the peak in Figure 6.5), has been stronger, increasing from 76 in 1990 to 88 in 2019 for men and from 84 to 91 for women over the same period. However, such figures are based on absolute numbers and so do not adjust for the age structure of the population making them particularly susceptible to variations according to the size of different birth cohorts. As shown in Figure 6.5, the rightward shift in the apex of the distribution of deaths by age is strongest for men – at a total of 12 years – while for women this development is weaker, at around seven years. A consequence of this compression of the age at death is that the difference between men and women in terms of modal age at death has been reduced from eight years in 1990 to only three years in 2019.

Figure 6.5 Distribution of deaths by age and sex in 1990 and 2019

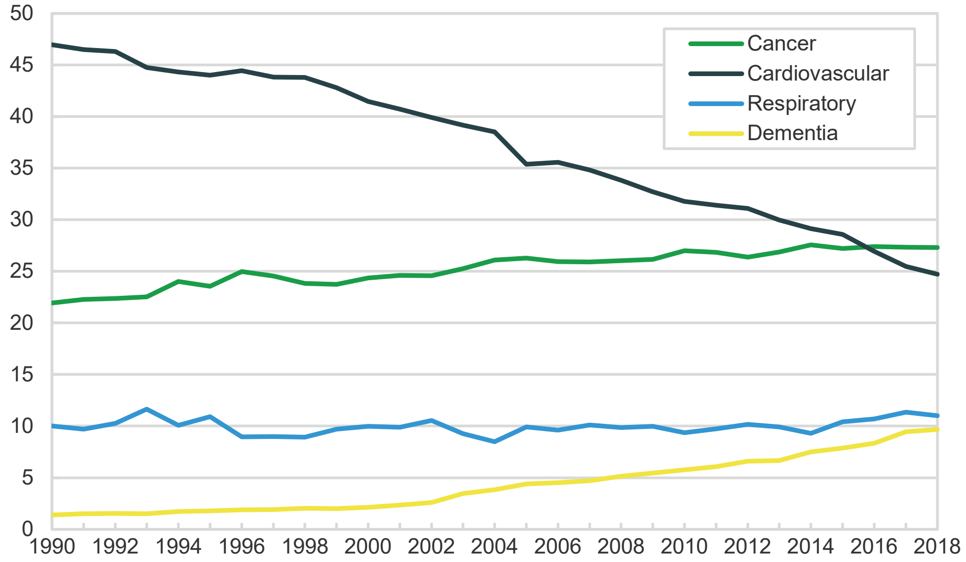


Source: Statistics Norway

Figure 6.6 shows the development over time in the number of deaths by selected causes of death.[16] Cardiovascular disease constitutes an ever-smaller proportion of all deaths, with the decline being particularly noticeable since the late 1990s. Figures from the Cause of Death Registry reveal that less than 25 percent of all deaths in 2018 were due to cardiovascular disease, this compares to its contribution to almost half (47 percent) of all deaths in 1990 (NIPH 2020c). While the proportion of deaths from cardiovascular disease has dropped significantly over time, the proportion of cancer-related deaths has increased – from just over one-fifth (21.9 percent) in 1990 to 27 percent today (NIPH 2020c). Indeed, 2017 was the first year in which cancer deaths accounted for a larger proportion of all deaths than cardiovascular disease. This is mainly a result of the fact that the population has grown older, with the age-specific death rates for cancer remaining relatively stable (Cancer Registry of Norway 2019). The proportion of deaths related to respiratory diseases (excluding cancer), which are largely linked to smoking, has been relatively stable in the period since 1990, at around ten percent. However, in the context of an ageing population, the mortality rate associated with dementia has been increasing since 2000 (NIPH 2019). In 2018, almost ten percent of deaths were linked to dementia, which is almost five times higher than the rate of incidence observed in 2000. While this increase can be linked to an ageing population, those who report cause of death have become increasingly better at correctly identifying dementia as the underlying cause of death. The proportion of violent deaths, such as accidents, suicide and homicide, has remained stable, accounting for approximately six percent of all deaths (NIPH 2020c).

[16] In Figure 6.6, all tumour related deaths are termed cancer. However, between 2-3 percent of tumour related deaths occur as a result of non-malignant tumours (Cause of Death Registry 2019).

Figure 6.6 Four major causes of death in Norway as a percentage of all deaths, 1990-2018



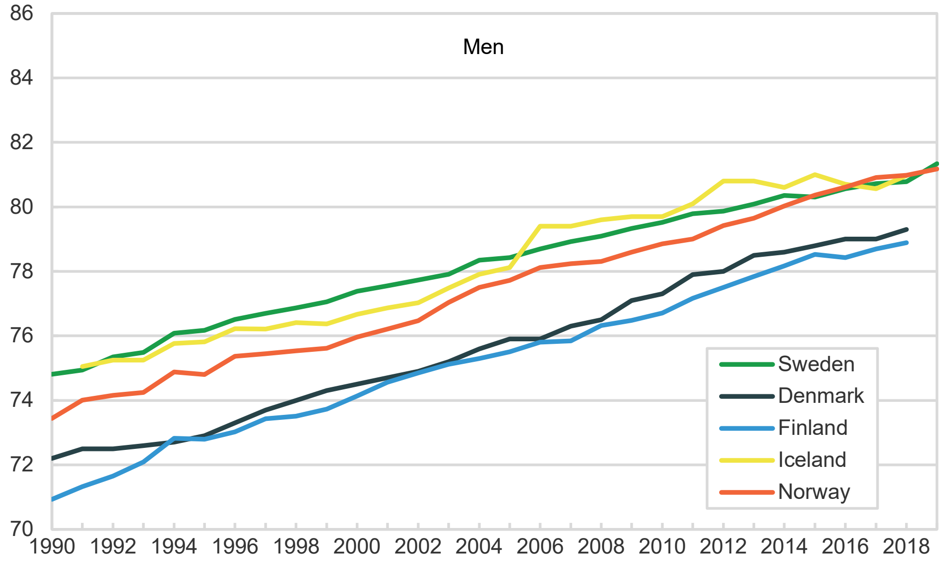
Source: Calculations based on data from the Norwegian Institute of Public Health (NIPH 2020c)

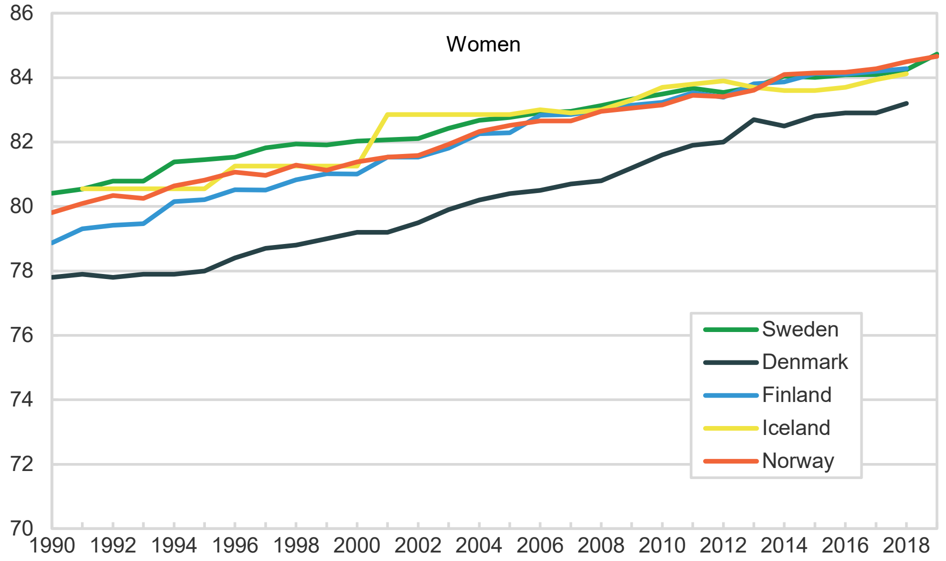
Placing Norwegian trends in an international context

There are many international comparisons of life expectancy, with both the UN and the statistical office of the EU (Eurostat), publishing regular overviews (United Nations 2019, Eurostat 2020). Norway's relative position with respect to life expectancy is somewhat dependent on the selected observation period, the data source used, and the countries selected for comparison. In the most recent United Nations (2019) publication, Switzerland and Hong Kong top the United Nations list for men, while Japan and Hong Kong top the list for women. Norway finds itself at 16th on the list for highest male life expectancy at birth and 20th on the list for highest female life expectancy (United Nations 2019). According to Eurostat (2020), which restricts its focus to European nations, Switzerland and Iceland are the top countries for male life expectancy at birth, while Spain and France are in the top positions for female life expectancy at birth. Norway is in fourth place for male life expectancy at birth, but only in 12th place for female life expectancy. In terms of the Nordic countries, both Iceland and Sweden are among the ten countries with the highest life expectancy for men, while no Nordic country is in the top ten list for women (United Nations 2019).

Figure 6.7 shows the development in life expectancy as calculated by the statistics offices in the Nordic countries. Since 1990, Norway has had a consistently higher male life expectancy than Finland and Denmark (Figure 6.7, top). Moreover, while Sweden and Iceland have tended to have a higher life expectancy than Norway over this same period, in recent years a catch-up has been observed with the figures for 2017 and 2018 showing the highest male and female life expectancies to be in Norway. With that said, the most recent figures, for 2019, show Sweden to be marginally higher in both male and female life expectancy, with the figures for Iceland yet to be published.

Figure 6.7 Life expectancy at birth for men (top) and women (bottom) in the Nordic countries, 1990-2019



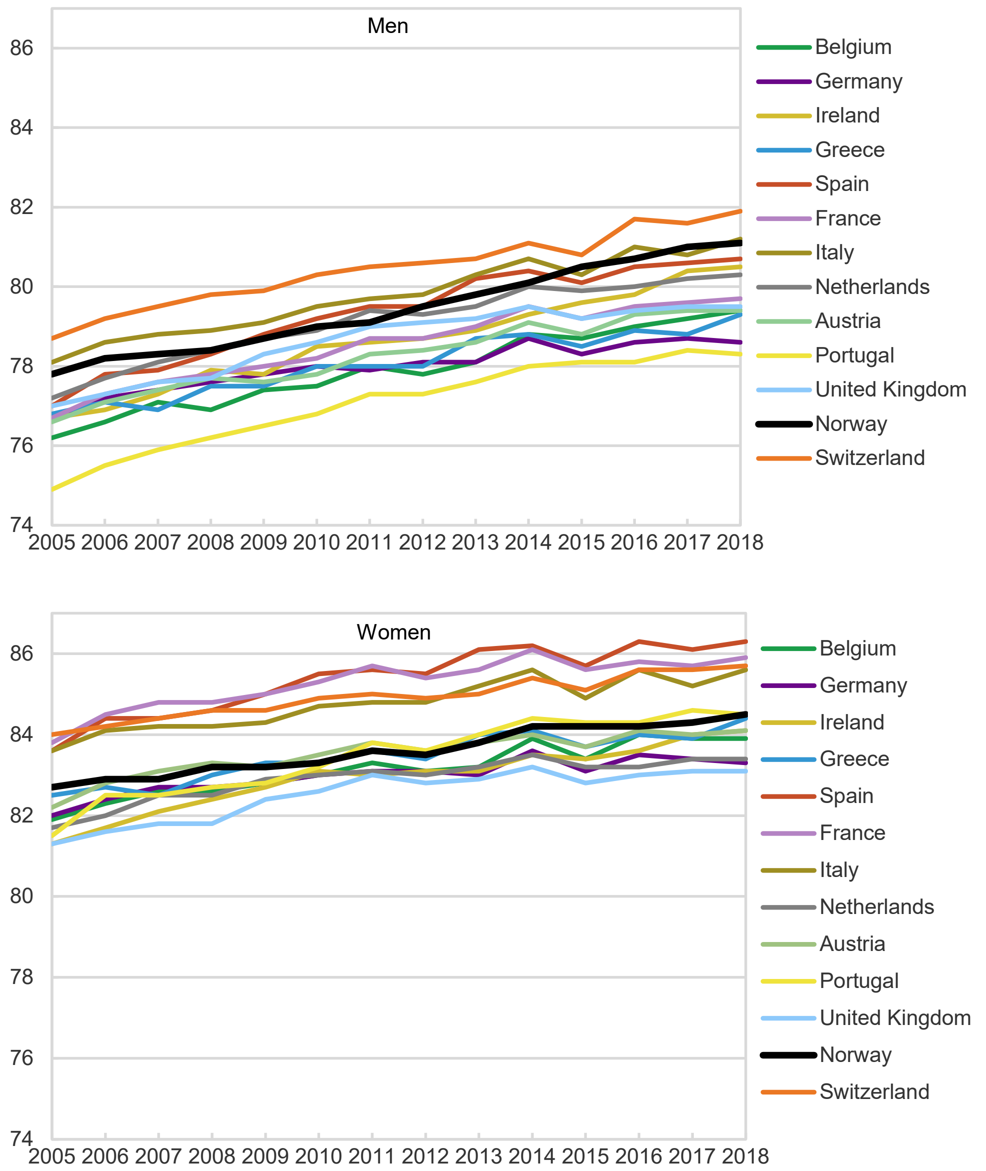


Source: National statistical agency for each country

Like many countries in Europe, Norway has experienced a long-term increase in life expectancy. However, a decline in male life expectancy was observed among two-thirds of European countries in 2014-2015 (Figure 6.8, top), while for women (Figure 6.8, bottom), a decline was observed in three-quarters of the countries studied (Eurostat 2020). The total decline in the EU-28 was 0.2 years for men (from 78.1 to 77.9 years) and 0.3 years for women (from 83.6 to 83.3).[17] This was the first decline observed since 2002, the year in which data for most countries became available. In 2016, life expectancy in most countries was found to increase again. As can be seen in Figure 6.7, Norway was among the few countries that did not witness the decline in 2014-2015. Figure 6.8 also reveals Norwegian male life expectancy is higher than in most other European countries, with a rate of increase higher than the EU-average (Eurostat 2020). Female life expectancy is somewhat lower in the European context but has developed in line with the EU average since 2007 (Eurostat 2020).

[17] The EU-28 refers to the current 27 EU members states plus the UK. A list of these countries can be found here: https://europa.eu/european-union/about-eu/countries_en.

Figure 6.8 Life expectancy at birth for men (top) and women (bottom) in selected European countries, 2005-2018



Source: Eurostat

What affects mortality?

Along with any differences in genetic vulnerabilities or predispositions for adverse health, mortality and health status are associated with a multitude of interrelated social characteristics and conditions, from individual and family backgrounds, income levels, educational attainment, family relationships and the places we live and work. Such characteristics are important because they are often closely linked to factors such as health and lifestyle behaviours, which are themselves known to bear influence over health and mortality outcomes (Rose 1992). Though it is also the case that individuals in various health select into different social groups (Elstad and Krokstad 2003). The international scientific literature lists a wide range of characteristics thought to be associated with health and mortality outcomes, including:

- Educational attainment. Lower educational attainment is associated with poorer health and higher mortality
- Income and socio-economic status. Higher income and higher educational attainments are closely linked to good health

- Physical environment. Safe water, clean air, safe working environments, housing, local environment and roads, all contribute to lower mortality
- Work and conditions in the workplace. Those who are employed have a relatively low mortality rate (the 'healthy worker effect')
- Social support and networks. Marriage, cohabitation, and parenthood are strongly associated with low mortality, as is support from other non-resident family, friends and neighbours in good health
- Genes and inheritance. Our genetic inheritance has some significance at the individual level, but once aggregated to the population level it seems likely that the significance is somewhat weaker than for other factors
- Health services. Access to and use of health care affects health and mortality to some extent, but in countries with high life expectancy, the relationship between access and mortality is weaker than in countries with lower life expectancy
- Gender. Men and women experience different health problems at different ages. In general, women tend to suffer from more long-term chronic illnesses and disabilities, while men are more likely to experience illnesses of a more acute nature which tend to lead to earlier deaths

Although Norway has witnessed continued improvements in life expectancy over many decades, underlying inequalities in morbidity and mortality among individuals persist. Among a wide range of factors, differences have been identified according to education, income, occupation, stage in the life course, family situation and immigrant background (Arntzen et al. 2019, NIPH 2018). On average, health is better among people with high education (Arntzen et al. 2019). International studies have shown that higher education is associated with lower risks of dementia (Sharp and Gatz 2011, Satizabal et al. 2016, Scommegna and Mather 2017), and lower cardiovascular disease and cancer-related mortality (Huisman et al. 2005). Such correlations may partly be due to selection effects, wherein those who are more resourceful and healthier, in the first place, are better able to pursue opportunities for higher educational attainment. With that said, studies that take into account such selection processes still find a positive effect of education on health (Adams 2002, Lleras-Muney 2005, Silles 2009). People with higher levels of education are also said to have advantages related to their better ability to understand complicated modern medical treatments (Berkman et al. 2011). As an example, within modern healthcare systems a larger part of the investigation and treatment of disease and illness takes place in outpatient clinics, wherein patients are expected to follow-up on their own appointments and stay informed about which examinations might be most relevant. As such, there is a requirement that patients need to be able to communicate with healthcare professionals about their response to treatment, since they are more often outside of a hospital environment and not under direct observation.

In Norway, the relationship between education and health is stronger than the relationship between income (measured in a broad sense) and health. Indeed, the public provision of healthcare services in Norway makes access less dependent on personal finances than in countries that orientate towards private-sector provisions of healthcare. With that said, researchers have identified a trend towards greater inequality in mortality by income in Norway (Mortensen et al. 2016), with a similar pattern observed in a study of the use of healthcare services (Vikum et al. 2012).

When it comes to family relationships, health is generally better among those in relationships and among parents (Berntsen 2011, Kravdal 2013). For both parenting and partnership, there are two factors that are thought to underpin these associations, social control and selection. Beyond this, we know that elderly family members perform many unpaid care duties, while outcomes are also known to be influenced by social networks of non-resident family, friends, colleagues and people in the local community and neighbourhood (Mather and Scommenga 2017).

In recent years, several Norwegian studies on immigrant health and mortality outcomes have emerged. Although immigrants tend to have similar levels of engagement with health care services (Elstad 2016, Sandvik et al. 2012, Diaz and Kumar 2014), they tend to have better health, on average, than the rest of the population. This holds even after accounting for the fact that immigrants tend to be younger than the population at large (Diaz et al. 2015). This advantage is also reflected in mortality patterns, with immigrants generally having lower mortality rates than the rest of the population (Syse et al. 2016a, Syse et al. 2018). With that said, the immigrant health advantage appears to lessen as their duration of stay increases (Elstad 2016, Syse et al. 2016a, 2018). Meanwhile, within the group of immigrants, those who move for educational or occupational reasons tend to have better health while the health status of refugees and migrants moving for family reasons (or as family members) tend to be somewhat worse.

The Survey on Living Conditions (SLC) is a useful source of information on health and lifestyle behaviour in Norway. Results from the SLC (Statistics Norway 2016), conducted in 2015, indicate that the proportion of smokers has been in decline, but that the decline has been somewhat slower among the elderly than among the younger population. The most recent data on tobacco use shows that 9 percent of persons aged 16-74 are daily smokers (Statistics Norway 2020c), and according the SLC survey, those who had the highest educational attainment were found to smoke the least. Alcohol use, on the other hand, is high and increasing, especially among the elderly (Statistics Norway 2016). In 2019, more than 30 percent of people aged 16-74 drank alcohol weekly – 39 percent of men and 28 percent of women. The corresponding numbers who binge drink, defined as six or more alcohol units on one occasion and the same occasion weekly, were 5 percent (total), 7 percent (men) and 3 percent (women) (Statistics Norway 2020d). With that said, in the European context, the Norwegian population has one of the lowest alcohol per capita consumption rates (WHO 2019).

Although most people have more sedentary jobs than in the past, four in five people report exercising or training at least once a week (Statistics Norway 2019). Norwegians have, however, become more overweight. At the end of the 1960s, around 5 percent of middle-aged men were obese (NIPH 2017a). Today around 25 percent of men and 20 percent of women aged 40-45 are obese, with between 15-20 percent of children and 25 percent of young adults considered overweight or obese (NIPH 2017a). A US study suggests that a significant increase in obesity can be expected in most countries, though this increase will be somewhat weaker in Norway and other Northern European countries than in less economically developed countries (NCD-RisC 2016). For Norway, this may relate to the fact that physical activity rates are relatively high, with the proportion of younger and older people who are physically active and/or exercise having increased over the last 15-20 years (Statistics Norway 2016). It is worth noting that this trend appears to have levelled off somewhat according to the latest data (Statistics Norway 2019).

The mortality rate of cardiovascular disease has decreased in recent years (see Figure 6.6). However, the trend in occurrence is somewhat variable. While the number of first-time cases has decreased among the elderly, it has increased among younger adults. This can be partly attributed to an increase in the number of overweight people in the population (NCD-RisC 2016). The share of the population suffering from cardiovascular disease is expected to increase due to an increasing proportion of older people in the population, as well as better survival rates after acute illness. At the same time, this means that more people are living with illnesses that require follow-up (NIPH 2018).

The number of people affected by cancer has slowly increased over the last ten years (see Figure 6.6), a trend that is expected to continue, partly because more people are surviving to ages where cancer incidence is highest. While a decrease in mortality from other illnesses has been a factor behind this increased incidence, overall cancer survival rates have increased greatly for both men (58.9 percent in 1999-2003 to 74.1 percent in 2014-2018) and women (63.0 percent in 1999-2003 to 73.5 percent in 2014-2018) (Cancer Registry of Norway 2019). As a result, there will be more elderly people living with a cancer diagnosis. Calculations from the Cancer Registry of Norway (2019) show that the number of cancer cases will increase by 40 percent over the next 15 years. The number of new cases for the 50-69 age group is expected to increase by 14 percent. For persons aged 70 or older, an increase close to 70 percent is expected. This increase is mainly due to the size of these older age cohorts and the fact that cancer prevalence is closely related to ageing.

In the case of respiratory disease, chronic obstructive pulmonary disease (COPD) is a frequent cause of death. It is estimated that around 200 000 Norwegians aged 40 or over are living with COPD and, depending on the severity, many are likely to be unaware that they even have the condition (Helseatlas 2018). The NIPH (2018) estimates the numbers to be somewhat lower, at around 150 000 persons. At a global level, there has been a rapid rise in the prevalence of COPD, and estimates predict that it will be the fourth most common cause of death by 2030 (Mathers and Loncar 2006). Assuming current trends in smoking continue, we can expect fewer people to be diagnosed with, and die from, COPD in the short term. In the longer term, it is conceivable that the relatively high proportion of smokers in their 40s and 50s will lead to an increased number of cases (NIPH 2018).

As a recorded cause of death, dementia has traditionally been linked to relatively few deaths in Norway, but in 2018 almost ten percent of deaths were attributed to dementia. It is estimated that around 80 000-100 000 people currently live with dementia in Norway (NIPH 2018), though it should be noted that this estimate is highly uncertain and there are currently no definitive figures in this area. As dementia is very closely associated with (older) age, an increase in the elderly – and especially those over 85 years of age – is likely to lead to an increased incidence of dementia in the future. In Europe, 21.9 percent of people aged of 85-89 is estimated to have significant dementia-related problems, rising to 40.8 percent among the over 90s (Alzheimer Europe 2019). In Norway, the estimate is somewhat lower, although estimates suggest there may be close to 200 000 patients with dementia by 2050 (NIPH 2019).

According to the Public Health Report, depression, anxiety, type 2 diabetes and fall-related accidents are also important causes of health loss among the elderly (NIPH 2018). These are illnesses that rarely lead to death, but which do require treatment and often have major impacts on the everyday life of the elderly. These conditions are associated with unhealthy diets, high blood pressure, smoking, being overweight and obese, physical inactivity, high cholesterol, high blood sugar and high alcohol consumption, and as such are all risk factors that can be addressed. However, results from a survey analysis indicate that the elderly are less active today than in the past, with physical inactivity among the elderly being associated with other unhealthy living habits such as smoking and being overweight or underweight (Morseth et al. 2016).

In summary, cancer, cardiovascular and respiratory diseases take the most lives in Norway today (NIPH 2018). These types of deaths can be linked to lifestyle and health behaviours, to varying degrees, and a certain proportion of deaths can potentially be prevented by lifestyle changes (e.g. minimizing smoking, alcohol consumption, unhealthy diets, and sedentary lifestyles). At the same time, the context around us matters in terms of influencing how we live our lives. Changes in living patterns, healthcare provision, educational attainment, family relationships and other environmental factors can all influence our health and mortality outcomes, either directly or through influencing changes in lifestyle and health behaviours.

6.2. Modelling future mortality

The assumptions about future mortality and life expectancy are mainly model-based and determined by historical trends in mortality. In short, we make assumptions about future mortality by age and sex using the product-ratio variant of a Lee-Carter model, where the trend in mortality for the selected time period, represented by two estimated time series, is extended using an auto regressive integrated moving average (ARIMA) model. This is described in more detail in Section 4.2. The historical period used as a basis for the projection is determined prior to each projection. If it seems appropriate, discretionary adjustments are also made to the model work.

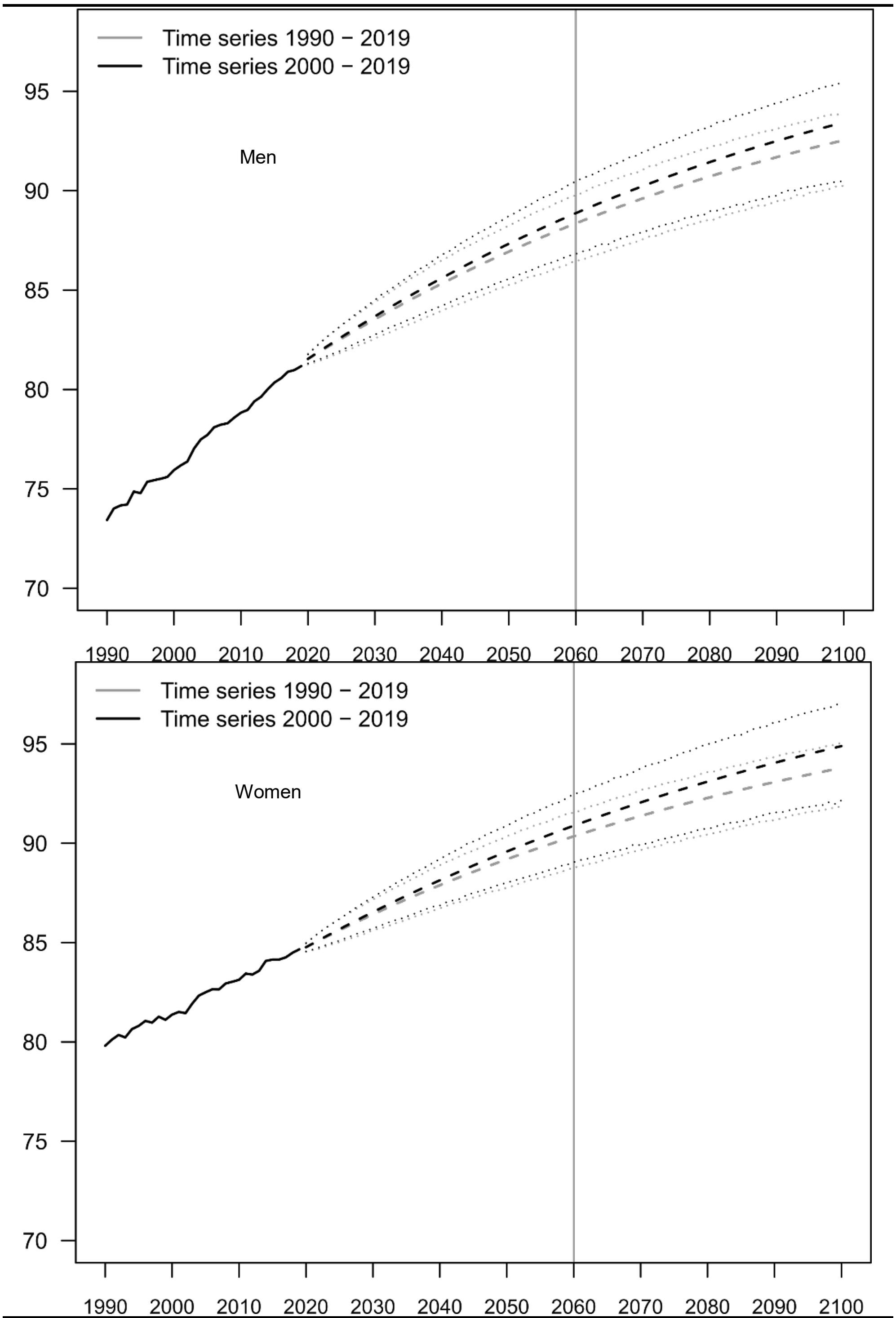
As the previous sections have shown, the pattern of mortality is different today than it was in earlier periods. We have a lower prevalence of smoking, cardiovascular disease is in decline, and the last decade has witnessed important advances in medical science and technology in the areas of stroke and cancer treatment. For this reason, it is reasonable to expect that future mortality trajectories will be closer to those observed in recent decades, than in the 1980s and 1990s for example. Moreover, detailed evaluations of projections from 1969 have shown that Statistics Norway has continuously underestimated the increase in life expectancy (Keilman 1997, Rogne 2016). In previous projections, relatively long historical time series have been utilised. In 2016 and 2018, the historical time series started in 1990. Given the recent trends in cause-specific mortality, as well as the expected developments in medicine and technology, this year's projection utilises time series of registered data for the years 2000-2019 (see Box 6.2). Applying these shorter time series has worked to reduce the underestimation in the trend of increasing life expectancy in the projections (see Figure 6.9).

Box 6.2. Data

The figures for the numbers of dead and the size of the population are taken from Statistics Norway's population statistics and the period 2000-2019 forms the basis for the calculations. Age-specific death rates (0-90 years) for each calendar year for men and women, and for both sexes combined, are calculated using a formula for piecewise constant death intensity (Foss 1998). When calculating age-specific rates, age is defined as age at the end of the calendar year. When the death rates are calculated, they are corrected for extreme values. Extremely low death rates, or cases where there are no deaths in some age groups and/or years, are replaced by the average of the rate for the age group before and after.

There are large fluctuations from year to year for ages 101-110. Therefore, to estimate projected death rates for these age groups, a logistic model has been used to extrapolate and smooth the estimated death rates for ages 101-110 years. Input in this model is death rates for the age groups 70-100 in the period years 2000-2019. This reduces the noise in the estimates at high ages and provides stable projected death rates for the entire age range. For ages 110-119 years, the probability of death is set at 0.5 for both men and women throughout the period.

Figure 6.9 Projected life expectancy at birth for men (top) and women (bottom), using 1990-2019 and 2000-2019 time series in three alternatives[1]



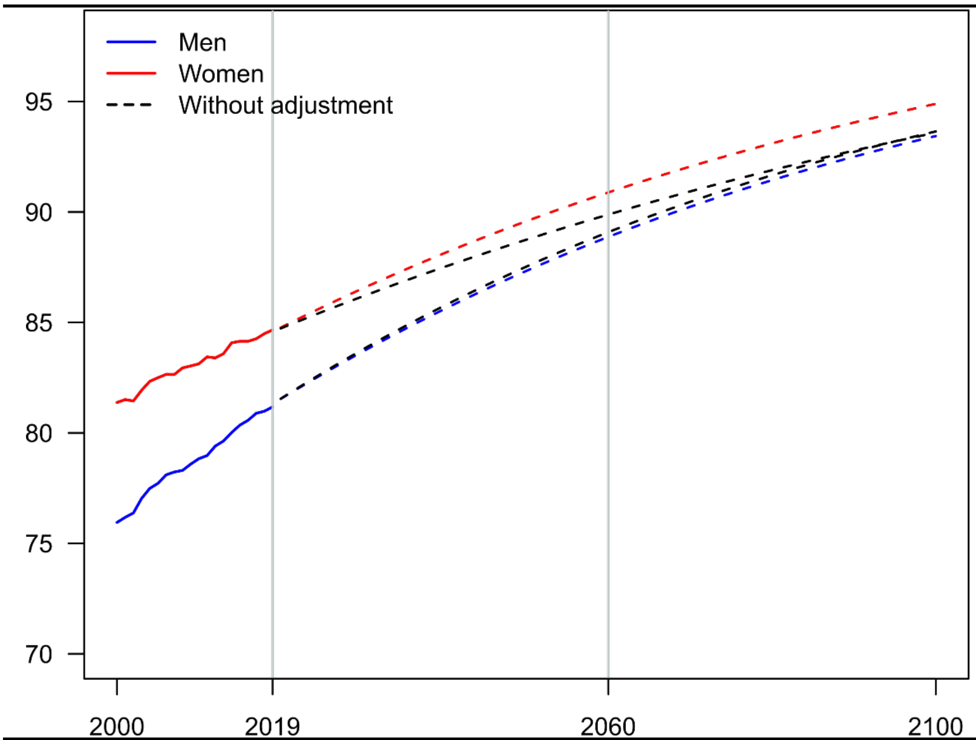
[1] The only difference between the two projections is the input period, 1990-2019 (grey) and 2000-2019 (black). Dotted lines represent low and high life expectancy alternatives, dashed lines represent the medium alternative.
Source: Statistics Norway

Discretionary adjustments

The medium alternative in the 2020 mortality projection is thus based on an extension of the mortality patterns for the period 2000-2019. But since male life expectancy has increased more rapidly than female life expectancy over recent decades, a purely mechanical model-based approach to extrapolations will lead to cross-overs in the death rates of men and women in the relatively near future. We consider it unlikely that men will have a higher life expectancy in the near future than women. This is partly because we have no evidence for such a trend occurring in modern times in societies similar to Norway, and partly because both the previous disparity between the sexes, and the recent 'catch-up' among men, is linked to changes in cardiovascular mortality and other smoking-related causes of death. Since men, on average, stopped smoking earlier than women, we assume that smoking-related mortality will contribute less in the future than it did in the 1990s and 2000s.

Bearing these points in mind, we decided to adjust the trajectories so that there are around two years between male and female life expectancy at birth in 2060. Figure 6.10 shows how this adjustment raises female life expectancy at birth by approximately 0.9 years in 2060. The increase proves effective in removing cross-overs in male and female death rates up to 2060 for all age groups. Instead of increasing life expectancy at birth for women, we could have chosen to lower male life expectancy. However, observing the development of female mortality in older ages in countries with clearly higher life expectancy than Norway (e.g. Japan, France, Spain and Italy), suggests we might expect to observe greater progress among women than among men. Moreover, given that the evaluations of previous projections have shown Statistics Norway to have systematically underestimated the development of male life expectancy (Rogne 2016), we feel justified in our approach. This discretionary adjustment, as well as the selection of shorter time series, was made following discussions with the advisory reference group on mortality (see foot note 16). The group consists of mortality experts from national and international institutions.

Figure 6.10 Life expectancy at birth for men and women, with and without discretionary adjustment, registered 2000-2019 and projected 2020-2100[1]



[1] Dashed line shows the medium alternative.
Source: Statistics Norway

Mortality is projected up to and including the year 2100. The adjusted projected death rates from the Lee-Carter and ARIMA modelling framework are converted into probabilities and then used as assumptions in Statistics Norway's population projection model, BEFINN. The probability of death varies only by sex, one-year age group and calendar year. We therefore do not take into account characteristics such as immigration category, country of birth or duration of stay.

In the future, immigrants will make up a larger share of the Norwegian population, from approximately 15 percent today to around 19 percent in 2060. Recently published studies comparing the mortality rate among immigrants and Norwegian-born children of two immigrant parents with the rest of the population show that, as a broad group, immigrants have a lower mortality rate (Syse et al. 2016a, Syse et al 2018). After accounting for the variables included in the BEFINN projection model (age, sex, calendar year and country group), the difference in the mortality rate is around seven to eight percentage points in total. This is a relatively small difference, and the difference also varies with age, duration of stay and country group of origin. While immigrants from Country Group 1, that is, Western Europe, the United States, Canada, Australia and New Zealand, have approximately the same mortality rate as the rest of the population, the mortality rates in Country Group 2 (new EU countries from Eastern Europe) and Country Group 3 (the rest of the world) are somewhat lower. However, with increased duration of stay in Norway, the mortality rate among immigrants from country groups 2 increases, such that their mortality converges to that of the rest of the population. Since the share of the immigrant population with longer durations of stay is expected to increase in the coming decades (see Chapter 7), the error associated with not accounting for immigrant/Norwegian born mortality disparities should decrease. Thus, for the time being, our models assume equal mortality rates for immigrants and the rest of the population (i.e. non-immigrants).

Considerations of the COVID-19 pandemic

While many other countries, such as Italy, Spain, Sweden and the United States have experienced high death tolls (EuroMOMO 2020, NCHS 2020), according to figures in StatBank Norway, reported mortality figures for Norway have not exceeded normal levels for the time of year.[18] By mid-May 2020, fewer than 240 persons had died of COVID-19, and most of these deaths involved the elderly and those with underlying diseases (NIPH 2020a, Zhou et al. 2020). The mean age at death of victims of COVID-19 is currently 82 in Norway, with the majority of deaths taking place in nursing homes (NIPH, 2020a). To offer some perspective, the median survival time in Norwegian nursing homes in non-pandemic contexts is approximately two years (Vossius et al. 2018). Based on the low number of deaths, the current knowledge of risk factors, and after dialogue with the advisory reference group for mortality, it is our opinion that many of these deaths would likely have occurred within the next few years even without the pandemic. Consequently, we do not expect to observe appreciable increases in mortality in our medium assumption of life expectancy. If there are appreciable effects on the mortality rate resulting from COVID-19, the low and constant assumptions of future life expectancy may be more appropriate in the short term.

Uncertainty and alternative trajectories

We do not know for sure how mortality will develop in the future and given the COVID-19 pandemic there is now an increased degree of uncertainty in the short term. To illustrate this uncertainty, we calculate four options for future mortality. The estimated (adjusted) projection using the ARIMA model is referred to as the medium alternative, around which we specify an 80 percent prediction interval, in line with international recommendations (Savelli and Joslyn 2013). The lower limit in the prediction interval for life expectancy is called the low alternative (low life expectancy), while the upper limit is called the high alternative (high life expectancy). In other words, we consider it 80 percent likely (odds of 4 to 1) that the future life expectancy at birth will be between these limits. In addition, we calculate a constant alternative, where the death rates for the first projected year are kept constant for all subsequent years. To further illustrate uncertainty, this chapter also presents estimates of life expectancy at birth with broader (95 percent) and

[18] https://www.ssb.no/en/statbank/table/07995/

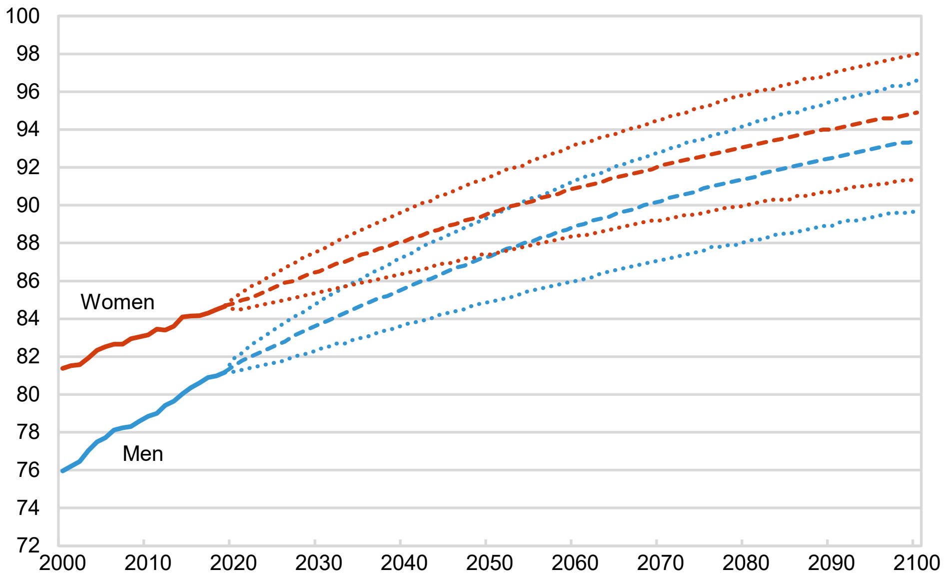
narrower (67 percent) prediction intervals, representing the low and high life expectancy alternatives (see Figure 6.12).

6.3. Assumptions about future mortality and life expectancy in this year's projection

Since 1990, life expectancy at birth has risen by 7.8 years for men (approximately three months per year) and 4.9 years for women (approximately two months per year). In this year's projection, we assume that mortality will continue to decline and life expectancy to subsequently increase. In the population projection medium alternative, we have assumed that male life expectancy at birth will rise by 7.7 years, from 81.2 years in 2019 to 88.9 years in 2060. For women, we expect a somewhat less steep rise, at 6.2 years, from today's 84.7 years to 90.9 by 2060. By 2040, the corresponding increase for men and women is expected to be around 4.4 years for men and 3.4 years for women, which translates into a life expectancy at birth of 85.6 and 88.1 years, respectively.

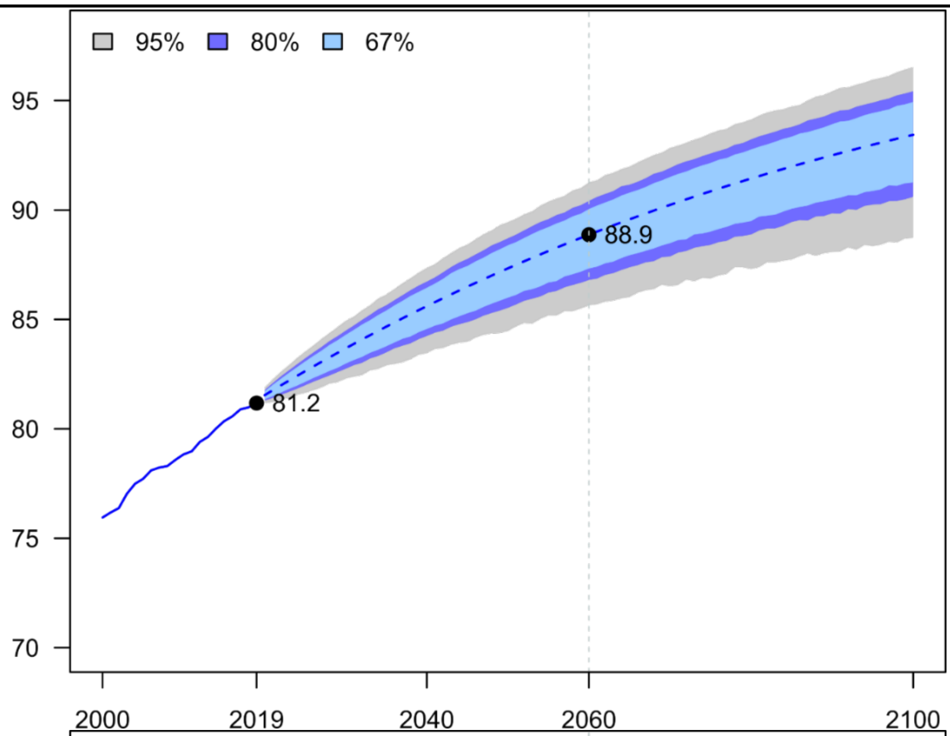
Because the trend in mortality is uncertain, we create alternatives for stronger and weaker increases in life expectancy. In the high alternative, the increase to 2060 is just over 10 years for men (to 91.3 years) and almost 9 years for women (to 93.2), whereas in the low alternative a weaker growth of around five years for men (to around 86.0 years in 2060) and almost four years for women (to 88.4) is assumed. The projected alternatives for life expectancy at birth for men and women are shown in Figure 6.11. From Figure 6.12 we can see that the uncertainty in the projection increases with time as we shift further from the projection baseline.

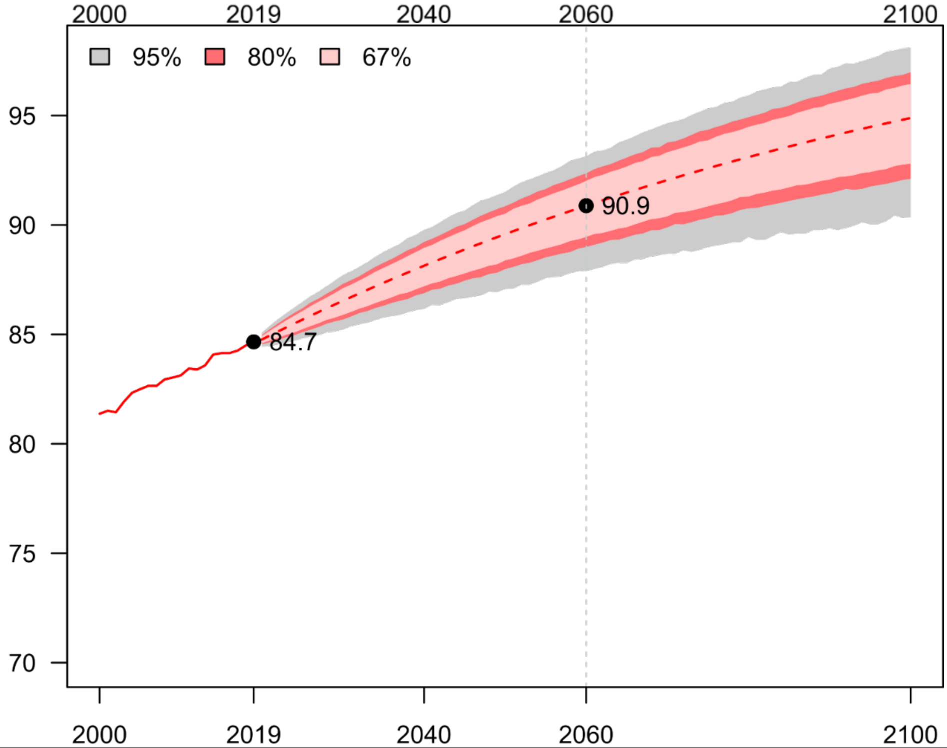
Figure 6.11 Life expectancy at birth for men (blue) and women (red), registered 2000-2019 and projected 2020-2100 in three alternatives[1]



[1] Dashed lines show the medium alternative, dotted lines show the high and low alternatives.
Source: Statistics Norway

Figure 6.12 Life expectancy at birth for men (blue) and women (red), registered 2000-2019 and projected 2020-2100, medium alternative with prediction intervals[1]

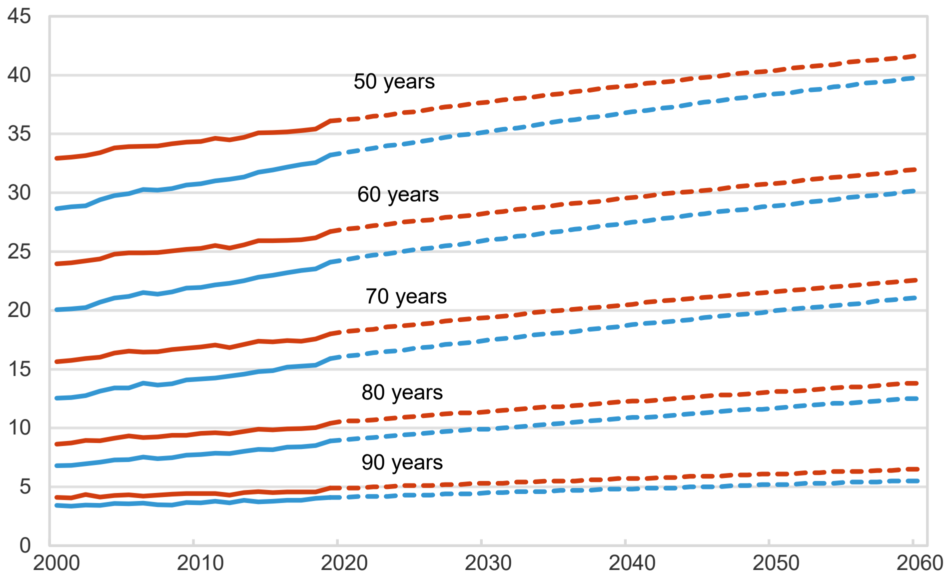




[1] Dashed lines show the medium alternative, while the shaded areas show the 67, 80 and 95 percent prediction intervals, respectively. The low and high alternatives correspond to the outer edges of the dark blue and dark red areas, as seen in Figure 6.11.

Source: Statistics Norway

Figure 6.13 Life expectancy at ages 50, 60, 70, 80 and 90, for men (blue) and women (red), registered 2000-2019 and projected 2020-2060, medium alternative

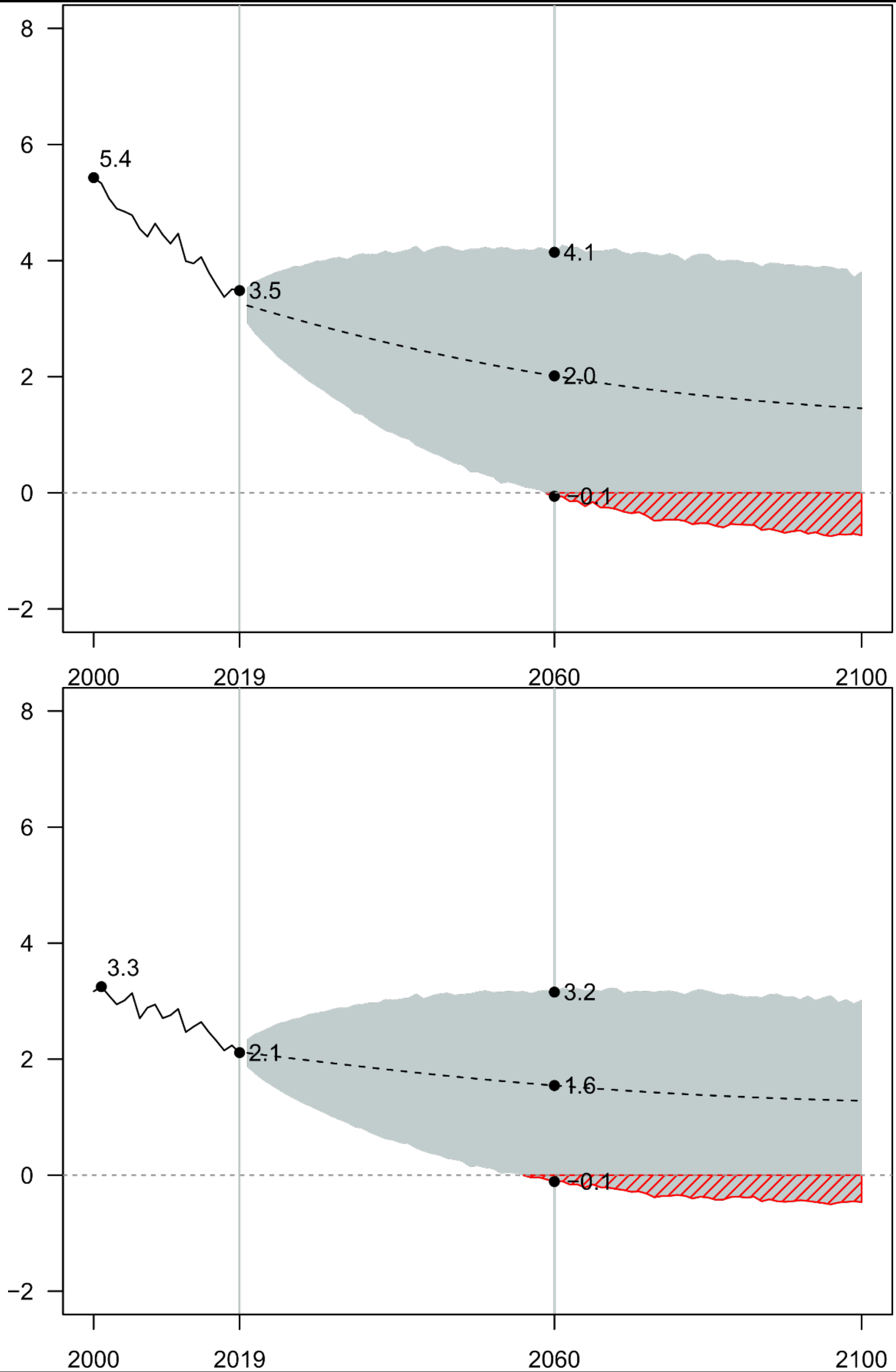


Source: Statistics Norway

As shown in Figure 6.13, we expect remaining life expectancy to increase, even among the very oldest in society. For 60-year-olds, remaining life expectancy in 2019 was just over 24 years for men and almost 27 years for women. In the medium alternative, 60-year-olds in 2040 are expected to have a remaining expectancy of almost 28 years for men and 30 years women. By 2060, men aged 60 are estimated to expect an average remaining life expectancy of just over 30 years, while women are estimated to have a remaining life expectancy of 32 years. As we move up the age distribution the relative increase in life expectancy is lower. For 90-year-olds in 2019, remaining male life expectancy was 4.1 years, while for women it was 4.9 years. By 2040 we expect this to increase to 4.8 years and 5.7 years, respectively. In 2060, it is expected to increase slightly more, to 5.5 years for men and 6.5 years for women.

Based on the medium alternative, Figure 6.14 shows the registered and projected difference between male and female life expectancy at birth (top) and at age 70 (bottom), with 80 percent prediction intervals indicated by the shaded area. The sex difference in life expectancy at birth is assumed to fall from 3.5 years to 2 years by 2060 – a result of our discretional adjustment. The area in red indicates that there is a very small chance that men will have a slightly higher life expectancy at birth by 2060. The difference between men and women in terms of remaining life expectancy at age 70 is also expected to fall, from 2.1 years in 2019 to 1.6 year in 2060. As time passes though, the pace of this reduction in the sex differential is expected to decline.

Figure 6.14 The difference between male and female life expectancy at birth (top) and age 70 (bottom), registered 2000-2019 and projected 2020-2100[1]



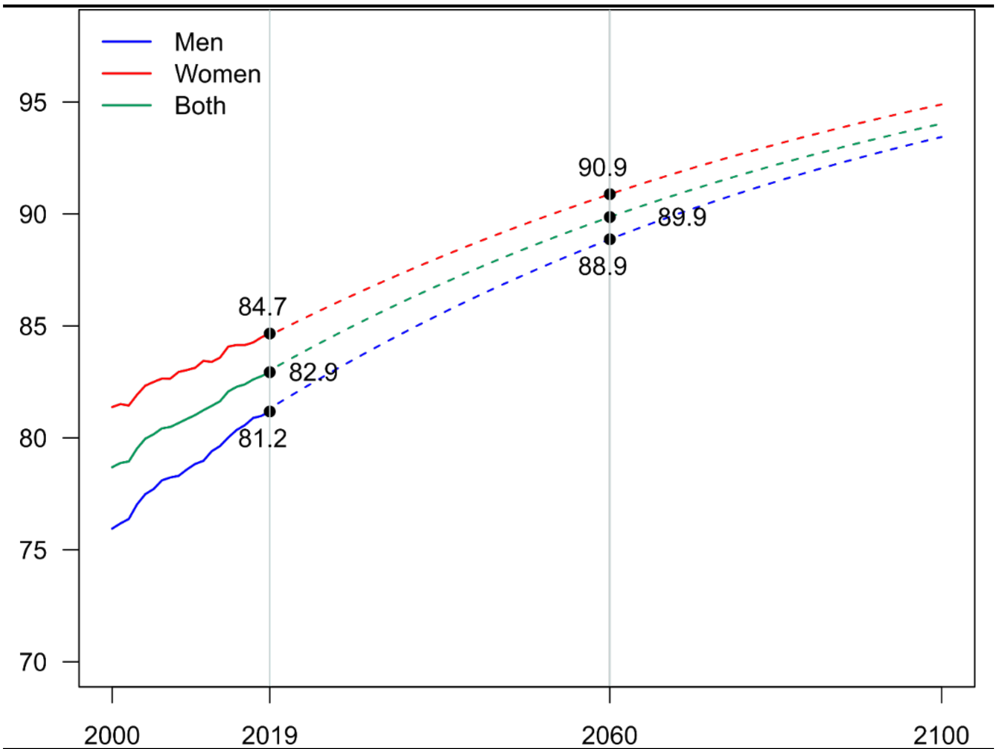
[1] Dashed line shows the medium alternative projection, while the coloured area shows the 80 percent prediction intervals. The area coloured red is where the difference is negative, suggesting there is a very small probability that men will have a higher (remaining) life expectancy than women in those years.
Source: Statistics Norway

6.4. Results from this year's projection

Life expectancy for both sexes combined

Life expectancy at birth for men was 81.2 years in 2019, and by 2060 it is expected to rise to 88.9 years according to the medium alternative. For women, life expectancy at birth was 84.7 years in 2019 and is expected to rise to 90.9 years by 2060. For both sexes combined, life expectancy at birth in Norway was 82.9 years in 2019 and by 2060 this is expected to increase to 89.9 (Figure 6.15). Projected estimates for both sexes combined can be useful for pension planning, since it is the combined remaining life expectancy that is used within pension calculations (Fredriksen and Stølen 2011). For the period 2019-2100, life expectancy at birth and remaining life expectancy for both sexes combined are published at the StatBank (https://www.ssb.no/en/statbank/table/12886).

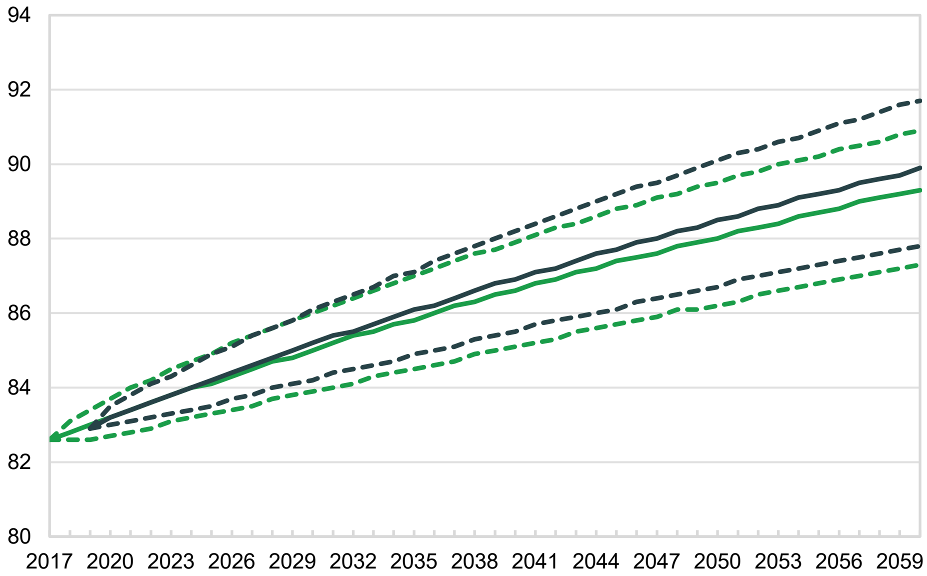
Figure 6.15 Life expectancy at birth for men (blue), women (red) and both sexes combined (green), registered 2000-2019 and projected 2020-2100, medium alternative[1]



Source: Statistics Norway

If we compare life expectancy at birth for both sexes combined in this year's projection to that from the previous projection in 2018, the estimate from the 2020 population projection is 0.3 years higher in 2040 and 0.6 years higher in 2060 (Figure 6.16). More details on the comparison with the 2020 projection can be found in Box 6.3.

Figure 6.16 A comparison of life expectancy at birth for both sexes combined in the 2018 (green) and 2020 (black) projections in three alternatives, 2017-2060[1]



[1] The solid lines represent the medium life expectancy alternatives, the upper dashed lines show the high life expectancy alternatives, while the lower dashed lines show the low life expectancy alternatives.
Source: Statistics Norway

In the next section, we will discuss life expectancy from a period and a cohort perspective. If, as expected, mortality improves over time, period life expectancies will underestimate expected lifespans. In doing so, we will also underestimate the real future pension costs. Cohort life expectancy incorporates improvements over time and can therefore be considered a more realistic measure of how long a person of a given age at a given time can be expected to live, on average.

Period versus cohort perspectives

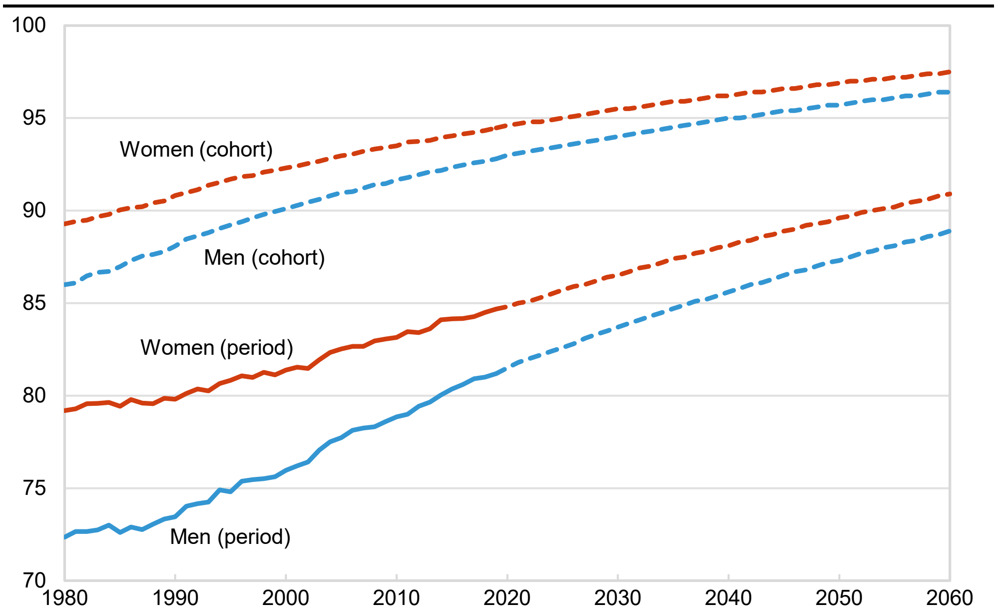
To have a definitive measure of life expectancy we must wait until everyone in a cohort has died. Consequently, it is common to construct a hypothetical cohort from which trajectories in life expectancy at birth and remaining life expectancy can be estimated. The most common means of estimating life expectancy is through the period approach. Period life expectancy estimates represent the average number of years a person can be expected to live according to the mortality experience of the entire population in a single-year (see Box 6.1). Period life expectancies are often criticised however, due to an assumption that mortality rates remain fixed throughout the remainder of a person's life. If, as expected, mortality improves over time, period life expectancies will underestimate expected lifespans.

For some birth cohorts it is now possible to compare estimated life expectancy at birth with realised durations of life. Indeed, for persons born prior to 1920, the average life expectancy was far higher than that obtained by calculating period-based life expectancy on the mortality pattern in the year of birth. Taking the 1900 birth cohort as an example, and disregarding the effects of immigration and emigration for simplicity, the estimated period life expectancy at birth for both sexes combined was around 54 years. However, over 56 percent of the 1900 birth cohort was still alive by age 60. By ages 70, 80 and 90, the percentage living was 46, 27 and 7 percent, respectively. As such, the majority lived significantly longer than the estimated (period) life expectancy at birth.

Period life expectancy remains a useful measure of mortality trends, with the benefit of requiring only a single year of data. Cohort life expectancies, on the other hand, require many years of historical and projected mortality rates. Cohort life expectancy estimates represent the average number of additional years a person can be expected to live according to the assumed future changes in mortality for their cohort over the remainder of their life. These estimates are calculated using registered and projected age-specific death rates for the same cohort throughout their life (e.g. for a cohort born in 2019, life expectancy is based on registered death rates for age 0 in 2019 and projected death rates for age 1 in 2020, for age 2 in 2021, etc.). Thus, in order to produce a cohort perspective of life expectancy for ages 0-105 over the period 2019-2100, we require registered historical mortality rates starting in 1914 (105-year-olds in 2019) and medium alternative projected death rates up to 2205 (i.e. 105 years of data for those born in 2100). The benefit of this approach is that we are able to take into account assumed mortality changes over time, and from this perspective cohort life expectancies can be considered a more realistic measure of how long a person of a given age in a given year will be expected to live, on average. However, it should be noted that the assumptions on future mortality changes become less reliable the further forward we move from the projection baseline, i.e. 2019.

Figure 6.17 shows the difference between the period and cohort estimates of life expectancy at birth for men and women, based on registered and projected mortality rates for both men and women. It is immediately apparent that life expectancy calculated from a cohort perspective is considerably higher than life expectancy calculated from the period perspective. Indeed, by taking into account assumed improvements in mortality, cohort life expectancy at birth in 2040 is estimated to be more than 9 years higher for men and 8 years higher for women, than the corresponding period estimates. By 2060, cohort-based life expectancy at birth is estimated to be approximately 96 years for men and 98 years for women. Estimates for cohort life expectancy up to and including 2100, by age and sex, are now published at the StatBank (https://www.ssb.no/en/statbank/table/12889/).

Figure 6.17 Period and cohort life expectancy at birth for men and women, based on registered and projected mortality rates, 1980-2060[1]



[1] Dashed line shows the medium alternative projection, while the solid line shows estimates based solely on registered data. For cohort life expectancies, all estimates draw, to varying degrees, on projected mortality rates.
Source: Statistics Norway

Future number of deaths

The number of future deaths is determined by population size, sex and age structure, as well as age- and sex-specific mortality patterns. According to our medium alternative (MMM), the number of deaths will increase from around

40 700 in 2019, to around 53 000 in 2040 and 62 000 in 2060. In the low life expectancy alternative (MLM), there will be a stronger increase in the number of deaths, with around 57 300 deaths expected in 2040 and 65 300 expected in 2060. In the high life expectancy alternative (MHM), it follows that we have a less significant increase in the number of deaths, with 49 000 expected in 2040 and around 58 000 expected in 2060.

The number of deaths will increase in the future because there will be more elderly people in the population, which is largely driven by the ageing of the large post-war cohorts. Today, the oldest in the population are drawn from the relatively small birth cohorts of the interwar years. Consequently, the number of deaths will remain relatively low in the short term, but a considerable increase will be observable from around 2030-2035. The average age at death in Norway will continue to increase in the coming years. According to the medium alternative, the average age at death will increase from around 80 years today, to 85 years in 2040 and 89 years by 2060. As discussed in Chapter 1, we can expect the elderly to constitute an increasingly significant share of the population, while the age of the very oldest should also increase steadily. The consequences of delayed mortality are discussed below in Section 6.5.

Box 6.3. Changes from the last projection

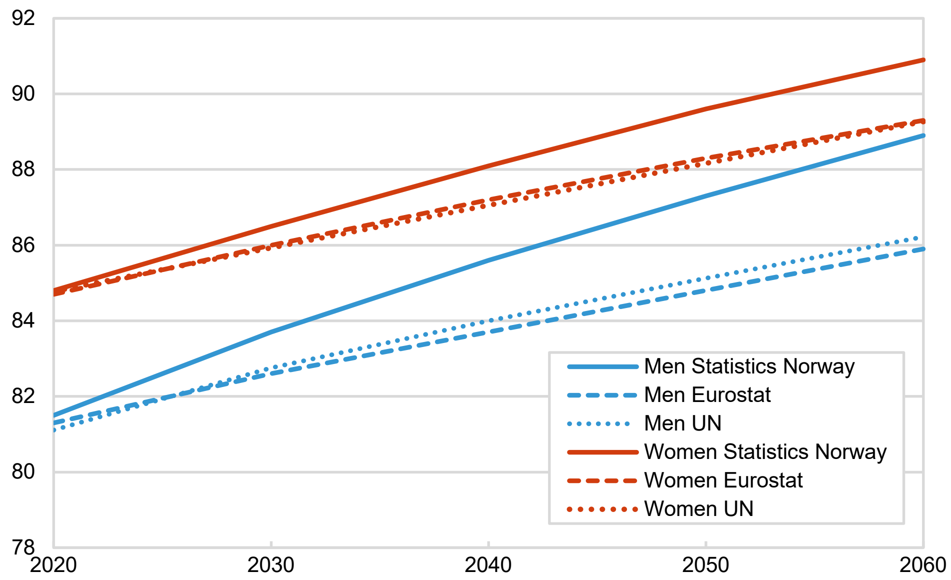
In the medium alternative for the 2018 projections, it was assumed that male (period) life expectancy at birth would rise to around 85.4 years in 2040 and 88.4 years in 2060. The corresponding figures for women were 87.8 and 90.3 years. An evaluation of the accuracy of these estimates in the very short term shows that the 2018 projection very slightly underestimated life expectancy by between 0.1-0.2 years, and thus projected around 200 fewer deaths in 2018 compared to what was observed. For 2019, however, the projected number of deaths was spot on.

In this year's projection, we have assumed a somewhat stronger long-term increase in life expectancy, though in the short-term the estimates remain close to the previous projection. Compared to the medium alternative in the 2018 projection, male life expectancy at birth is the same in 2022 but is increased by 0.2 years in 2040 and 0.5 years in 2060. The corresponding figures for women are 0.0, 0.3 and 0.6 years. This year's medium alternative (MMM) gives a total of about 50 fewer deaths in 2022 and around 1 400 fewer deaths in 2060 than the medium alternative in the previous projection.

6.5. Life expectancy projections from an international perspective

Both Eurostat (2020) and the United Nations (2019) publish their own life expectancy projections for Norway. The United Nations publishes estimates for five-year periods, with the calculated figures suggesting an estimated life expectancy for Norwegian men of 86.2 years in 2060, while the corresponding estimate for women is 89.3 years. The corresponding figures from Eurostat are 85.9 years and 89.3 years, respectively. Figure 6.18 compares the development of the three projected middle alternative estimates. Statistic Norway's own projection is clearly the highest, with the difference for men between Statistics Norway and Eurostat being the most pronounced at around three years in 2060. For women, the difference between the projections is around 1.5 years.

Figure 6.18 A comparison of life expectancy at birth medium assumptions for Norway made by the United Nations, Eurostat and Statistics Norway, 2020-2060[1]



[1] United Nations probabilistic projections based on to 5-year grouped estimates (e.g. 2020-2025, 2030-2035, etc.). Eurostat and Statistics Norway projections are based on single-year estimates (e.g. 2020, 2030, etc.).
Source: United Nations, Eurostat and Statistics Norway.

Compared to the other Nordic nations, the 2020 population projections produced by Statistics Sweden and the 2019 population projections produced by Statistics Denmark provide very similar estimates for life expectancy at birth by 2060, at around 87 years for men and 89 years for women.[19] Meanwhile, Statistics Finland's 2019 population projections assume a life expectancy at birth of 87.5 years for men and 90.7 years for women in 2060. Thus, by 2060, Norway assumes around a two-year life expectancy advantage over Sweden and Denmark, while for Finland we assume a slightly smaller advantage for men (1.4 years higher), while our estimates for women are very similar. Updated figures from Statistics Iceland are not yet available.

6.6. Consequences of increased life expectancy

Ageing

Population ageing in Norway will be far weaker than is expected in many other countries (see Chapter 1, and Raftery et al. 2013, United Nations 2019). This is because Norway has seen a smaller fall in fertility and a relatively high immigration of younger cohorts compared to other countries in Europe, while life expectancy has also not been among the highest.

Still, as is shown in Table 6.1, both the number and proportion of older people will increase significantly in the future. Growth is relatively marked in all three life expectancy alternatives. In the medium alternative, the group comprising those aged 70 years or older is expected to more than double by 2060: From just over 670 000 to almost 1.4 million people. As a share of the population, this group is expected to increase from around 12 percent of the population in 2020 to around 22 percent of the population in 2060.

[19] Life expectancy by age and sex for Sweden (http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0401__BE0401A/BefProgLivslangdN/), Denmark (https://www.statbank.dk/10022) and Finland (http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__vrm__vaenn/statfin_vaenn_pxt_129b.px/).

As a group who tend to be major users of health and care services today, the number of people aged 80 years or older will more than double by 2040 and more than triple by 2060. This means an increase from approximately 230 000 today, to around 590 000 by 2040 and almost 720 000 in 2060. In percentage terms, this translates into an increase from just over 4 percent of the population in 2020, to around 8 percent in 2040 and 12 percent in 2060. The number of people aged 90 years or older is also increasing, more than doubling in size by 2040. By 2060 we expect the number of over 90s to reach 210 000, representing 3.5 percent of the total population. As we would expect, ageing is somewhat weaker in the low-life expectancy alternative and slightly greater in the high life expectancy alternative.

Table 6.1 Elderly in different age groups in numbers (N) and percentages (%), registered and projected for selected years in three alternatives[1]

	Total population	70+		80+		90+	
	N	N	%	N	%	N	%
2020	5 367 580	666 544	12.4	230 710	4.3	45 230	0.8
Medium alternative							
2040	5 856 800	1 096 500	18.7	491 900	8.4	108 800	1.9
2060	6 073 600	1 358 100	22.4	718 000	11.8	210 400	3.5
2100	6 253 700	1 619 800	25.9	983 500	15.7	376 200	6.0
Low life expectancy							
2040	5 789 800	1 042 000	18.0	451 900	7.8	92 200	1.6
2060	5 923 600	1 231 800	20.8	615 100	10.4	155 700	2.6
2100	6 005 500	1 405 600	23.4	793 800	13.2	245 400	4.1
High life expectancy							
2040	5 918 500	1 148 300	19.4	531 500	9.0	126 900	2.1
2060	6 209 700	1 479 100	23.8	821 900	13.2	274 200	4.4
2100	6 474 100	1 827 500	28.2	1 178 500	18.2	534 800	8.3

[1] The population estimates refer to the population on 1 January.
Source: Statistics Norway

The marked increase in the proportion of elderly people also means that the old age dependency ratio (OADR), here as the ratio between the number of persons aged 65 and over and the number of persons aged 20–64, will increase regardless of the projection alternative used. Today, the OADR is 0.30. In 2040 this is expected to reach 0.45, and by 2060 it is expected to reach 0.55 according to the main alternative. If correct, this means that there will be 55 older people per 100 people of working age by the year 2060. In contrast, the child support burden will remain reasonably stable, ranging between 0.39 today to around 0.38 in 2060. Consequently, there will be more older people (65+) than children in Norway. This point is discussed in more detail in Section 1.2.

The elderly contribute in the labour market, in voluntary work and in informal care for parents, friends and grandchildren. At the same time, they are also major consumers of health and care services. The health and well-being of the elderly will have a great influence over both their future needs for services, as well as their abilities and opportunities to contribute. With population ageing expected even in low life expectancy alternative, health in old age is discussed in the next section.

Life expectancy and future morbidity

We assume that the elderly population will live considerably longer in the future than they do today. We expect particularly strong growth among those over 75. Increased life expectancy is an unconditional good if the *quality* of the extra years is also good. However, given that increased life expectancy in the European context now translates into a longer period of life in the very oldest ages, many people are now living with the chronic health problems that often come with the ageing process.

Yet, the consequences of population ageing are neither obvious for society, nor for the individuals who are soon to enter old age. This is because we still have limited knowledge about how increased life expectancy relates to changes in morbidity (Prince et al. 2015). Whether an increased number of years of life results in an average of more, fewer, or as many years in good health is currently unclear (Crimmins and Beltran-Sanchez 2011). Today there are three alternative scenarios for morbidity that are supported, to varying degrees, by the scientific literature: i) Compressed morbidity, where the number of healthy years increases more than the number of years of life; ii) Suspended morbidity, where morbidity comes later, and the number of healthy years increases as much as the number of years of life; and iii) Prolonged morbidity, where, as life increases, so does the time people spend with illness and/or disability. We elaborate on these scenarios in more detail below.

Prolonged morbidity
If we assume that morbidity in the future is prolonged, so that the number of life years spent with illness increases more than the number of healthy-life years, population ageing will result in more elderly with more health problems. Prolonged morbidity implies that more elderly people will need health and care services than before. Most likely, this will have negative implications for the elderly themselves, in the form of pain and distress, feelings of inadequacy and a generally lower quality of life. It may also have implications in terms of placing greater pressure on family members, with potentially problematic consequences for labour-market engagement among their adult children, especially among female adult children (Jakobsson et al. 2013), and their ability to balance various other important daily demands. This scenario might also be expected to have a negative impact on the health of the generation below, wherein the prioritisation of necessary care activities for sick parents might lead to a lack of attention being paid to their own health and wellbeing (Leopold et al. 2014). Beyond this, the age at which participation in the labour-market can be increased is not expected to rise to the same extent as the pension reform proposes, as more people will be prevented from participating in work due to the onset of morbidity. On the other hand, the proposed reforms could be appropriate if the scenario of suspended morbidity plays out.

Suspended morbidity
Let us assume that morbidity occurs later in life, but to the same extent as life expectancy increases. This will have a strong impact on public finances through increased costs for pension withdrawals and health service provision (Bloom et al. 2015). Still, the consequences for health costs will be less than in the scenario of prolonged morbidity.

As life expectancy increases, the average period at which retirement benefits can be accessed will be extended. Although many countries have implemented reforms to minimise the effects of ageing, by adjusting for increased longevity in pension schemes, pension costs are expected to continue to increase (Bloom et al. 2015). Norway is no different, because the total number of pensioners is expected to increase (OECD 2019b). However, if morbidity is postponed, it is conceivable that older people could work longer, and thus partially compensate for this. This contrasts with the prolonged morbidity scenario described above. However, it remains unclear as to whether the health of the elderly would be affected, in a negative or positive sense, by working into older age. Indeed, studies in this field find mixed results, with support for a deterioration, an improvement and no change in health observed (see Syse et al. 2016b). This is an area that requires further investigation before decisions are made to raise the age of retirement.

Another factor worth considering is how a delay in morbidity might affect the interventions needed to treat illnesses. For example, the average costs of treatment and care can increase with age, as conditions in the oldest age groups tend to require longer hospital stays and more complex treatments covering multiple conditions at the same time (Bähler et al. 2015), although higher levels of education and fewer elderly people living alone may prove to be countervailing factors. It is more uncertain how the effects of having a more diverse older age population will play out, as elderly immigrants from non-Western backgrounds come with differing cultural factors, social network characteristics and a differing balance between formal and informal care provision.

Compressed morbidity
If we assume that morbidity in the future will be compressed, such that the number of healthy-life years increases more than the number of years with illness, the future looks brighter. In this case, a larger share of the elderly population will be able to manage at home without formal public care assistance. At the same time, older people will be better able to play a role in care provision for their own families, as well as potentially contribute to their wider community and economy (Rogne and Syse 2017), with some adjustments (discussed below). This could be especially important in communities with high OADRs and deficits in the share of younger people of working age.

In line with this, Statistics Norway (2016) has estimated that 84 percent of women's lifetimes will be in good health, while this applies to a full 91 percent of men's lifetimes. This share has increased since 2005. To some extent, compressed morbidity could be achieved through the reorganisation of living conditions and the local environment, as functional ability inherently involves interaction with the environment (WHO 2001). The WHO (2002) describes how active ageing can be improved through the implementation of 'age-friendly' initiatives (WHO 2002). In Norway, this was emphasised by the Hagen Committee (ONR 2011), the Norwegian Government's strategy for an age-friendly society (MHCS, 2016), and even more recently by the Norwegian Ministry of Health and Care Services (2018) reform 'A full life – all your life'. The latter targets the implementation of improvements in areas such as activity and socialisation, food and meals, healthcare and continuity of services. If one can organise living conditions and the local environment to meet these priorities, the elderly will be better placed to utilise their own resources well into old age, something that would also benefit other groups in society.

The self-reliance associated with mortality compression also implies a reduced need for care-related services among the elderly. Vision-related operations and the increased use of hearing aids are existing examples of developments that have already helped to improve the self-reliance and independence of the elderly. With that said, recent research has noted how similar or even greater levels of demand might still emerge in this scenario because of developments in the occurrence of, for example, cancer, obesity and dementia. As such, the needs of health and care services are expected to change in line with the changing prevalence of different illnesses and conditions. Indeed, findings from the Nord-Trøndelag Health Study (HUNT) suggest that, despite older people reporting better health functioning in daily life than in previous decades, the use of general practitioners and outpatient clinics has increased significantly (Aunsmo and Holmen 2017) – though caution should be applied to these findings due to low participation rates in recent rounds of the survey.

What does the research say?
The relationship between increased life expectancy and morbidity in older age has been a key focus of research for many decades, and it remains so today (Gruenberg 1977, Fries 1980, Chatterji et al. 2015, Jagger et al. 2016, Zeng et al. 2017). A relatively recent study summarising the international research on developments in

this area emphasises the point that there exists no clear evidence in support of any one of the three alternatives (Chatterji et al. 2015). It appears that different health indicators provide support for slightly different alternatives. For instance, Chatterji et al. (2015) find that if morbidity is measured as functional limitations in everyday life, the hypothesis of suspended morbidity is supported – that is, increased life expectancy comes with more years in good health. But if morbidity is defined as living with a chronic illness, they find support for the hypothesis of prolonged morbidity – wherein increased longevity brings with it an increased period in poor health.

Research by Jagger et al. (2016) has identified trends towards lower cognitive impairment, more healthy years of life and a decline in mild disabilities, but no decline in severe disabilities. Meanwhile, it has been suggested that increased longevity may lead to an extension of the period of impaired physical and cognitive functioning because an ever-increasing number of frail and elderly survive with health problems (Zeng et al. 2017). Similar implications of morbidity have been documented in a Swedish study that looks at changes in both subjective and objective measures of health among the elderly, contrasting data from 1992 and 2002 (Parker et al. 2005). It appears that groups who live the longest experience fewer and slower functional impairments than those who die earlier (Verbrugge et al. 2017). In Norway, there is a suggestion that the period of functional limitations before dying has become somewhat shorter, while life expectancy has increased (Langballe and Strand 2015). However, in the short period until death, everyone can expect to experience a brief reduction in functioning (Elstad and Reiertsen 2018, Chernew et al. 2016, Gregersen 2014, Riley and Lubitz 2010), a fact that will remain the same for all the scenarios discussed here.

To summarise, except for the increased occurrence of dementia, there is little research to suggest that Norway will experience a scenario of prolonged morbidity. Moreover, it is conceivable that the increased level of education among older people in the future will help to reduce the incidence of dementia, such that the consequences are less than expected in the current projections and estimates – which only account for the proportion of older people increasing (Sharp and Gatz 2011). Increasing obesity and possible antibiotic resistance can increase morbidity, but they are also likely to reduce life expectancy – and thus not significantly prolong morbidity. This point has been noted in research from the United States, where, after decades of declining mortality, there is now a trend toward increasing mortality among middle-aged people (Case and Deaton 2015). However, we can be fairly confident that the increased number of elderly people will lead to increasing numbers of people with cancer, since cancer is very closely linked to ageing. Given the dramatic improvements in cancer survival in recent decades, a trend which is expected to continue, more people will live with the difficult experiences of cancer and its treatment (Cancer Registry of Norway 2019).

Use of health and care services

Older people often suffer from several simultaneous health problems (Verbrugge et al. 2017). For instance, more than 45 percent of Americans aged 65 or over report having two or three health problems, while an additional 14 percent report having more than four (NIA 2017). Norwegian statistics are not as good in this area, but according to the Survey on Living Conditions, 46 percent of those aged 67 and older responded that they were struggling with long-term illness or a health problem – the corresponding figure is 34 percent for those aged 66 and below (Statistics Norway 2016). Many of the older people suffering from multiple health problems will of course require considerable support from formal, and informal, health and care providers.

Regardless of how morbidity trends develop in the future, a combination of an ageing population and demands for continued improvements in the medical and health sectors will inevitably lead to increased future costs for service providers (European Commission 2016, OECD 2019b, Holmøy and Nielsen 2008). Future health and care expenses are expected to increase significantly by 2060, while the increased number of older people may well demand an increased number of employees in the health and care services (Holmøy et al. 2016), something which could prove difficult in the context of a shrinking working-age population.

Possible consequences of the future morbidity scenarios
At the national level, several measures have been implemented in anticipation of prolonged population ageing. The retirement age has been increased, the pension system has been reformed, and more treatment has been moved from specialist to municipal health care providers. Whether these measures will prove adequate will depend on the relative health status and functioning of the future elderly population.

Whether the projected compression of the age at death coincides with a compression of morbidity is not yet obvious. However, a consequence of our expectation for a compression in the time of death should make it easier to plan, as the need for medical, health and care-related services are known to be greatest in the immediate years before death. Indeed, it is estimated that 18-28 percent of total health service provision is offered in this period (Gregersen 2014). With that said, the treatments received by older persons in the final years of their life tend to be cheaper than those received by younger individuals in the same situation, meaning that the health care costs associated with illnesses linked to death are lower among the elderly (Gregersen 2014). It has also been noted that the elderly have fewer admissions to hospital prior to death than is the case among younger age groups who are close to death (Elstad and Reiertsen 2018). Thus, although health costs are strongly related to age, these may become somewhat more affordable if people are older when they require more intensive health and social care – at least in a scenario of suspended morbidity. On the other hand, we know that individuals with high educational attainment, and more resources, often receive more specialised treatment (Fiva et al. 2014), which could work to push in the opposite direction and therefore increase costs.

Increasing life expectancy and more elderly people are likely to increase the use of both home-based services and residential/institutional services. A Finnish study showed that hospital use before death declined among the very oldest, but that the use of nursing homes increased to such an extent that the overall cost of institutionalisation would rise in accordance with longer life expectancy (Murphy and Martikainen 2013). If a larger proportion of deaths in Norway in the future are due to dementia-related illnesses, the consequence may be fewer hospital admissions in the time before death but a prolonging of the time people spend in elderly care homes.

For the elderly themselves, suspended morbidity would result in more healthy years of life enabling more active participation in the community, which is in line with the perspective of active ageing (WHO 2002). The WHO defines 'active ageing' as a process to optimise health, participation, coping and safety conditions in order to improve the quality of life for older people. Important determinants are the availability and quality of health and social services, the individual's behaviour, personality traits, physical surroundings, working life, as well as wider social and economic conditions. Statistics Norway (2016) describes a positive development in healthy living years, a conclusion that is partially supported by results from the International Burden of Disease Project (NIPH, 2017b).

6.7. Summary

In the population projections, assumptions about mortality and life expectancy are made using statistical models based on developments in mortality observed over recent decades. Changes in risk factors that we know have implications for mortality, such as changes in socioeconomic resources (including education, financial resources and family relationships), health behaviours (such as reduced smoking and increased obesity), causes of death (such as increased cancer incidence and reduced cardiovascular disease), are thus only implicitly taken into account to the extent that changes that have already occurred are reflected in the trends in the historical time series. In this year's projection we use time series of registered death rates (for men, women and both sexes combined) covering the period 2000-2019 as input to our Lee-Carter model.

Medical advances and fewer risk factors in everyday life (less smoking, safer workplace environments, fewer transport accidents, fewer environmental toxins, etc.) indicate that, on average, mortality will continue to decline. However, the relative rate of this decline remains uncertain, as demonstrated by our high and low life expectancy alternatives. As the COVID-19 pandemic demonstrates, the possibility of pandemics and medical setbacks, such as the growing concern of antibiotic resistance, adds a great deal of uncertainty to mortality projections. For the current pandemic, however, we do not expect any appreciable effect on short or long-term mortality rates. Diet and physical activity also affect how long we live, and if more sedentary lifestyles and increased obesity affect greater proportions of the population, this will negatively impact life expectancy in the future. Whether we will be able to meet the health and care needs of the future population at a time when the burden of elderly care is set to increase is also an open question.

For the coming years, we assume that the strong increase in life expectancy will continue approximately as before. In our medium alternative, male life expectancy at birth increases from around 81.2 years today to just over 89 years in 2060, while the increase for women is somewhat weaker, from 84.7 years today to around 91 years by 2060. Thus, we assume that the age difference between men and women will be reduced from 3.5 years today, to around two years by 2060. Life expectancy in the oldest age groups will also be characterised by strong increases. According to the medium alternative, life expectancy among 70-year-old men and women is projected to increase by around 4-5 years up to 2060. Even for 80-year-old men and women, life expectancy is expected to increase by around 3.5 years over this same period.

Given the assumed increase in life expectancy among the oldest age groups, the age composition of the Norwegian population will be very different in 2060 than it is today. Those aged 70 and over represent just over 12 percent of the population today, whereas by 2060 we expect this share to rise to 22 percent. The growth in the number of people aged 80 and over is expected to be particularly strong – increasing from around 4 percent today to around 12 percent by 2060. Unless the health of the very oldest people in society improves significantly in the future, we can expect strong increases in the demand for formal and informal health and care services.

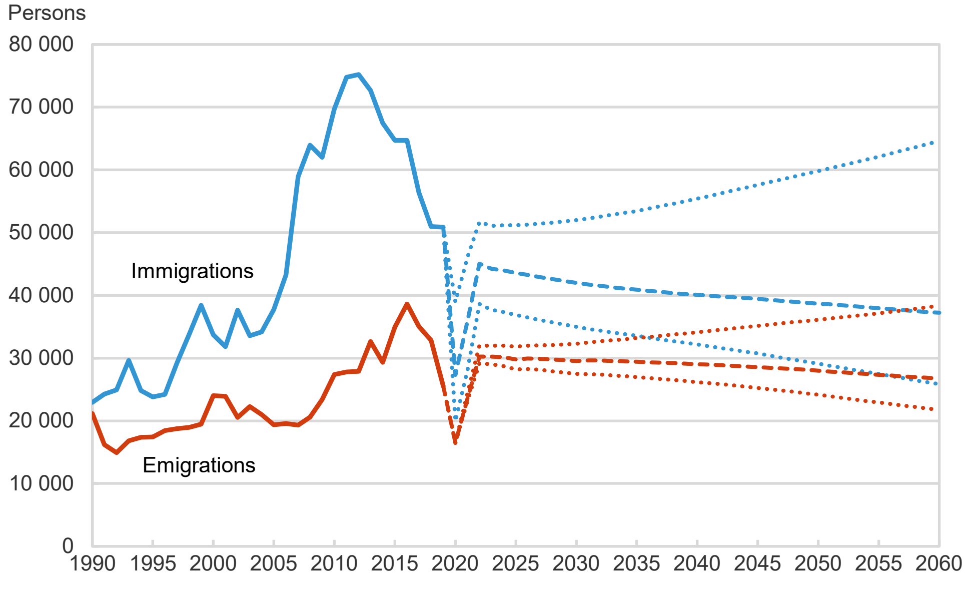
The ageing of the population will be particularly strong from 2030-2035. Fortunately, in the short-term national population ageing will be relatively weak, providing some room for necessary planning to be made. National and regional politicians will have to make important choices in the years to come; considering how best to balance priorities in health and social care against priorities in other important sectors. Difficult decisions will also emerge within the health domain, with decisions on prioritisation between different disease groups, and even within different disease groups, likely to become necessary.

7. International migration – Assumptions and results

Ådne Cappelen, Terje Skjerpen and Astri Syse[20]

In the medium alternative of the national population projections we assume that the immigration to Norway will decline somewhat, from around 45 000 in 2022 to around 37 000 in 2060. We assume that immigration will decline from all country groups, except for a slight increase in re-immigration of persons with a Norwegian background. Compared to previous projection rounds, the immigration from countries in Africa and Asia and other countries from the Global South is much lower, in part due to model changes that now mean we account for the age distribution in sending countries. People tend to migrate at younger ages, and as both Africa and Asia are projected to experience a pronounced ageing, this contributes to a reduced immigration from these countries. At the same time, we expect that Norway's economic advantage over the rest of the world will be reduced as Norwegian oil and gas revenues decline. This lowers the immigration further. Furthermore, we expect capital income from the Government Pension Fund Global to fall as a share of national income. The spending of these incomes domestically is likely to have a positive effect on Norwegian GDP. Future immigration is, however, uncertain, as is portrayed in Figure 7.1. In our low immigration alternative, we assume an even stronger decline, to around 26 000 in 2060, while our high immigration alternative assumes a relatively sharp increase, up to around 65 000 over the same period.

Figure 7.1 Immigrations and emigrations, registered 1990–2019 and projected 2020–2060 in three alternatives[1]



[1] Excludes persons who have both immigrated and emigrated during the same year. The three alternatives are MMM (main), MMH (high immigration) and MML (low immigration).
Source: Statistics Norway

Future emigration from Norway depends in part on the number of people in the country who could potentially emigrate. Immigrants are more likely to emigrate

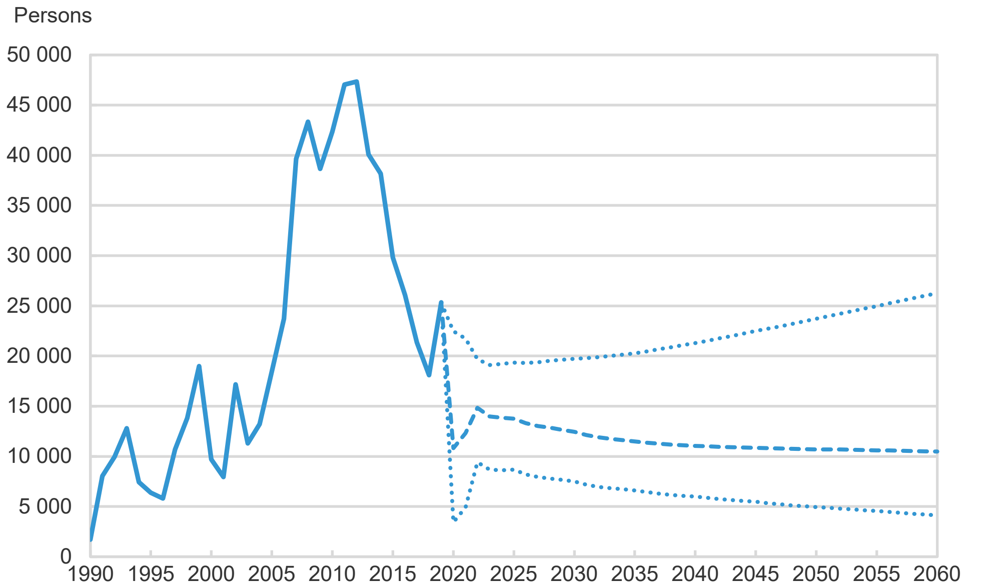
[20] We thank the advisory reference group for migration, which consisted of the following members: Jan-Paul Brekke (Norwegian Institute for Social Research), Grete Brochmann (University of Oslo), Tormod Claussen (The Norwegian Directorate of Immigration), Minja Dzamarija (Statistics Norway), Marta Bivand Erdal (Peace Research Institute Oslo), Marie Hesselberg (The Norwegian Directorate of Immigration), Lena Lundkvist (Statistics Sweden), Silje Vatne Pettersen (Ministry of Education and Research), Marianne Tønnessen (NIBR, OsloMet). Members are listed in alphabetical order with institutional association in parentheses. We are especially grateful for their useful input in the formation of our assumptions.

than persons who are born in Norway, meaning that the total emigration is expected to be higher if there are more immigrants in Norway. In the main alternative, we project fairly stable emigration levels, though there is a small decrease from around 30 000 to around 27 000 per year in 2060 (see Figure 7.1). In the low immigration alternative, we project a more pronounced decline in emigration, falling to around 22 000 in 2060. In contrast, around 38 000 are projected to emigrate in 2060 in the high immigration alternative.

Net migration is calculated by deducting annual emigration from annual immigration.[21] Before 2011, assumptions were made about future net migration, but this is now a result of the assumptions about gross immigration and emigration. However, it should be noted that for the stochastic projections, presented in Chapter 9, the projected net migration in the main alternative was delivered as input, by sex and one-year age groups.

Figure 7.2 shows the projected net migration in the main alternative, as well as in the low and high immigration alternatives. Net migration remains positive until 2060 in all alternatives, although the magnitudes vary considerably. In the main alternative, we project a yearly net migration of around 15 000 from 2022 onwards, declining gradually to around 10 000 in 2060. In the low immigration alternative, we project a more pronounced relative decline, from around 9 000 to around 4 000. In the high immigration alternative, net migration is projected to increase, from around 20 000 per year to around 26 000 in 2060.

Figure 7.2 Net migration, registered 1990–2019 and projected 2020–2060 in three alternatives[1]



[1] The three alternatives are MMM (main), MMH (high immigration) and MML (low immigration).
Source: Statistics Norway

In our main alternative, the number of immigrants in Norway will increase from 790 000 in 2020 to more than 1.1 million in 2060, and the number of people born in Norway to two immigrant parents will increase from almost 190 000 today, to 440 000 in 2060.

Projecting future immigration and emigration is notoriously difficult due to the many 'moving parts' that work to influence international migration flows, from demographic and economic developments in Norway, to relative changes in such

[21] Net migration corresponds to the difference between the number of immigrations to and emigrations from the country during a single-year period. It is net migration that constitutes the contribution of immigration and emigration to population change in Norway.

factors across the world, as well as the unpredictability of future wars, conflicts, pandemics and natural disasters. As such, uncertainty increases considerably the further into the future we look. This can be illustrated by our high and low alternatives, wherein we have produced alternative assumptions about future population development in the sending areas as well as for future income level differences between Norway and the rest of the world. The ongoing COVID-19 pandemic adds an additional layer of uncertainty to this year’s projection, meaning that uncertainty is even more pronounced than usual, also in the short-term. This is discussed in more detail in Section 7.1.

This chapter first discusses some potential impacts of the COVID-19 pandemic, before it goes on to discuss historical patterns in immigration and emigration. Next, we present the methods used by Statistics Norway in producing the assumptions about immigration and emigration, before attention turns to a focus on the results of the projection. The main focus is directed towards the forecast of gross immigration to Norway. Towards the end of the chapter, we show how the number of immigrants and Norwegian-born to two immigrant parents will change in the future based on the alternative immigration and emigration assumptions formed in this projection round.

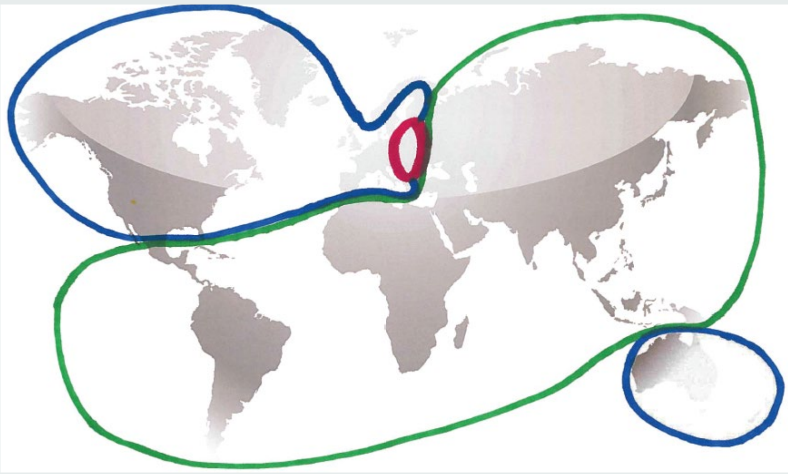
Box 7.1. The country groups

We have divided the countries of the world into three groups. Even though there are pronounced differences within each country group of origin, there are also certain similarities.

Country Group 1 comprises all the Western European countries, i.e. countries that were part of the 'old' EU (pre-2004) and/or the EEA and EFTA, as well as the US, Canada, Australia and New Zealand. On average, nationals from these countries display relatively similar demographic behaviour for fertility and emigration. Moreover, few or no restrictions apply in terms of opportunities for living and/or working in Norway.

Country Group 2 comprises the eleven new EU countries in Eastern Europe (EU members in 2004 or later): Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bulgaria and Romania. Migration from these countries was a major contributor to the immigration peak in Norway from 2007 to 2016. Moreover, of all the EU countries, it is these 11 countries where the income differences are greatest relative to Norway, while the expected demographic development in these countries also differs from other parts of the EU. As with all EU citizens, persons from this country group have the right to live, work and study in Norway.

Country Group 3 comprises the rest of the world, e.g. the rest of Eastern Europe, Africa, Asia (including Turkey), South and Central America and Oceania (excluding Australia and New Zealand). Nationals from these countries must apply for a permit to live and work in Norway. This group is particularly heterogeneous, and we have primarily grouped these countries for the sake of simplicity.



It is a person's country of origin that decides which group he or she belongs to. For persons born abroad, this is (with a few exceptions) their country of birth. For persons born in Norway, it is their mother's country of birth.

A more detailed description of which countries belong to which country group may be found in Appendix A.

Box 7.2. Immigrants, immigration, and other commonly used terminology

In the population projections – and in Statistics Norway's other statistics – an *immigrant* is defined as a person born abroad with two foreign-born parents and four foreign-born grandparents, and who are registered as resident in Norway.

Immigration is defined as the number of migrations to Norway during a single-year period, irrespective of the immigrants' country of birth or citizenship. For example, during a calendar year, immigration to Norway includes 8 000-10 000 Norwegian citizens, most of whom are born in Norway and are thus not considered immigrants.

Emigration is defined as the number of migrations out of Norway during a period, irrespective of the country of birth or citizenship.

Net migration corresponds to the difference between the number of immigrations to and emigrations from Norway during a single-year.

In the population projections, we project the population from one year-end to the next. This means that people who move in and out of the country – or vice versa – within a year are not included in the population projections figures for immigration and emigration. As such, the immigration and emigration figures from the population projections are somewhat lower than the corresponding figures from Statistics Norway's population statistics, as explained in Chapters 2 and 3. Net migration figures are, however, comparable.

Norwegian-born with two immigrant parents are defined as persons born in Norway to two parents born abroad, and who also have four grandparents who were born abroad.

When we divide immigrants and Norwegian-born with immigrants according to the three country groups, we use 'country background' and not, for example, citizenship or which country they emigrated to Norway from. *Country background* is constructed based on information on country of birth. For immigrants, this is (with a few exceptions) their own country of birth. For Norwegian-born to two immigrant parents, the mother's country of birth is used.

7.1. COVID-19 and implications for migration

The 2020 national population projections were produced during a particularly unusual and uncertain time, with all populations experiencing at least some effect of the COVID-19 pandemic, as is summarized in Chapter 1.

Since the WHO declared a pandemic on 11 March, strict global measures affecting economies and societies across the world have been implemented. On the one hand, since both the infection rate and the death tolls in Norway are minor, and our hospitals are well equipped and have the capacity to handle sick individuals, potential immigrants are not likely to avoid Norway for health reasons. On the other hand, unless the circumstances are dire, people tend to stay put in times of uncertainty (Lindley 2014). During the current health crisis, and subsequent economic crisis, most borders have been closed, making international travel very difficult. This will have clear effects on all forms of migration, from labour migration to refugee, student and family migration. In addition, quarantine regulations make it difficult to work cross-nationally, and most schools and universities have been physically closed. Furthermore, the negative economic consequences, such as increased unemployment, layoffs, and slow wage growth, are likely to have an impact. The number of refugees is also likely to decline. Very few asylum seekers have been entering Norway so far in 2020, with the number of applications having fallen drastically (UDI 2020b), see Section 7.5 for more details. In addition, there have been reduced services relating to the handling and processing of asylum seekers, while resettlement refugees have not been able to travel to the municipalities they have been granted access to, and the respective municipalities have had to direct their efforts towards managing health and local social care systems during the pandemic. Indeed, according to the Norwegian Directorate of Immigration, all of the 3 000 resettlement refugees Norway had agreed to receive in 2020 remain to be granted access (UDI 2020a). Taken together, these factors should all work to substantially reduce future immigration, at least in the short-term.

However, for persons living abroad with a Norwegian background, Norway might appear relatively more tempting than in the pre-pandemic context, as the relative situation may be worse elsewhere. The long-term effects on immigration are less clear-cut. Norway is less affected than some other countries, both in terms of the number of deaths and the economic consequences of the pandemic.

At the same time, it is reasonable to expect that emigration will be affected, with restrictions on travel and people's propensity to stay put in uncertain times both important factors. We might therefore expect a reduced emigration from Norway in the short-term. Bringing expectations about immigration and emigration together, net migration might be less affected.

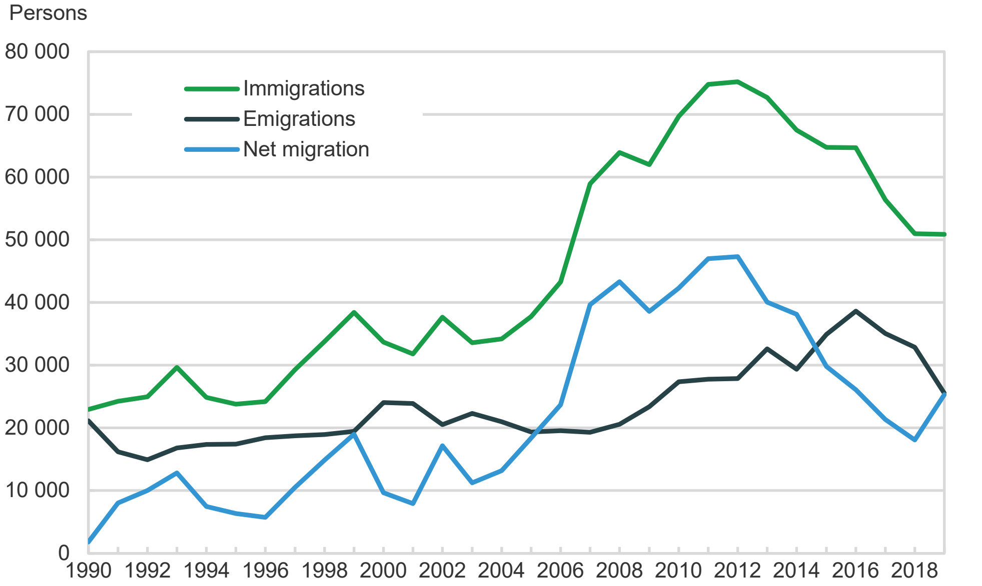
In the very short-term, we have attempted to account for the immediate effects of the COVID-19 pandemic by reducing the immigration and emigration for 2020 and 2021. More specifically, our *ad hoc* assumptions in the medium alternative is that immigration will be reduced by 50 percent for 2020 and 25 percent for 2021. This is discussed in more detail in Sections 7.3 and 7.5. We have, however, scarce information from which to inform our assumptions for both immigration and emigration in the longer term. As such, from 2022 onwards, trends in immigration and emigration are purely the result of the model-based assumptions.

How long this crisis will last, and how fast the world will go back to normal, remains unknown. It may take years before an effective vaccine is available, or before a sufficiently large share of the population has developed immunity. In summary, both the economic repercussions as well as the practical issues associated with the pandemic will have important implications for international migration, but the precise implications, in both the short and longer-term, are still uncertain. In our migration projections, we have assumed a return to relative normality by 2022, but this too is a decision open to much debate.

7.2. Past trends in immigrations and emigrations

As is shown in Figure 7.3, immigration to Norway was at its highest in the years 2011 and 2012. Since then, immigration has declined. However, last year the decline was relatively minor, down only 300 persons from 2018. Over the last decade, emigration has ranged between 20 000 and 40 000 per year, but it too has started to see a decline since the peak in 2016. In 2019, administrative changes in procedures at the National Population Register resulted in fewer than usual administrative deregistrations (see Box 7.3). Consequently, net migration was relatively high this year.

Figure 7.3 Immigration, emigration and net migration, 1990-2019

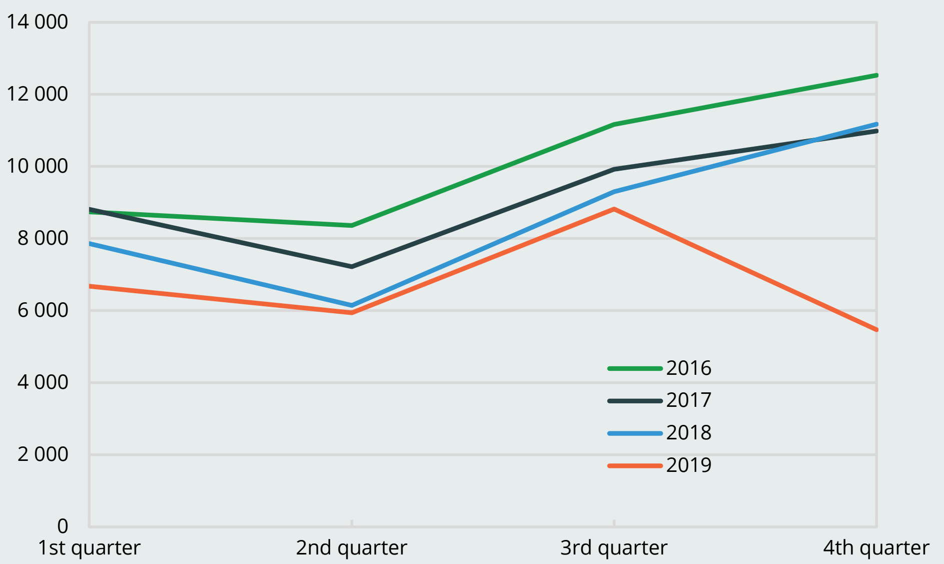


Source: Statistics Norway

Box 7.3. Artificially low emigration

In 2019, there was a marked decline in the number of administrative deregistrations of individuals that was a consequence of decisions made by the National Population Register. Typically, administrative deregistrations account for about half of all registered emigrations. If the percentage of deregistrations had been the same as in the previous three years, there would have been just over 5 000 more emigrations and correspondingly fewer residents at the end of the year. This figure pertains primarily to non-Nordic EEA citizens, of whom 1 700 are Poles and 870 Lithuanians. For Norwegian, Nordic and third-country nationals (i.e. persons who are not citizens of the EU), the changes in the percentage of deregistrations are largely within what one must consider to be natural fluctuations. As shown in Figure 7.4, the decline in deregistrations is clearly visible and limited to the fourth quarter of 2019. Numbers for the first quarter of 2020 were recently published and show that the registrations have picked up (to 7 922), similar to the level in 2018.

Figure 7.4 Emigrations from Norway, by quarter, 2016-2019



Source: Statistics Norway

Fewer immigrations from the typical sending countries

Since 2011, fewer persons have immigrated to Norway from the most common sending countries of Europe, such as Poland, Sweden and Lithuania. In the past couple of years, the immigration from these countries appears to have stabilized somewhat, now accounting for around 5 000, 2 500 and 2 000 annual immigrations, respectively.

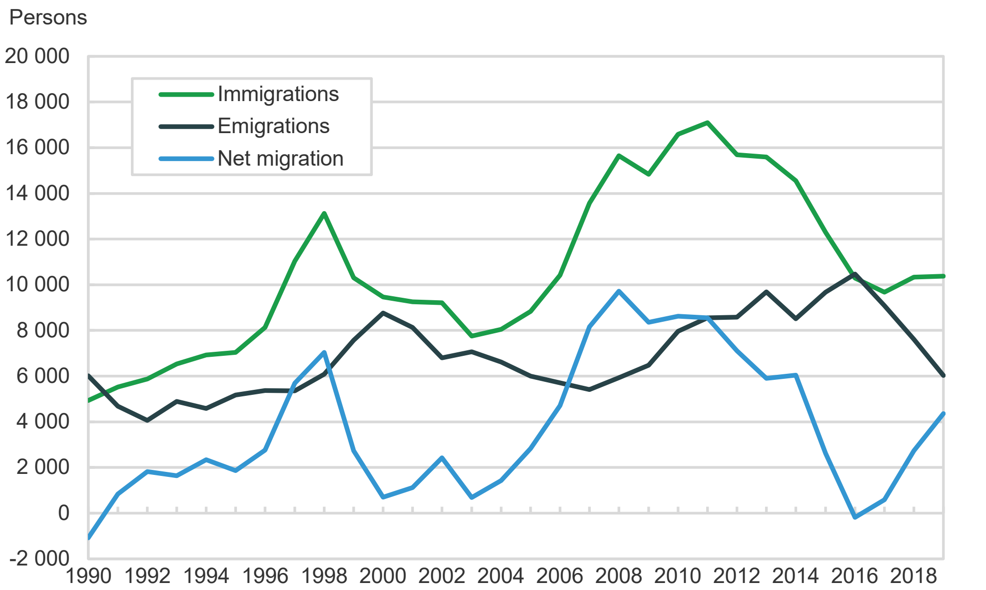
When we look outside of Europe, Syrians have been the largest immigrant group in the previous few years. Syrian immigration was especially large in 2016, as many came to Norway as asylum seekers during the autumn of 2015, staying and entering the population statistics the following year. Since 2016, fewer Syrians have arrived, but immigrants from Syria still comprise a large share of the immigrants who arrived in 2019, near 1 500 in total. In 2019, and for the first time since 2013, there were more immigrants from the Philippines than from Syria. At the same time, an ever-increasing number of immigrants from India have arrived, with 2 400 immigrants arriving in 2019. There was also a large percentage increase in immigrants from the Democratic Republic of Congo (DRC). While only around 700 persons came from the DRC in 2018, the number almost doubled in 2019, to around 1 300. Immigration has been relatively stable from other sending countries including Afghanistan, the Philippines and Somalia.

Migration by country group

Although it is interesting to know the development in immigration trends from individual countries, our assumptions are made at the country group level (see Box 7.1). We will therefore focus our attention on developments in migration for each country group.

Figure 7.5 shows the movement of persons from Country Group 1 to Norway. According to Figure 7.5, immigrations from Country Group 1 are less common today than in the peak migration years of 2007-2015. Since 2016, however, immigration has been fairly stable. Emigration, on the other hand, declined markedly after 2016, and as a result net migration has increased. However, the overall contribution from Country Group 1 has amounted to less than 5 000 net migrations per year since 2014, and in 2016 the net migration was negative for the first time since the early 1990s.

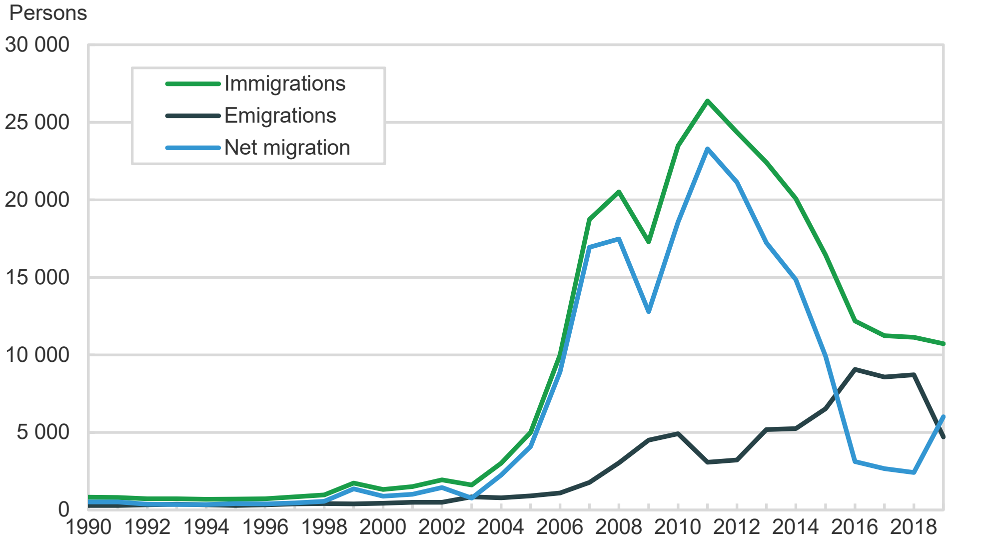
Figure 7.5 Immigrations, emigrations and net migration for Country Group 1, 1990-2019



Source: Statistics Norway

Figure 7.6 illustrates the movements of persons from Country Group 2, with the effect of the EU-enlargements from 2004 onwards clearly visible in the raised immigration and net migration figures. However, since 2011, immigration among this group has declined, rapidly initially, but for the past couple of years a trend towards stabilization has been observed at a level slightly above 10 000 annually. Figure 7.6 also illustrates the sharp drop in emigration from Norway for 2019, as noted in Box 7.3. This fall in emigrations is linked to the sharp increase in net migration in the same year. The net migration in 2016-2018 was down to the pre-EU-enlargement levels, below 3 500 per year, with the contribution of this group to total net migration being fairly minor.

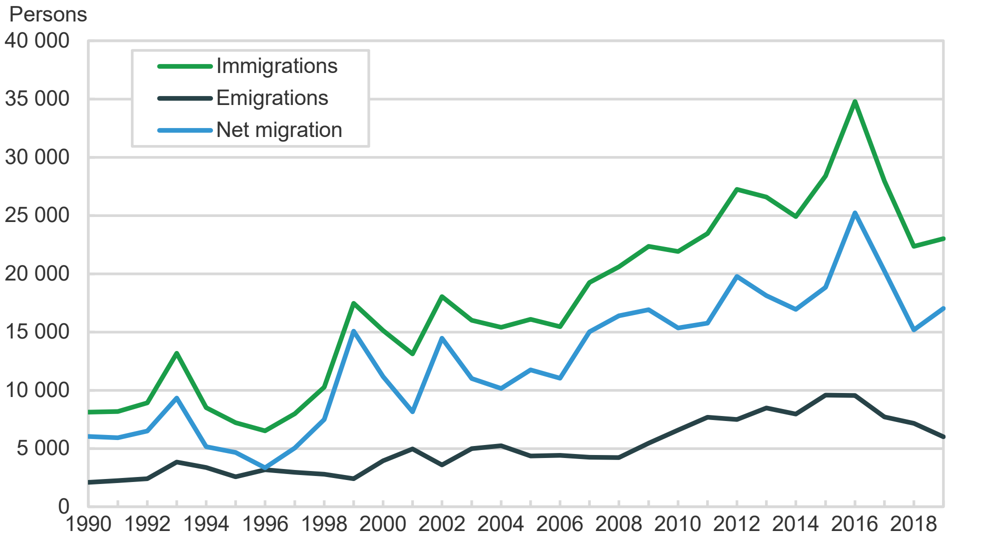
Figure 7.6 Immigrations, emigrations and net migration for Country Group 2, 1990-2019



Source: Statistics Norway

As is show in Figure 7.7, there was a fairly steady increase in immigration from Country Group 3, up to a peak of near 35 000 in 2016. Although the levels have dropped somewhat since then, the annual figures have remained above 20 000, and for the past couple of years (2018 and 2019) immigration has been fairly stable at around 22 000-23 000. The relative number of emigrations is lower for Country Group 3 than for the two other country groups and, as such, net migration is comparatively higher – being at or above 15 000 per year since 2007.

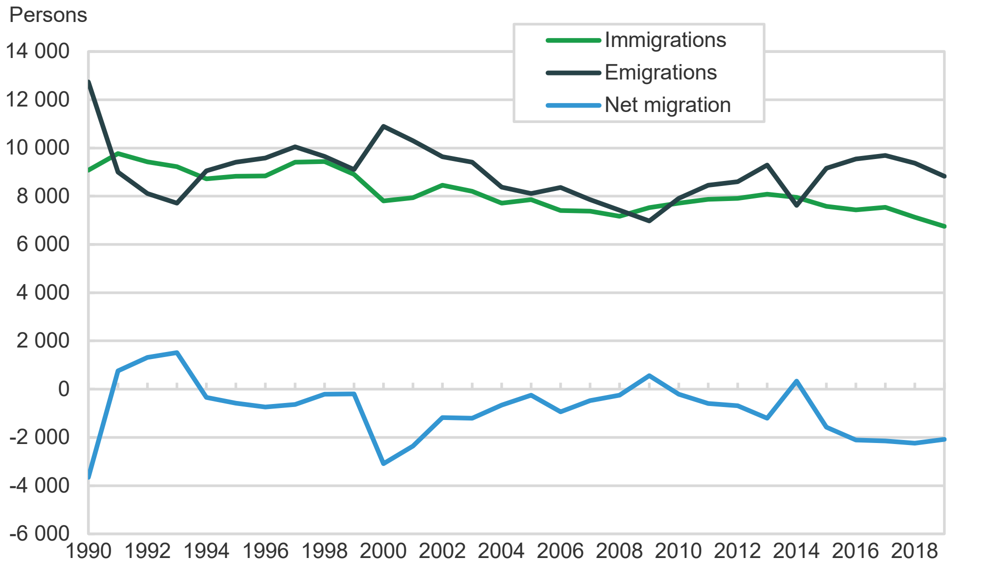
Figure 7.7 Immigrations, emigrations and net migration for Country Group 3, 1990-2019



Source: Statistics Norway

Figure 7.8 shows the migration behaviour among the non-immigrant population. This group also includes Norwegian-born to two immigrant parents (see Box 7.2). As is evident from the figure, immigrations and emigrations have been similar in scale and have remained fairly stable, at around 7 000-10 000 annually. For the last four-five years, the number of emigrations has been around 2 000 higher than that of immigrations, resulting in a negative net migration which has tended to be the norm in the years since the mid-1990s.

Figure 7.8 Immigrations, emigrations and net migration for non-immigrants, 1990-2019

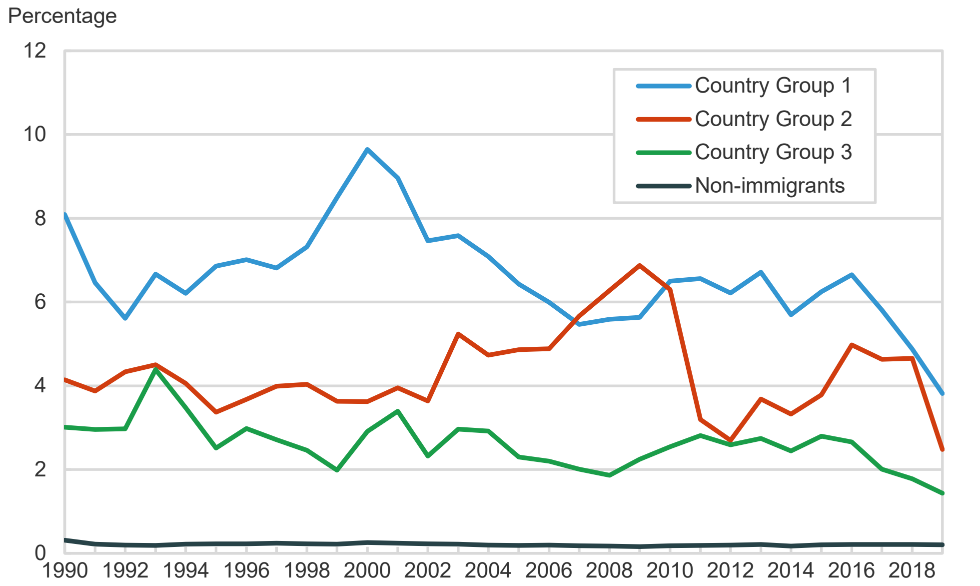


Source: Statistics Norway

In summary, Country Group 3 has contributed most in terms of both immigration and total positive net migration. Since 2016, it has accounted for more than two-thirds of all net migration to Norway. Immigrants from Country Group 1 usually contribute positively to the net migration, although exceptions have been noted. Indeed, the number of immigrants from this group has tended to fluctuate, with no clear upward or downward trend. Country Group 2 contributed to a marked growth in the net migration for quite some years, but since 2016 the levels have been more moderate. The contribution from non-immigrants to net migration is usually fairly minor. For the past five years they have contributed negatively, i.e. there have been more people leaving Norway than entering from this group.

The absolute numbers of emigrations for each country group has been shown in the previous figures, but Figure 7.9 summarizes emigrations relative to the number from the respective country group already living in Norway. As is evident, the likelihood of emigrating is far greater for immigrants than for non-immigrants when viewed in this perspective. It is also clear that the emigration rate for Country Group 3 is relatively low, while persons from Country Group 1 have had the greatest propensity to emigrate through most of the period 1990-2019. The only exception was around 2008-2009, when a larger share of immigrants from Country Group 2 opted to emigrate.

Figure 7.9 Emigrations rates by country group, 1990-2019



Source: Statistics Norway

7.3. Model for future immigration

Statistics Norway uses a separate model to make assumptions about future immigration to Norway (Cappelen et al. 2015). In this model, immigration to Norway is largely determined by the following factors, measured at the country group level (see Box 7.1):

- Per capita average income in Norway relative to the per capita income of each of the country groups (purchasing power-adjusted gross domestic product (GDP) in nominal value (US dollars) per capita)
- Unemployment in Norway and in Country Groups 1 and 2
- Network effects for Country Group 3, i.e. the number of immigrants (from the same country group) who already live in Norway
- Size of the population in broad age groups in the three country groups

This section explains how we forecast gross immigration to Norway. First, we outline the basic theory that motivates our choice of variables to use when modelling immigration. We also explain how we have modified this framework given the current context, by for instance also accounting for the age distribution in sending countries. Secondly, we present the data used as well as the results from the estimation of equations used in the forecasting exercise. Finally, the assumptions used when forecasting gross immigration to Norway, from 2020-2100, are shown along with the forecasts in various alternatives or scenarios.

Modelling framework

Our modelling approach follows Cappelen and Skjerpen (2014) and the references therein. There are two countries: (o)rigin and (d)estination. The log of wages that an individual living in the origin country would receive if not migrating (w_o) is assumed to be

$$\log(w_o) = \mu_o + \varepsilon_o,\ \text{where}\ \varepsilon_o \sim N(0, \sigma_o^2). \tag{1}$$

Here, μ_0 is the expected wage being determined by observed individual characteristics such as education, sex, etc., whereas ε_0 is a normally distributed stochastic variable with zero mean and a constant variance that captures unobservable characteristics. For individuals who migrate, the wage model in the destination country is similarly

$$\log(w_d) = \mu_d + \varepsilon_d, \text{ where } \varepsilon_d \sim N(0, \sigma_d^2). \tag{2}$$

The error terms are possibly correlated with a correlation coefficient, ρ.
The decision to immigrate or not is determined by the sign of an index, I

$$I = \log\left(w_d / (w_o + c)\right) \approx \left(\mu_d - \mu_o - \delta\right) + \varepsilon_d - \varepsilon_o. \tag{3}$$

Here, c is the level of migration costs (discussed below), whereas δ is the wage equivalent migration cost. Immigration occurs if the value of the index I is positive. Based on our assumptions, the emigration probability, P, for an individual,[22] from the origin country is given by

$$\begin{aligned} P &= \Pr\left(I > 0\right) = \Pr\left(\frac{\varepsilon_d - \varepsilon_o}{\sigma_\varepsilon} > \frac{-\left(\mu_d - \mu_o - \delta\right)}{\sigma_\varepsilon}\right) = \\ &1 - \Phi\left(\left(-\mu_d + \mu_o + \delta\right) / \sigma_\varepsilon\right) = \Phi\left(\left(\mu_d - \mu_o - \delta\right) / \sigma_\varepsilon\right). \end{aligned} \tag{4}$$

σ_ε denotes the standard deviation of the difference of the error terms, $\varepsilon = \varepsilon_d - \varepsilon_o$. The term $\frac{\varepsilon_d - \varepsilon_o}{\sigma_\varepsilon}$ is standard normally distributed and Φ is the normal cumulative distribution function.

Eq. (4) suggests some hypotheses about migration. First, higher expected income in the origin country lowers P, whereas higher income in the destination country increases P. In addition, the income effects are the same but with opposite signs. We cannot observe expected incomes (μ). Instead we proxy expected income by using observed incomes and unemployment. We use GDP per capita in a common price set as our measure of incomes. To control for differences between measures of income in national currencies and actual purchasing power, we use measures of GDP per capita in nominal purchasing power parities (or PPP for short) in US dollars. Because we only use relative incomes per capita, in line with the theory (Cappelen and Skjerpen 2014), the price terms cancel out. To capture the income uncertainties that immigrants face, both at home and in the destination country, we include the unemployment rates in addition to the income variables to capture the chance of not getting a job. Thus, an increase in the unemployment rate in the destination country (i.e. Norway in our case) will make it less likely for an immigrant to get a job and earn the income that we proxy with GDP per capita.

Second, the variance of ε is given by

$$\sigma_\varepsilon^2 = \sigma_d^2 + \sigma_o^2 - 2\sigma_{do}. \tag{5}$$

If the destination country has a more equal distribution of income than the origin country, and this would usually be the case when Norway is the destination country, an increase in inequality in the destination country will reduce the

[22] The empirical counterpart to this probability is the share of persons that have emigrated relative to the population in the origin area, or M/P used in the econometric model later.

standard deviation σ_{ε} .[23] If the term in brackets in Eq. (4) is negative, such that the income in the destination country is higher than in the origin country, after adjusting for migration costs, an increase in destination inequality will increase immigration. Because consistent time series for the Gini-index for many countries are difficult to obtain, we simply neglect the effects of the income distribution effects in what follows.

Third, Eq. (4) also states that higher migration costs relative to income in the destination country will reduce migration. One hypothesis is that migration costs decrease with the number of migrants already settled in the destination country, because these migrants send information about job and housing markets to friends and family in the origin country and generally provide a network for new entrants. The empirical specification of migration costs is a central part in many econometric analyses of immigration. Standard proxies used are language differences, geographical distance, and migration policy indicators. It is common to include social indicators, accounting for differences in welfare systems, economic development, political stability, and other factors, to explain migration flows. These factors are important in explaining the pattern of migration between individual countries but not so important when the purpose is to model variation in immigration to one single country from many origin countries. We simply proxy these factors using the stock of resident immigrants by country as one indicator for migration costs. It is only for Country Group 3 that this proxy is found to be statistically significant.

Finally, we introduce a set of binary variables to capture the effects of the Norwegian migration policies or regulations that we consider likely to have affected immigration to Norway. We add separate dummy variables, each capturing a policy change, to a standard model of immigration. In some cases, we have introduced impulse dummies to capture specific shocks in the countries of origin. We have also tested if these dummies interact with some of the economic variables discussed above, or if they enter only as shift dummies for individual country groups. In our preferred models, all dummies appear without any interaction with other variables. In contrast to the country results described in Cappelen and Skjerpen (2014), we find effects of these migration policy dummies for Country Group 2, but not for Country Group 1.

Data

For immigration, the world outside Norway is divided into three country groups of origin, as shown in Box 7.1. In short, the country groups are as follows:

1. Western Europe, the US, Canada, Australia and New Zealand
2. Eastern EU member countries
3. The rest of the world

Data on immigration to Norway are derived from Statistics Norway's population statistics. If someone moves both to and from Norway (or vice versa) during the same calendar year, this is neither registered as an immigration nor an emigration, since the population projections are based on changes taking place from the turn of one year to the turn of the next. This does not affect the figures for net migration, but both the gross immigration and emigration figures will be a little lower than Statistics Norway's official migration figures. This applies in particular to persons

[23] Note that $\partial\sigma_{\varepsilon}/\partial\sigma_{d} = \left(\sigma_{d} - \sigma_{o}\right)/\sigma_{\varepsilon}$ when ε_{d} and ε_{o} are assumed to be perfectly correlated.

from EU countries (i.e. Country Groups 1 and 2), who can move freely between the EU/EFTA/EEA countries.

Statistics for immigration to Norway from every country in the world are readily available at Statistics Norway’s StatBank (www.ssb.no/en/statbank/list/flytting). We have chosen to model immigration by country of birth, rather than citizenship. The stock of immigrants from country group *i* is thus the number of people living in Norway that were born in country group *i*.

For economic statistics, we rely on relative income measured by GDP per capita in purchasing power parities (PPPs) and current US dollars, based on information from the OECD and/or the World Bank. We use per capita GDP figures in nominal PPP in USD-terms. Because only relative per capita GDP levels are used in the model, the common nominal factor cancels out. We could have used GDP data in real PPP-terms as well, and this would give identical data for relative incomes.

The unemployment rate in Norway is based on the ILO definition and is taken from the labour force survey conducted by Statistics Norway. Similar data for Country Groups 1 and 2 may be found in databases from the OECD and Eurostat. We do not have data on unemployment for Country Group 3.

For the emigration rate, GDP per capita and unemployment we aggregate individual country data to averages for each group using population shares as weights.

For the dummy variables we shall only focus on a few policy changes in this study. In 2004, several countries joined the EU, with citizens of these countries subsequently gaining easier access to Norway. Some transition rules were put in place (subsequently lifted in 2007 and 2009), but it seems that they had only marginal effects in limiting immigration from these countries. To capture the effects of accession in 2004 we use an indicator variable, *DUM2004*, that takes the value 1 until 2003, 0.33 in 2004 and 0 thereafter. As such, it is expected to affect immigration from these countries positively and permanently. In 2007, changes in regulations were made affecting potential immigrants from EEA countries, as well as immigrants more generally. The new EU members in 2007 (Bulgaria and Romania) were included in the Schengen Area. This is captured by the dummy *DUM2007*. Croatia became a member in July 2013 and we have tried to estimate an effect of this change also using a step dummy that takes the value 1 from 2014 onwards.

Econometric models for three country groups and three age groups

In this section we present estimations of relations for gross emigration rates to Norway from three country groups, with each country group divided into three age groups. Gross emigration to Norway from a country group equals, of course, gross immigration viewed from the Norwegian perspective. The basic model is based on the discussion relating to Eq. (4). Heuristically, we specified the following model for the emigration rate for each age group and country group

$$\text{Emigration rate} = F(\text{rel. incomes, unempl. rates, migration costs, policy}) \qquad (6)$$

In contrast to what has been the case in previous projections, undertaken in 2018 and earlier, we now use a disaggregated approach when it comes to age composition of the immigrants. We now split the population in each country group into three different age groups. Group 1 consists of persons aged 0 to 14 years, group 2 consists of those aged 15 to 39 years and group 3 consists of those aged 40 years or older. Thus, the emigration rate, which is the immigration rate to Norway, is disaggregated into three different variables. This is the same age-disaggregation as employed by Tønnessen and Skjerpen (2019) using almost the same population data. However, we do not have data for incomes, unemployment and migration costs that are disaggregated by age, so we continue to use aggregated series for these variables in Eq. (6). One motivation behind the disaggregation of the immigration rate is the fact that most migrants tend to be young, typically belonging to age group 2. We also expect future changes in the age composition of the origin countries, with such changes likely to be important when projecting immigration to Norway over the coming decades. According to the United Nations population projections, a larger share of the population in Country Groups 1 and 2 will consist of people in the oldest age group, an age group with traditionally low migration propensities. It is reasonable to assume that the immigration rate of the youngest age group is linked to the rate of the other two age groups because most child migrants arrive with their parents. Since we use annual data, we encounter a simultaneity issue when estimating the immigration rate of the youngest age group, given its dependence on the migration rate for the other two age groups. This is handled in the modelling approach to which we now turn.

The most common variables, excluding dummies, used in the models are:

M_{ijt} The number of individuals in age group *i* that emigrate to Norway from country group *j* in year *t*.

i=0-14,15-39,40+; *j*=1,2,3.

P_{ijt} The mean population (in 1000s) in age group *i* in country group *j* in year *t*.

i=0-14, 15-39, 40+; *j*=1,2,3.

RY_{jt} Nominal GDP in Norway per capita (in PPPs) in year *t* divided by nominal GDP per capita in country group *j* in year t.

U_{kt} The unemployment rate in year *t* measured in percentage terms for country group *k*.

k=NOR,1,2.

$STOCK_t$ The stock of immigrants living in Norway at the start of year *t*.

This variable is used only for Country Group 3.

Country Group 1

Immigrants from Country Group 1 to Norway consist of people from broadly three categories of countries. First, people from the other Nordic countries have had unlimited access to Norway without even the need of passports since the late 1950s. Second, we have EU-countries, including members of the Schengen Area, that have had unrestricted access to Norway since 1993 (or later). Finally, the group includes people from other OECD countries (the US, Canada, Australia and New Zealand) that in practice have similar access to Norway. We have estimated three emigration equations for Country Group 1. The emigration rate is defined as migrants to Norway divided by the population in the origin countries for each age group (*M/P).* Relative incomes (GDP per capita) are denoted *RY*, while the unemployment rate is denoted *U.* We have suppressed the country index for convenience.[24] The estimated equations are (t-values in parentheses are shown below each parameter estimate):

[24] To simplify the notation, we do not distinguish between observed and predicted variables, but the left-hand side variables in (7) and corresponding places should be interpreted as (within-sample) predicted variables.

$$\log(M/P_{0\text{-}14})_t = \underset{(-1.95)}{-0.715} + \underset{(6.49)}{0.916}*\log(M/P_{15\text{-}39})_t - \underset{(-4.18)}{0.633}*\log(M/P_{15\text{-}39})_{t-1} +$$

$$\underset{(4.88)}{0.629}*\log(M/P_{0\text{-}14})_{t-1} + \underset{(1.73)}{0.647}*\log(RY)_{t-1} - \underset{(-1.40)}{0.497}*\log(RY)_{t-2}$$

$\sigma = 0.082$; $AR_{1\text{-}2} = 2.366$ (0.11) ; ARCH $_{1\text{-}1} = 0.000$ (0.98) ;
Normality = 1.42 (0.49); 1976-2019

$$\log(M/P_{15\text{-}39})_t = \underset{(-4.07)}{-1.854} + \underset{(5.45)}{0.553}*\log(M/P_{15\text{-}39})_{t-1} + \underset{(3.96)}{0.688}*\log(RY)_{t-1} -$$

$$\underset{(-7.43)}{-0.441}*\log(U_{nor})_t + \underset{(4.66)}{0.304}*\log(U_{nor})_{t-2} + \underset{(4.17)}{0.576}*\log(U_1)_{t-1} - \underset{(-3.02)}{0.406}*\log(U_1)_{t-2}. \tag{7}$$

$\sigma = 0.080$; $AR_{1\text{-}2} = 0.479$ (0.62) ; ARCH $_{1\text{-}1} = 2.267$ (0.14) ;
Normality = 4.157 (0.13); 1976-2019

$$\log(M/P_{40+})_t = \underset{(-4.71)}{-\,2.876} + \underset{(5.51)}{0.525}*\log(M/P_{40+})_{t-1} + \underset{(4.36)}{0.622}*\log(RY)_t \underset{(-5.69)}{-0.422}*\log(U_{nor})_t +$$

$$\underset{(4.56)}{0.305}*\log(U_{nor})_{t-2} + \underset{(4.04)}{0.406}*\log(U_1)_t - \underset{(-2.88)}{0.250}*\log(U_1)_{t-2}$$

$\sigma = 0.089$; $AR_{1\text{-}2} = 0.400$ (0.67) ; ARCH $_{1\text{-}1} = 0.024$ (0.88) ;
Normality = 0.657 (0.72); 1977-2019.

The estimated equations in (7) have been chosen based on a predesigned set of criteria. We do not accept models where variables enter with the wrong sign in the short and long run. The estimated residuals should be Gaussian, i.e. have zero expectation, not be autocorrelated nor heteroscedastic. The autocorrelation test (AR) and test for homoscedasticity (ARCH) are both F-tests while the normality test is a Chi-square test. P-values are shown in parenthesis behind the values of the test statistics. The estimated standard error of regression is given by σ. All the equations above satisfy these predesigned criteria. The first equation is estimated using instrument variables (IV) because the immigration rate of children depends on the immigration rate of 'parents', who are members of the other two age groups. The instruments used are lagged values of the variables entering the equation for $M/P_{15\text{-}39}$. The two last equations are estimated using ordinary least squares (OLS). The chosen models have quite stable parameters during the last 20 years according to recursively estimated models.[25] The models have initially been formulated as so-called equilibrium correction models but transformed to a standard autoregressive distributed lag (ADL) form which we employ for forecasting.[26]

Looking at the first equation in (7) we should note that the emigration rate for 'parents' ($M/P_{15\text{-}39}$) enters twice both with and without a lag. This is also the case for the relative income ratio. In the long run the emigration rate for children increases by 0.76 percent when the 'parent' emigration rate increases by one percent, and by 0.40 percent when per capita income in Norway increases relative

[25] Details are available upon request.

[26] For a discussion of possible cointegration between the variables included in the equations for Country Group 1, see Cappelen and Eika (2020).

to that in Country Group 1. For the second age group, the emigration rate for 15-39 years old increases by 1.54 percent when relative incomes in Norway increase by one percent. An increase in the unemployment rate in Norway from 4 to 5 percent lowers the long-run emigration rate by 6 percent, while a similar increase in the unemployment rate in Country Group 1 increases the emigration rate by roughly 7.5 percent. We could have imposed a symmetric response in the unemployment rate, like we have done for incomes, from a purely statistical point of view, but this has not been done. The equation for the oldest age group has a long-run income effect of 1.31 percent, quite similar to that of the younger group. The unemployment effects are much stronger for the older group. An increase in the unemployment rate from 4 to 5 percent in Norway will reduce the emigration rate and thus immigration to Norway by 18 percent while a similar increase in the unemployment rate in Country Group 1 increases immigration to Norway by nearly 13 percent. Note that the equations in (7) do not include any impulse or step dummies. The policy changes that increased the potential for migration when Norway became member of the EEA or the Schengen area have not resulted in any significant effects. This is probably due to the aggregate nature of this country group, that consists of Nordic countries where there have been no policy changes, the original EU-countries where changes have occurred and the US and Canada where these policy changes probably have not had much effect, see Cappelen and Skjerpen (2014).

Country Group 2

This group of countries consists mostly of Eastern European countries that changed their economic and political system from around 1989 and onwards. For this country group our sample starts in 1990. Initially it was difficult for citizens of these countries to move to countries in Western Europe, except when employed in seasonal work. However, when a number of these countries became members of the EU, in May 2004 and some later in 2007, the restrictions on migration were gradually lifted. When formulating our forecasting equations, we have included a step-dummy that has the value of one up to 2003, 0.33 for 2004 (as the change took place in May) and 0 after that. Because our models are specified in logarithms it implies that the percentage changes are unaffected by the policy change in 2004, but since there is a positive shift in the constant term the absolute effects of changes in the explanatory variables become much larger. We also need to include some impulse dummies to achieve a reasonably stable model. The estimated equations are (t-values are shown below each parameter estimate):

$$\log(M/P_{0\text{-}14})_t = \underset{(-2.37)}{-\,0.356} + \underset{(12.8)}{0.576}*\log(M/P_{0\text{-}14})_{t-1} + \underset{(10.2)}{0.416}*\log(M/P_{40+})_t +$$

$$\underset{(3.43)}{0.411}*\log(U_{2,t}/U_{2,t-1}) \underset{(-2.28)}{-\,0.333}*\log(U_{nor,t}/U_{nor,t-1}) + \underset{(4.54)}{0.614}*\log(RY)_{t-2} + \text{dummies}$$

$\sigma = 0.077$; $AR_{1-2} = 0.326$ (0.73); ARCH $_{1-1} = 0.148$ (0.70);
Normality = 2.018 (0.36); 1992-2019

$$\log(M/P_{15\text{-}39})_t = \underset{(-0.501)}{-\,0.133} + \underset{(19.4)}{0.684}*\log(M/P_{15\text{-}39})_{t-1} \underset{(-5.59)}{-\,0.658}*\log(U_{nor})_t +$$

$$\underset{(4.81)}{0.694}*\log(U_{nor,t-2}/U_{nor,t-3}) + \underset{(3.82)}{0.618}*\log(RY)_{t-2} + \text{dummies} \qquad (8)$$

$\sigma = 0.096$; $AR_{1-2} = 2.533$ (0.10); ARCH $_{1-1} = 0.041$ (0.84);
Normality = 0.03 (0.99); 1991-2019

$$\log(M/P_{40+})_t = -0.91 + 0.311*\log(M/P_{40+})_{t-1} + 0.158*\log(M/P_{40+})_{t-2} - 0.695*\log(U_{nor})_t$$
$$(-2.32) \quad (3.38) \quad (1.89) \quad (-4.28)$$

$$0.655*\log(U_{nor})_{t-2} - 0.886*\log(U_{nor})_{t-3} + 0.707*\log(RY)_t + 1.451*\log(RY_{t-2} / RY_{t-3})$$
$$(2.54) \quad (-4.17) \quad (2.61) \quad (2.98)$$
+ dummies

$\sigma = 0.125$; $AR_{1-2} = 0.412\ (0.67)$; $ARCH_{1-1} = 0.244\ (0.63)$; Normality = 2.54 (0.28); 1992-2019

For the youngest age groups for Country Group 2, the 'parent' effect is almost one in the long run. There are only short-run effects of unemployment, but the long-run effect of relative incomes is quite strong, (1.45). For the age group 15-39 years, the long-run income effect is nearly 2 showing that this age group is highly mobile across borders. There is also a very high long-run response to changes in the Norwegian unemployment rate, where the elasticity is also close to 2, but negative. As such, a permanent increase in the Norwegian unemployment rate from 4 to 5 percentage points will, in the long-run, reduce immigration by 40 percent. For the oldest age group, the income effect is 1.33 and the unemployment effect is -1.74. Both effects are somewhat smaller than for the 15-39 age group, but still quite large. Note that the unemployment rate in Country Group 2 has no long-run effect on migration to Norway according to these estimates. It is only the Norwegian unemployment rate that matters. This is very different compared to what we found for Country Group 1.

Country Group 3

The immigrants from Country Group 3 consist of persons that emigrate to Norway for different reasons. Economic incentives represent only one factor affecting the emigrations from this group. Indeed, a considerable share of this group are refugees, though labour migrants and family migrants still comprise the largest groups. In 2019, the shares were 20, 21 and 42 percent, respectively, whereas education migrants comprised 13 percent.

Compared to immigrants coming from Country Group 1 and Country Group 2, persons from Country Group 3 that wish to settle in Norway are faced with a comprehensive juridical evaluation before eventual settlement is allowed. Immigration from Country Group 3 is impacted by factors both on the supply and the demand side. The supply side is influenced by economic incentives, but also by the needs of persons in Country Group 3 to find a safe place when confronted with conflicts, war and persecution. The demand side is constituted by Norwegian authorities, but also by Norwegian firms in need of high-qualified workers. In the econometric model presented below, we mainly account for factors on the supply side. When it comes to the estimation of the model used for projection, we include a couple of impulse dummies to capture marked changes in immigration, accounting for the effects of certain shocks that cannot be explained by the other variables included in the model.[27] Of course, similar shocks will probably take place also during the projection period. The size and sign of future shocks are very difficult to predict. The same is true for their timing and effects. Furthermore, it is also hard to foresee what the response of Norwegian authorities will be according to these potential shocks. For instance, with respect to the high immigration alternative outlined below, the government could choose to tighten regulations on

[27] $DUM1999_t$ An impulse dummy being 1 in 1999 and 0 in all other years. It is related to a large influx of immigrants from Balkan in 1999.
$DUM2016_t$ An impulse dummy being 1 in 2016 and 0 in all other years. It is related to a large influx of immigrants from Syria in 2016.

immigration in response to positive supply shocks relating to a potentially large influx of immigrants from Country Group 3.

The econometric model for Country Group 3 is a system of three regression equations (one for each age group). The endogenous variables are the three (log-transformed) emigration intensities. We expect the income ratio variable, (RY), and the stock variable, $\log(STOCK_t)$, to enter with positive effects. The same is true for the two dummies, i.e. $DUM1999_t$ and $DUM2016_t$, as they both pick up high immigration in a single year. The two unemployment variables, i.e. log(Unor) and the change in this variable, are expected to have a negative effect on emigration. The three errors in the system are assumed to be distributed according to a trivariate normal distribution, where the expectations are zero and where the covariance matrix of the contemporaneous error terms is full and positive definite.

$$\log(M/P_{0\text{-}14})_t = \underset{(-114)}{-4.966} + 0.474 * \log(M/P_{0\text{-}14})_{t-1} + 0.317*\log(RY)_{t-2} +$$

$$0.095*\log(STOCK)_t + \underset{(2.83)}{0.615}*DUM1999_t + \underset{(2.61)}{0.576}*DUM2016_t$$

$\sigma = 0.213$; 1994-2019.

$$\log(M/P_{15\text{-}39})_t = \underset{(-50.9)}{-3.972} + 0.474 * \log(M/P_{15\text{-}39})_{t-1} + 0.317*\log(RY)_{t-2} +$$

$$0.095*\log(STOCK)_t - \underset{(-6.99)}{0.379}*\log(Unor)_{t-1} + \underset{(1.58)}{0.208}*DUM1999_t + \underset{(3.00)}{0.394}*DUM2016_t \tag{9}$$

$\sigma = 0.129$; 1994-2019.

$$\log(M/P_{40+})_t = \underset{(-244)}{-5.219} + 0.474 * \log(M/P_{15\text{-}39})_{t-1} + 0.317*\log(RY)_{t-2} +$$

$$0.095*\log(STOCK)_t - \underset{(-3.18)}{0.248}*\log(U_{nor,t-1}/U_{nor,t-2}) + \underset{(3.78)}{0.407}*DUM1999_t +$$

$$\underset{(3.15)}{0.341}*DUM2016_t$$

$\sigma = 0.104$; 1994-2019.

For the iterations (in the projections, to be commented on later) to converge also in the high alternative, it has been necessary to monitor some of the parameters. We have set the income effect equal to a common value, 0.317, which is the same as the one used for the aggregate approach in 2018 (see Section 3.4 in Syse et al. 2018). The size of the parameter of the network variable is important when it comes to convergence. If it is too high, one encounters convergence problems in the high alternative. We have calibrated it such that it is one third of the size of the coefficient of the income ratio variable. The derived value is thus 0.095. Neither the parameters of the lagged endogenous variables (one for each age group) should be too high. We have set them to a common value of 0.474, which is the same value that was employed in conjunction with the official projections in 2018. An alternative procedure would have been to allow for age-group-specific responses related to the three right-hand side variables mentioned above. However, it is hard to know a priori how one should rank the groups with respect to the size of different parameters for the right-hand side variables. Thus, we have chosen a simple and practical solution. Conditional on the values of the three calibrated parameters, we have estimated the remaining parameters by full information maximum likelihood (FIML). In all three equations we have estimated the effects of the two impulse dummies. For two of the age groups, the estimated effect of the Norwegian unemployment rate is negative. However, one should note that for the age group 15-39 it is the lagged (log) unemployment rate that enters the equation, whereas for the age group 40+ years it is the lagged relative change in the unemployment rate that enters the equation. The derived value of the long-run relative income effect is 0.6, which is much smaller than for the other country groups.

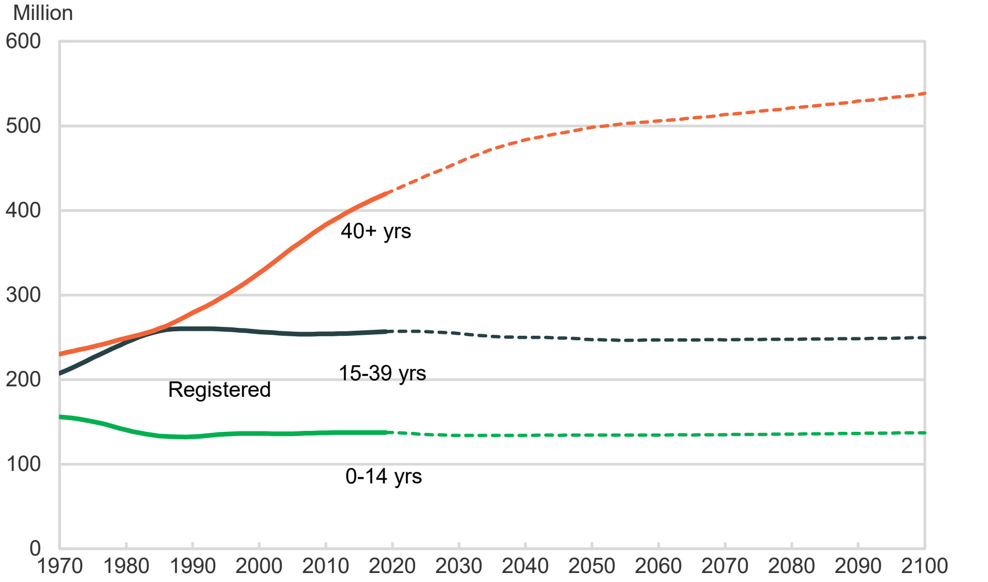
Forecasts of the variables

Once the parameters have been estimated for each of the nine equations, they are used to calculate how immigration to Norway will develop in future. To be able to do this, we need forecasts of how the economic and demographic variables will develop in the projection period (the explanatory or forcing variables). These forecasts are taken partly from international sources and partly from Norwegian sources and our own estimates.

The figures for the future development of the world's population in the three country groups are taken from the United Nations most recent population projections, made in 2019. In our medium alternative, we use the United Nations medium-variant. In our high and low alternatives, we use United Nations high- and low-fertility variants, respectively. In the high and low alternatives from the United Nations we have only access to data for each fifth year, i.e. the years 2020, 2025, …, 2100. To obtain values for each of the remaining years, we use piecewise linear interpolation to impute values.

The figures below show the (mean) population by age for the three age groups and the three country groups. For Country Group 1 we see how much change there is in the expected age distribution both in recent decades and going forward (Figure 7.10). Figure 7.10 refers to the United Nations medium alternative. While the number of children has roughly been constant at 137 million from the early 1980s, the number of people aged 40 + years has been increasing and is expected to reach 500 million during the 2040s. The most mobile age group, 15-39, is roughly constant and is expected to remain around 250 million people in Country Group 1.

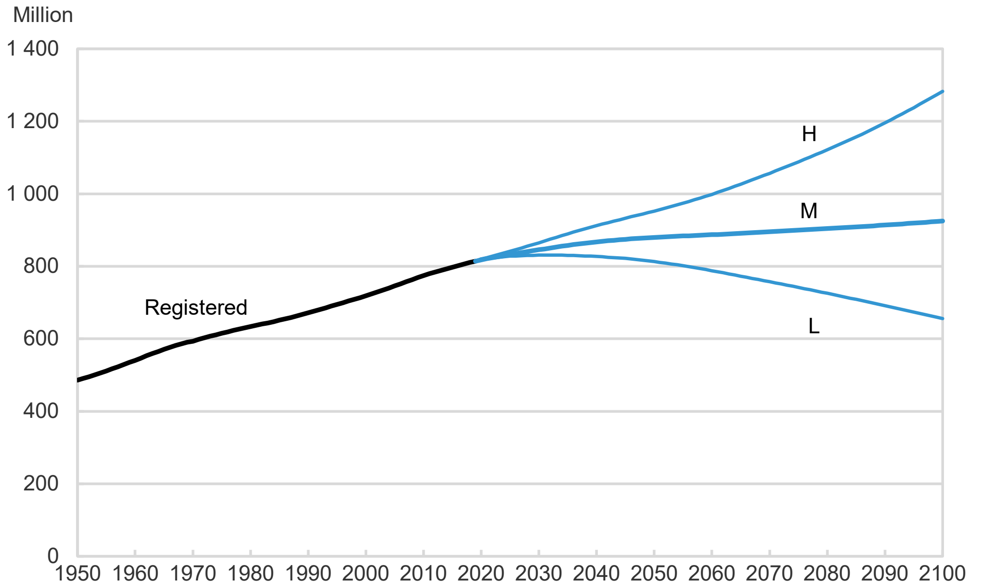
Figure 7.10 Population in Country Group 1 in three age groups, registered 1970–2019 and projected 2020-2100 by the United Nations, medium-variant



Source: United Nations (2019)

The total population in Country Group 1 in the three United Nation alternatives are shown in Figure 7.11. As can be seen from the figure, there is marked uncertainty as to whether the total population will remain stable, decrease or increase.

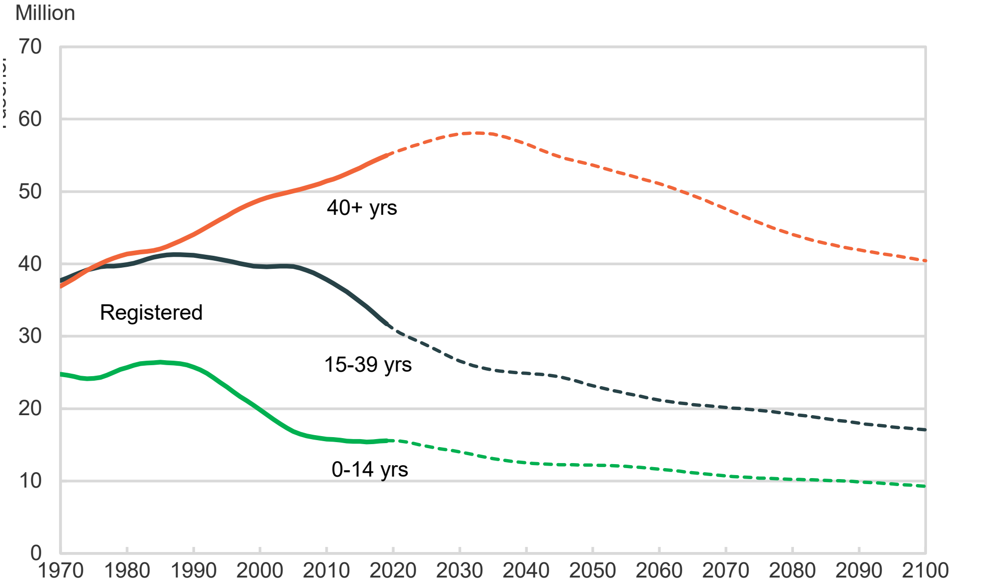
Figure 7.11 Total population in Country Group 1, registered 1950–2019 and projected 2020-2100 by the United Nations in three alternatives[1]



[1] The alternatives are medium-variant (M), low-fertility variant (L) and high-fertility variant (H). The medium-variant corresponds to the median trajectory of the probabilistic forecast.
Source: United Nations (2019)

As can be seen in Figure 7.12, the age distribution for Country Group 2 is expected to change considerably. We see that the number of inhabitants in the most mobile age groups started to decline at the time most of these countries became EU-members. This is to some extent a result of the fact that many people in this age group migrated to Northern and Western European countries, including Norway. It is expected that the population in Country Group 2 will decline over the coming decades, with the most rapid decline among the most mobile age group likely to occur during the 2020s.

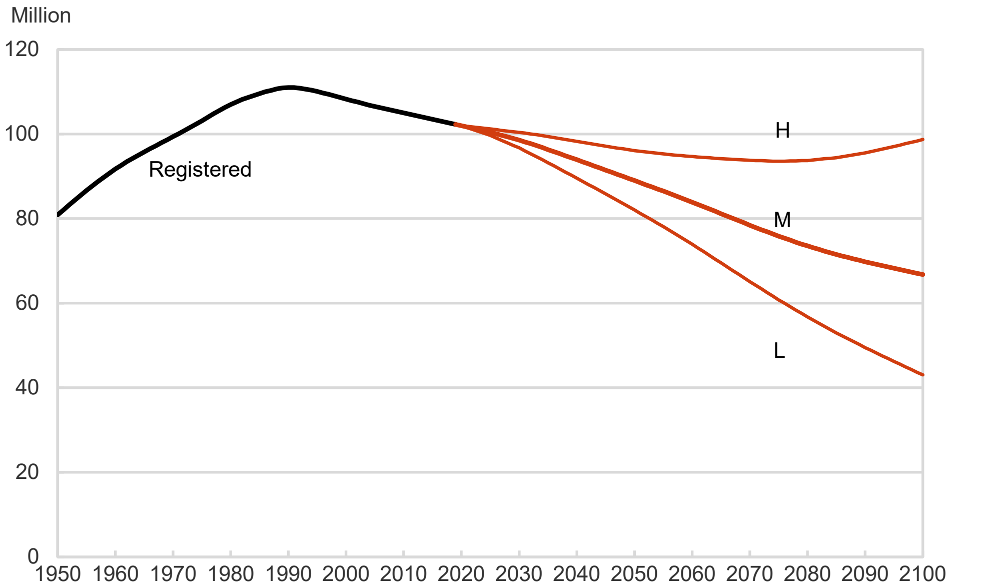
Figure 7.12 Population in Country Group 2 in three age groups, registered 1970–2019 and projected 2020-2100 by the United Nations, medium-variant



Source: United Nations (2019)

The total population of Country Group 2 is currently around 100 million, see Figure 7.13. It is expected to fall below 70 million by 2100 according to the United Nations medium alternative. If the aggregate emigration rate to Norway from Country Groups 2 were constant, the decline in the population of Country Group 2 would alone lead to a reduction in annual immigration from this group of 30 percent from 2020 to 2100.

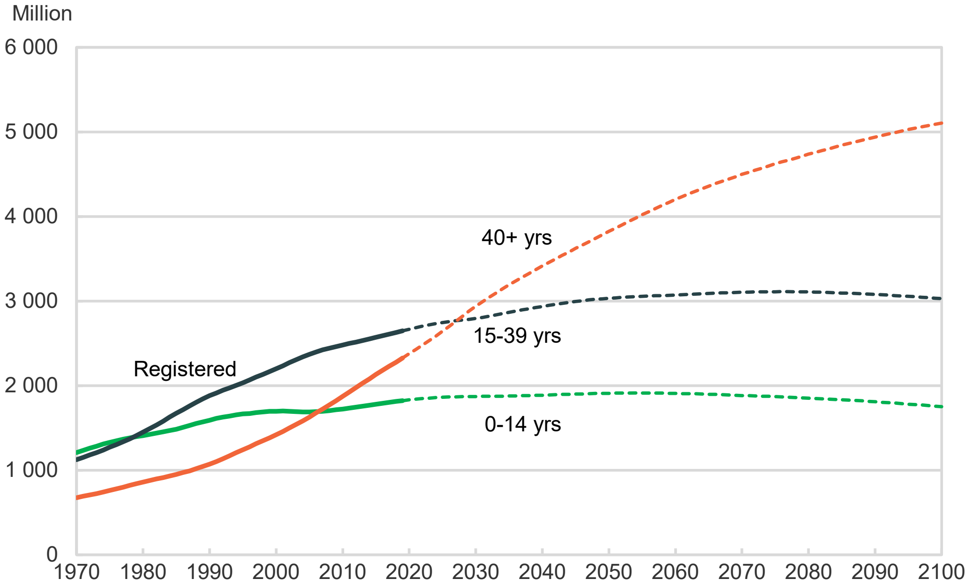
Figure 7.13 Total population in Country Group 2, registered 1950–2019 and projected 2020-2100 by the United Nations in three alternatives[1]



[1] The alternatives are medium-variant (M), low-fertility variant (L) and high-fertility variant (H). The medium-variant corresponds to the median trajectory of the probabilistic forecast.
Source: United Nations (2019)

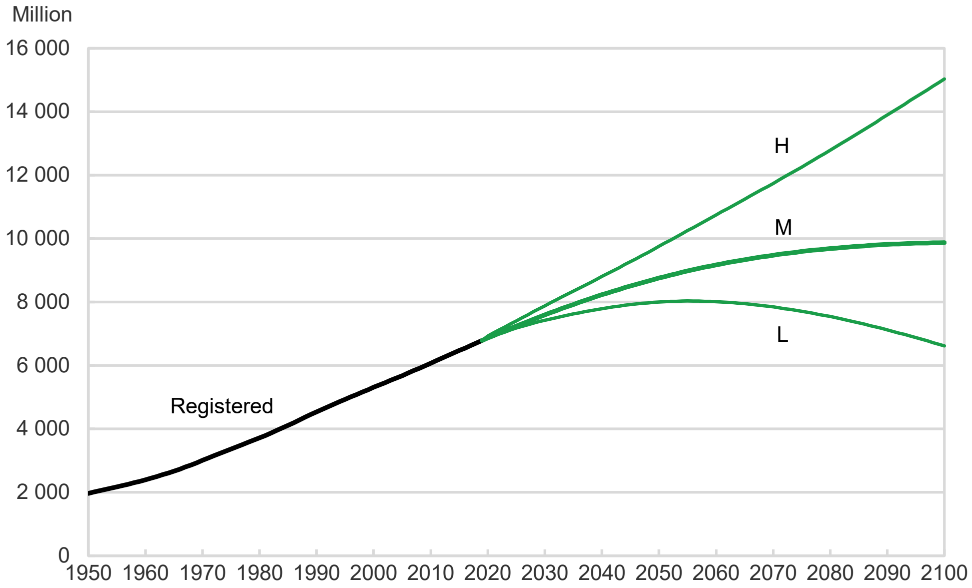
Country Group 3 has by far the largest population among the three country groups. The figures below show the historical development as well as the projected trends in the size of the three age groups (Figure 7.14) and the total population (Figure 7.15). According to the latest United Nations forecast the population in this country group will reach 10 billion by 2100. In the low alternative it will reach a maximum of around 8 billion sometime during the 2050s, while in the high alternative the trend in population growth over the last 30 years or so will simply continue for another 80 years. As is clear from Figure 7.14, a significant ageing process will accompany this total growth.

Figure 7.14 Population in Country Group 3 in three age groups, registered 1970–2019 and projected 2020-2100 by the United Nations, medium-variant



Source: United Nations (2019)

Figure 7.15 Total population in Country Group 3, registered 1950–2019 and projected 2020-2100 by the United Nations in three alternatives[1]



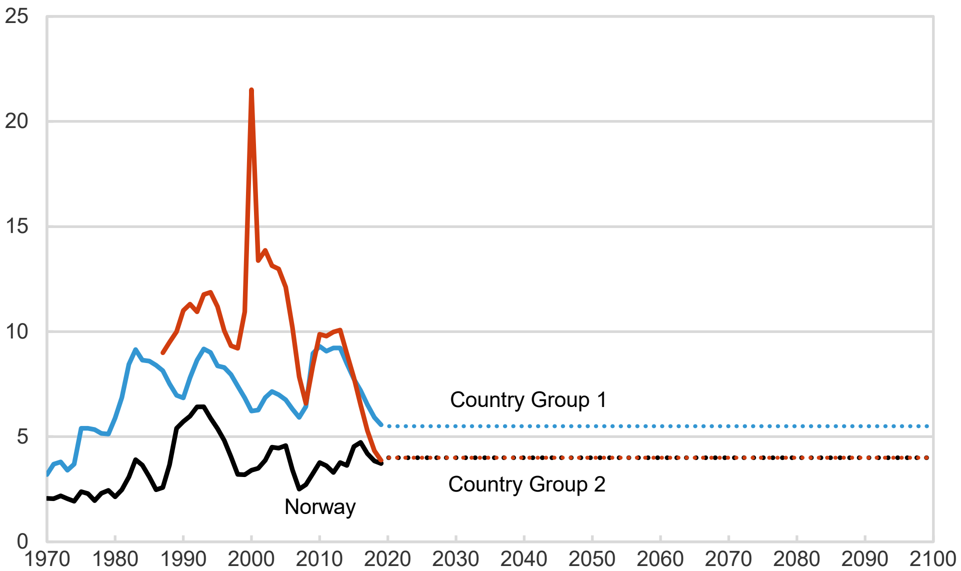
[1] The alternatives are medium-variant (M), low-fertility variant (L) and high-fertility variant (H). The medium-variant corresponds to the median trajectory of the probabilistic forecast.
Source: United Nations (2019)

The initial estimates of the future number of immigrants residing in Norway (which are used to identify the network effect) are based on figures from the population projection made in 2018. Once the number of immigrations has been predicted, the whole population projection model is run using the updated figures. The model produces new estimates of the number of resident immigrants from each country group. These figures are then used to estimate immigration again. Such iteration rounds are repeated several times until convergence is obtained. As mentioned earlier, a network effect is only present for Country Group 3.

In the past, political decisions and wars have influenced immigration to Norway. When estimating the model, we have therefore included two indicators for years when important political changes have taken place. We are not able to predict when new political changes might occur and how these would influence immigration.[28] The same applies to natural disasters or armed conflicts that lead to new flows of refugees. We do however control for the effects of these changes in the estimation.

Forecasts of the unemployment rate in Norway are taken from Statistics Norway's macroeconomic projections.[29] In the long term, the unemployment rate has been levelled off to a historically 'normal' level around the average of the last three decades (4 percent). In recent years the unemployment rate in Country Group 2 has been significantly reduced, and more than we expected in our forecasts two years ago. We assume that it will stay at a low level similar to the Norwegian level in the long run. For Country Group 1, the unemployment rate has also reduced but will increase dramatically in 2020 like in most countries. In the long term, however, the unemployment rate is expected to stay at a fairly low level when compared to previous decades (see Figure 7.16). The changing demographic structure in both Country Groups 1 and 2 is one reason why we think this is a reasonable assumption in the long run. The Norwegian unemployment rate is assumed to be the same in all three scenarios. It is set to 4 percent in all years in the period 2022-2100.

Figure 7.16 Unemployment rates in Norway and Country Groups 1 and 2, registered 1970-2019 and assumed future values 2020-2100. Percent[1]



[1] Norway's future unemployment rate is assumed similar to that of Country Group 2 and is thus 'hidden' behind the red dots.
Source: OECD, Eurostat and Statistics Norway

Three alternative paths have been made for future income development (low, medium and high alternatives). They reflect three different alternatives with respect to future economic development. The high alternative assumes the greatest income differences between Norway and the rest of the world in the years ahead. In this

[28]From 1 January 2020 Norway allows dual citizenships, provided that the country one already is a citizen of allows this. If this is not the case, one may lose the original citizenship when one becomes a Norwegian citizen (www.udi.no/en/word-definitions/dual-citizenship/). The new law may lead to both higher immigration and emigration, but it is hard to know whether the effects will be sizeable. We have not attempted to account for the effects in this more flexible law.

[29] http://www.ssb.no/nasjonalregnskap-og-konjunkturer

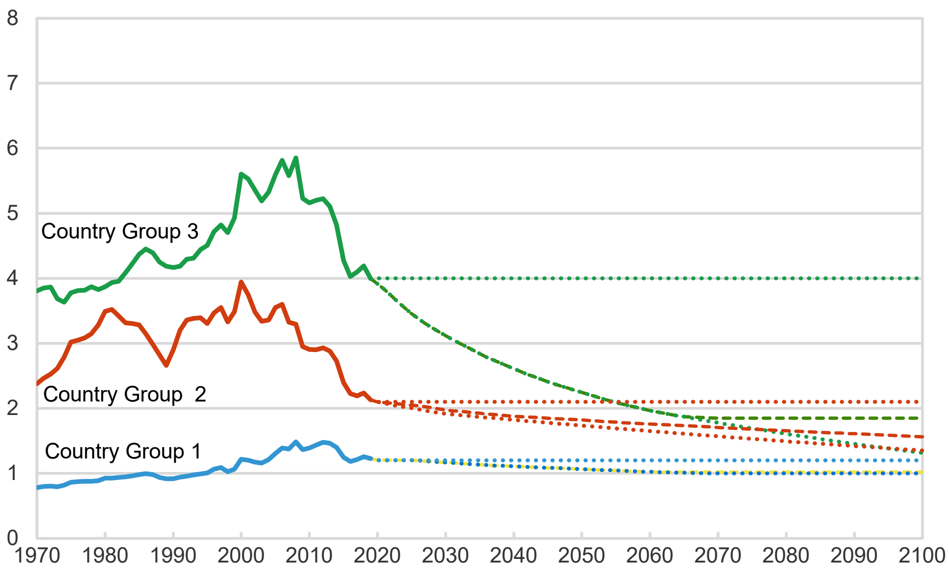
case the last observed relative income levels have simply been extended until 2100. The medium alternative assumes that non-oil GDP per capita in Norway follows that of Country Group 1, while the gradual phasing out of oil and natural gas exploration in Norway takes place according to the most recent figures available. In the low alternative there is more absolute convergence in relative incomes between Norway and the three country groups, also in the very long run. The effects of the COVID-19 pandemic that is currently affecting the world economy have been difficult to account for in these forecasts. We base our forecasts on relative incomes per capita. As long as all countries are negatively affected in roughly a similar fashion, there should be little change in relative incomes due to the pandemic.

It is reasonable to assume that the large increase in unemployment in most OECD countries will reduce migration significantly. Other factors, such as closing of borders, quarantine rules and general uncertainty due to the pandemic may also have large effects on immigration to Norway. The COVID-19 pandemic is therefore accounted for in the following way: Initially, we make projections as if the pandemic had not taken place. Based on these projections we reduce the projected immigration by 50 percent in 2020, and by 25 percent in 2021. The resulting values for 2020-2021 are then fixed. We then restart the dynamic simulations in 2022.

Since the lagged age-group-specific immigration variables enter with a one-year lag, we need to fix also the value for the assumed 'normal' year 2022. This procedure is necessary particularly for Country Group 3 where the low immigration in the years 2020 and 2021 will impact the number of immigrants living in Norway, which is itself as an explanatory variable in the econometric equations employed in the forecasting.

Figure 7.17 shows the historical relative income per capita ratios for each country group and for the three alternatives. For Country Group 1 relative incomes are not expected to change much compared to the historical data in any of the three alternatives. For all country groups the high alternative is constructed by extra-polating the 2018/19 relative income level until 2100. The middle alternative is constructed assuming that a gradual decline in Norwegian oil revenues will lead to a reduction in Norwegian GDP per capita in relative terms. For Country Group 2 we expect a catch up in incomes to continue in the middle and low alternative but to different degrees. For Country Group 3, the income ratio declines from about 4 in 2019 to about 1.85 in 2070 and thereafter it remains constant for the remaining part of the projection period in the medium alternative. This development is related to phasing-out the petroleum activity in Norway but more importantly with a continuation of economic growth in Country Group 3. In the low scenario there is no difference in the income ratio until 2064 when compared to the development in the medium alternative. In this year the income ratio is set to about 1.9. From this level the income ratio decreases further, to around 1.3 in 2100. Thus, according to the low scenario (PPP-adjusted) GDP per capita in Norway is only 30 percent higher than the corresponding level in Country Group 3. In the high scenario the income ratio is set to the constant value of 4 for the entire projection period.

Figure 7.17 Relative GDP per capita, registered 1970–2019 and assumed paths 2020-2100 in three alternatives



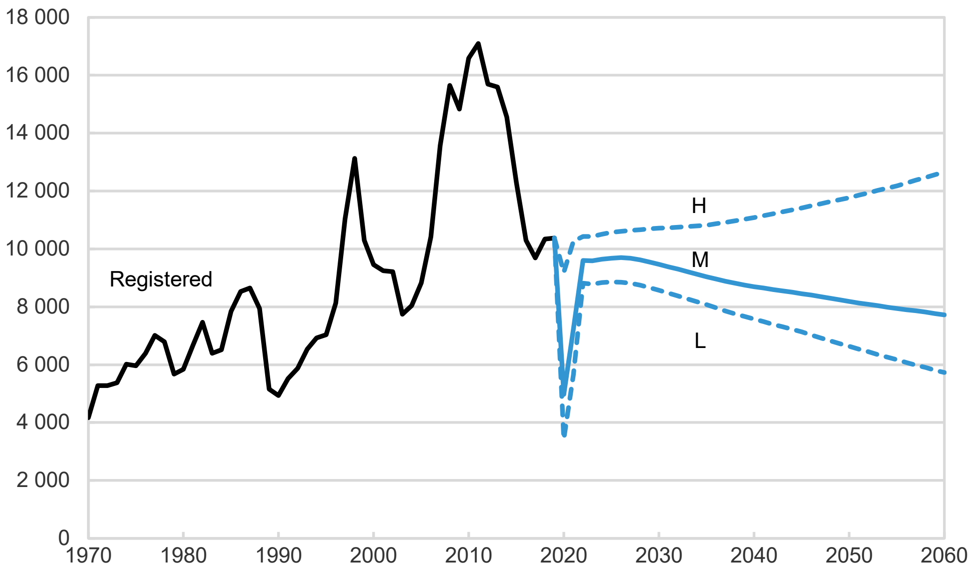
Source: OECD, the World Bank and Statistics Norway

Immigration forecasts for the three country groups

The estimated equations corresponding to equations (7)-(9) are utilized for dynamic projections. First, the unknown parameters are replaced by their estimates and the errors are set to zero. Second, the estimated equations are transformed such that it is the log of immigration of the age groups that occur as left-hand side variables. After having predicted the log emigration for the three age groups by performing iterated forecasting, one may derive the prediction for emigration in levels. Note that we have time series for the exogenous variables on the right-hand side for the period 2020-2100. Values for the lagged right-hand side variables are obtained recursively ('dynamic forecasts'). Below we present the forecast for the three country groups in the medium, high and low alternatives based on the various assumptions for relative incomes and United Nations population projections.

Figure 7.18 shows gross immigration to Norway from Country Group 1. The large drop in immigration in 2020 and 2021 is mainly driven by our *ad hoc* assumptions regarding how the COVID-19 pandemic will affect immigration in the short run, see Section 7.1. In the medium alternative immigration gradually drops, mainly due to lower relative incomes for Norway, making Norway a less attractive country to live and work compared to what has been the case in previous years. The population in Country Group 1 is not changing much according to the most recent United Nations population projections, and this contributes to only a moderate change in emigration to Norway. In the high alternative relative incomes are constant and the small increase in immigration is mostly due to population increase. The low alternative differs only marginally from the middle alternative when it comes to relative incomes, so it is a lower population in Country Group 1 that drives immigration down.

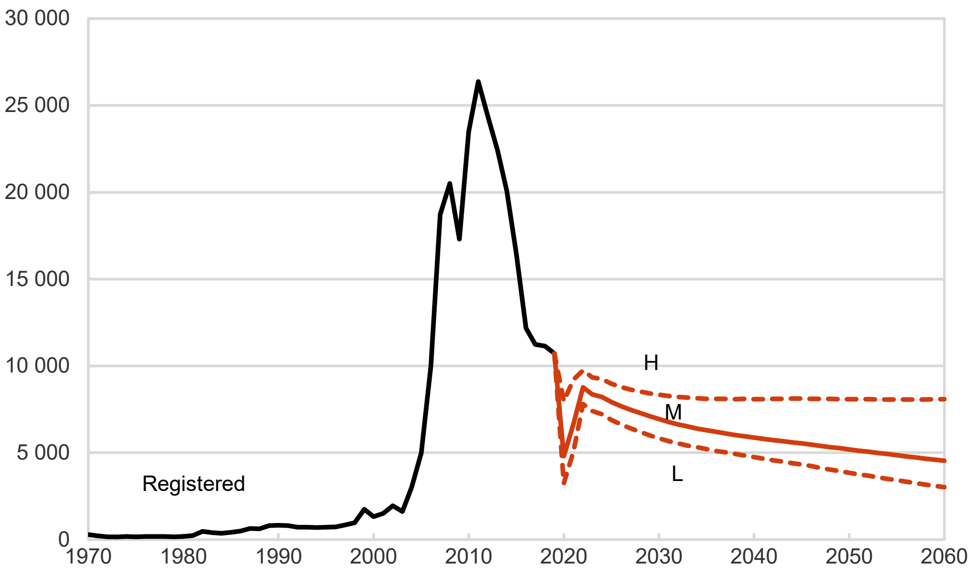
Figure 7.18 Gross immigration to Norway from Country Group 1, registered 1970–2019 and projected 2020–2060 in three alternatives[1]



[1] The alternatives correspond to the medium (M), low (L) and high (H) immigration assumptions.
Source: Statistics Norway

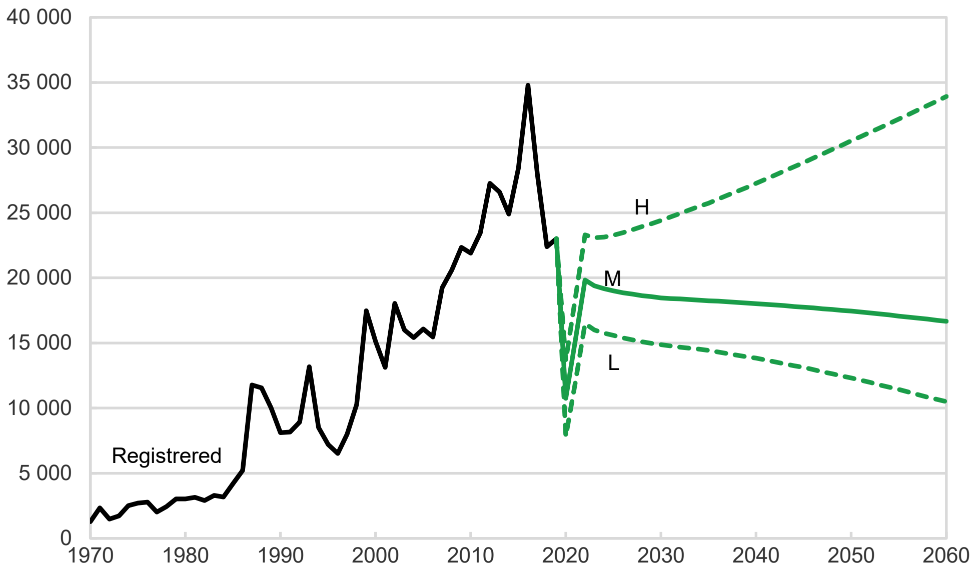
Immigration from Country Group 2 is shown in Figure 7.19. The effect of gaining EU-membership in 2004 is quite dramatic. The recent decline in immigration is mainly due to the relatively positive economic development in Eastern Europe over the last decade. Our assumption regarding relative incomes in Figure 7.17, is that this improvement will continue. Together with a decline in the population, this will lead to a decline in gross immigration to Norway in all three alternatives.

Figure 7.19 Gross immigration to Norway from Country Group 2, registered 1970–2019 and projected 2020–2060 in three alternatives[1]



[1] The alternatives correspond to the medium (M), low (L) and high (H) immigration assumptions.
Source: Statistics Norway

Figure 7.20 Gross immigration to Norway from Country Group 3, registered 1970–2019 and projected 2020–2060 in three alternatives[1]



[1] The alternatives correspond to the medium (M), low (L) and high (H) immigration assumptions.
Source: Statistics Norway

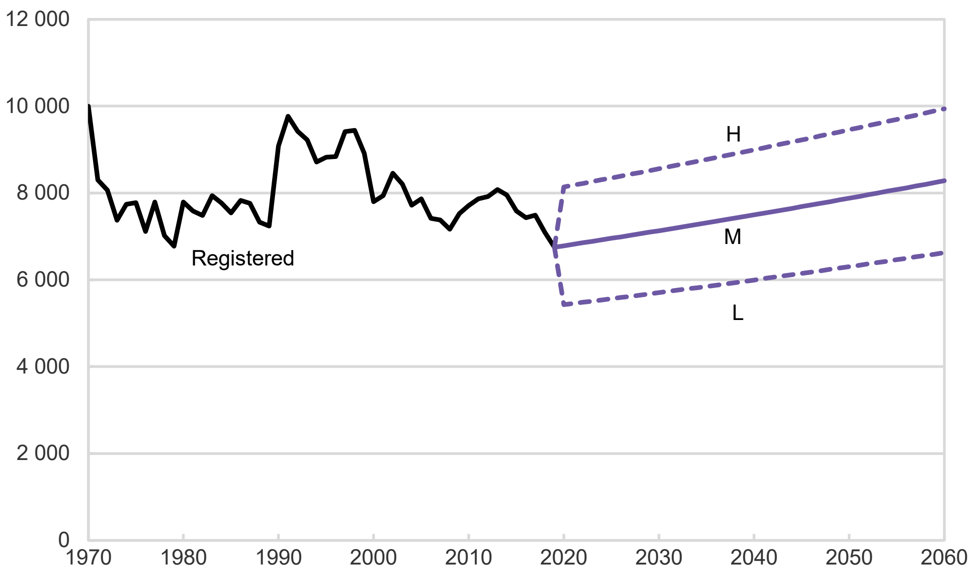
Figure 7.20 shows the projected immigration of persons from Country Group 3 according to the three alternatives. The COVID-19 pandemic is assumed to influence immigration in 2021 and 2022. In the medium assumption scenario, immigration from Country Group 3 is projected to be 10 750 persons in 2020 and just over 15 000 in 2021. According to this projection, gross immigration from this country group increases further in 2022, but thereafter it shows a weak negative trend. Gross immigration is projected to be about 18 000 in 2040, 16 700 in 2060 and 16 000 in the projection's end-year, 2100. In the low assumption scenario, which in addition has been adjusted downwards by one standard error of the forecast error, immigration is set at 7 835 in 2020 and to about 12 000 in 2021. The corresponding figures for the three years, 2040, 2060 and 2100, are 13 800, 10 500 and 4 500. In the high alternative, which in addition has been adjusted upwards by one standard error of the forecast error, immigration is set at 13 700 in 2020 and to about 18 500 in 2021. The corresponding figures for the three years, 2040, 2060 and 2100, are about 27 300, 34 000 and 47 300.

7.4. Immigration of non-immigrants

Every year, a number of people with a Norwegian background who have been living abroad migrate back to Norway. This group also includes persons born in Norway to two foreign-born parents. Assumptions about the future immigration of this group are based on registered immigration patterns over the past decade, but also account for an expected increase in the trend towards 2100 (see Chapter 4, Section 4.3 for details). The trend is assumed to increase because, as emigrations occur, the stock of people with a Norwegian background (who could potentially return) will also increase. As the net migration from this group has been negative since 2014, we have allowed for it to be negative in future years too.

In our medium assumption, we except the immigration of 'non-immigrants' to increase, from around 6 750 today to 8 300 in 2100. In the high assumption, the increase is stronger – to 9 900 in 2100, and in the low assumption the number is reduced to around 6 600 immigrants in 2100 (Figure 7.21). For this group, no COVID-19 *ad hoc* adjustments have been made in the medium assumption, even in the short-term. The reasoning behind this was discussed in Section 7.1, above. The high and low assumptions have, however, been spanned out from 2020, due to the pronounced uncertainties also in the shorter term.

Figure 7.21 Gross immigration to Norway for non-immigrants, registered 1970–2019 and projected 2020-2060 in three alternatives[1]



[1] The alternatives correspond to the medium (M), low (L) and high (H) immigration assumptions. They do not depend on any assumptions used for the other components.
Source: Statistics Norway

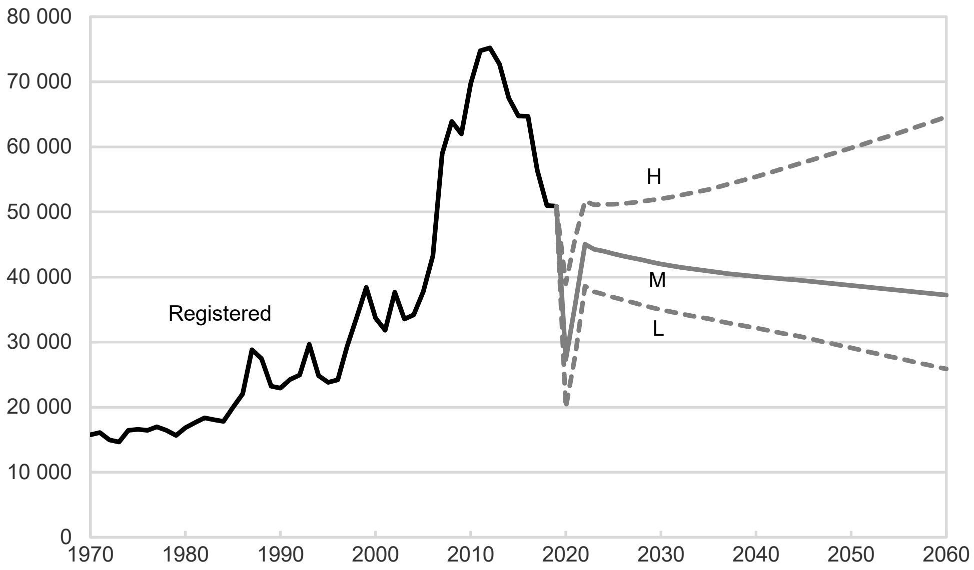
7.5. The uncertainty of future immigration

The total future immigration to Norway is comprised of immigrations from the three country groups, as well as of the non-immigrants. As can be seen in Figure 7.22, the short-term *ad hoc* adjustments for 2020 and 2021 have quite substantial effects. As was seen from Figures 7.18-7.21, in our medium immigration assumptions, we expect a reduction in the immigration from today's levels for all three country groups from 2022 onwards, whereas we expect the immigration from non-immigrants to increase. In total, the yearly immigration to Norway in the medium alternative is expected to remain fairly stable, albeit declining slightly to annual levels below 40 000 by 2060. Recently released first quarter figures show a reduction from that observed in the first quarter last year, from 12 333 to 10 498, corresponding to a 15 percent decrease.

However, the uncertainty in these figures should not be overlooked, and as is evident from Figure 7.22, there is much uncertainty associated with future immigration. In a long-term perspective, uncertainties relate to, for instance, the assumed paths for the explanatory variables in the model, such as income disparities, network effect and unemployment. Furthermore, despite the model accounting for many factors that impact immigration, there are several other factors that have a large bearing on immigration but are challenging or impossible to predict. This applies not least to future political changes, such as a future EU expansion (for instance Serbia, where plans have been made for an inclusion in 2025) or reduction (e.g. Great Britain, which has formally left the EU as of 1 January 2020, 'BREXIT'), and changes in European and Norwegian asylum and immigration policies. Whereas the latter factors primarily affect the demand side, i.e. how many are Norway willing (or able) to take on, wars, conflicts and natural disasters are examples of supply side factors that can have a marked impact on immigration. In addition to the difficulties in predicting when and where wars will break out or end, quantifying how this will impact on the influx of immigrants to Norway is also a challenge. Indeed, history has shown us that after great influxes, policies are often put in place to reduce future entries, such as was the case in the aftermath of the 2015-2016 asylum wave.[30]

Under the low immigration assumption, all groups experience reduced immigration, and the overall level declines from around 39 000 to around 26 000 in 2060 and 18 000 in 2100. Contrary to this scenario, the high immigration assumption projects a high and increasing immigration, reaching above 50 000 at the start of the period, before increasing further to around 64 000 in 2060 and 84 000 in 2100.

Figure 7.22 Total gross immigration to Norway, registered 1970-2019 and projected 2020-2060 in three alternatives



Source: Statistics Norway

As stated, immigration to Norway can become either higher or lower than our main assumptions suggest. It will likely be higher if new wars break out or more serious crises and conflicts arise, particularly if this happens within or close to Europe. For as long as the war in Syria continues, there remains potential for the arrival of new Syrian refugees. Such immigration, as well as the high immigration from Africa, largely depends on available asylum routes to Europe. Although Europe's leaders have learned valuable lessons from the refugee crisis in 2015, as demonstrated by the 2016 EU-Turkey refugee agreement, new crises may take on different forms, for which national governments and authorities at the EU-level are less prepared (Collett 2018).

A further enlargement of the EU may lead to an increase in immigration to Norway. As was seen in Figure 7.19, a large increase in immigration from Country Group 2 was observed following the eastward expansion of the EU in 2004 and 2007. However, the enlargement in 2013 is hardly visible (Croatia), though the admission of a single (and fairly small) country would clearly have less of an impact than the more widespread expansions in 2004 and 2007. In terms of the list of possible candidates for future expansion – Turkey (applied in 1987, roughly 80 million inhabitants), North Macedonia (applied in 2004, roughly 2 million inhabitants), Montenegro (applied in 2008, 600 000 inhabitants), Albania (applied in 2009, almost 3 million inhabitants), and Serbia (applied in 2009, 7 million inhabitants) – the most populous country (Turkey) may seem the least likely to

[30] BREXIT might also be seen as a response to unprecedented levels of immigration to the UK.

gain admission to the EU.[31] For the others, the immigration impact for Norway may be similar to that of Croatia (approximately 4 million inhabitants).

Figure 7.19 also shows an anticipated future decline in immigration from Country Group 2. A drop in the number of new migrant workers from Eastern European countries in the EU may however result in an increased demand for migrant workers from other parts of the world, such as from Country Group 3. In Asia and Africa, the level of education is increasing (UNESCO 2018), which may make it easier for people from these countries to gain work permits and jobs in Norway. This might lead to an increase in the immigration from Country Group 3

The ageing of the Norwegian population, as assumed in the population projections (and discussed in Chapter 6), is also likely to lead to a greater demand for health and care workers. If these are mainly recruited from abroad, it might imply a higher demand for immigration.

For poorer countries in Country Group 3, there may also be mechanisms that drive emigration up in line with economic development, as individuals need certain resources to meet the costs for migration (Clemens and Postel 2017). In our model, we have not found such effects for Country Group 3, which may be linked to the vast size of this grouping, as well as the fact that it includes a heterogenous mix of countries with many already above the income level at which economic development often leads to an increase in emigration. While the levels of affluence in these countries may mean it is less attractive to emigrate, it will also likely make these countries attractive destinations for migrants from poorer parts of Country Group 3. Our model does not give much consideration to how other potential destination countries may be more or less attractive to potential migrants, i.e. third country effects.

In a similar manner, the situation in other Western European countries may not only affect migration from these countries to Norway, but also the migration of people from other countries, where Norway is considered just one of several potential destinations. This latter point is particularly relevant now that the UK has decided to leave the EU. It is still unclear what BREXIT will mean for future immigration to Norway. The migration of British citizens to Norway has remained at around 1 000 per year over the last 10–15 years. This figure may fall if it becomes more difficult for people from the UK to get permission to move here. Conversely, the UK has long been a major destination for migrant workers from the new EU countries in Eastern Europe, such as Poland and Lithuania. Negotiations on future trade and migration policies between the UK and EU, as well as the UK and many other countries around the world, are ongoing. However, EU citizens already living in the UK are expected to be allowed to stay (Hunt and Wheeler 2018), and it is unlikely that this group will leave the country in any great number (Makosa 2018). The question is how easy or difficult it will be for citizens of EU/EFTA countries to move there in the future, and whether those who are not allowed to travel there will choose to go to Norway instead. Moreover, if the UK relaxes immigration restrictions for countries outside of the EU, to counterbalance the loss of labour supply from within the EU, there may also be implications for Norway in terms of greater competition of non-EU labour migrants. In our model, we have not made any changes to the future immigration paths as a result of BREXIT. However, if this impacts on immigration to Norway, it is not inconceivable that it may result in a slight fall in immigration from Country Group 1, but an increase from Country Group 2.

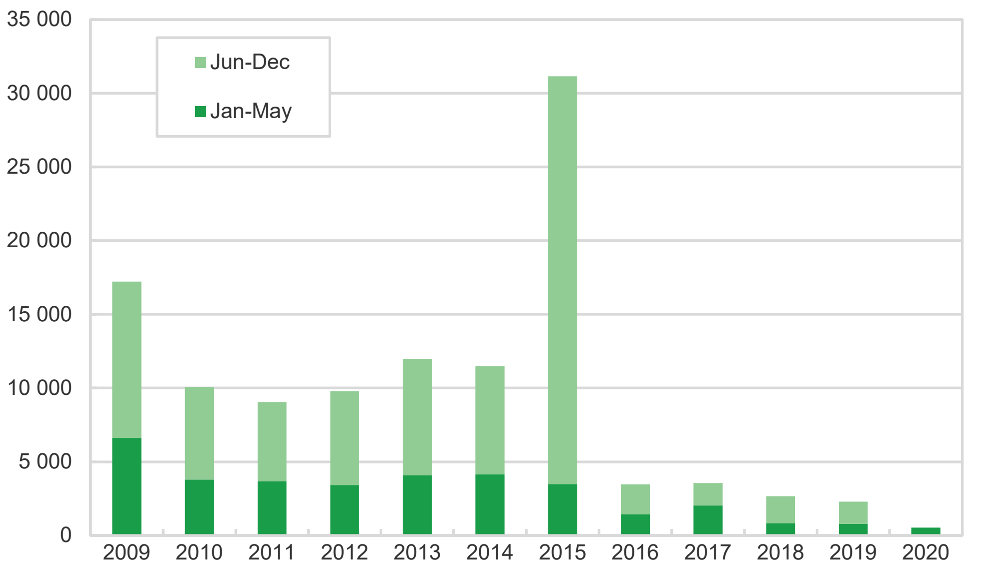
[31] Early stage processes and talks about possible future EU inclusions are also going on in other countries, such as Georgia, Moldova and Ukraine.

Last, but not least, the effects of climate change may also potentially influence the size of immigrant flows to Norway. This is discussed in more detail in Tønnessen (2014).

Our model does not predict political changes, nor changes to long-term global migration patterns. If policy regimes in the years to come result in fewer immigrations than what has been the case during the period used to estimate our model, this is not accounted for in our assumptions. The current immigration climate in Europe suggests that there might be a tightening of future immigration policies, with more coordinated immigration policies appearing to be warranted. Control of the borders and restrictions on the number of migrants arriving from Africa and Asia are high on the agenda. In Norway, there has also been a clear political desire to limit low-skilled immigration from non-EU countries. This might mean that immigration from Country Group 3 could be lower than that which we have assumed in the medium alternative. More European emergency measures for new refugee flows can also mean fewer unexpected peaks in immigration, as was seen in connection with the considerable influx of asylum seekers in the autumn of 2015 (see below) – the peak for 2016 in Figure 7.20 reflects the fact that many of these were included in the population statistics in 2016.

Given the time it takes from when an asylum application is submitted to when the applicant is granted residence and registered as an immigrant, we can use the Norwegian Directorate of Immigration's figures for new asylum applications[32] as an early indicator. Figure 7.23 shows the number of asylum applications per year dating back to 2009. There is a clear peak in autumn 2015, but since then the number of asylum applications has been very low in Norway. In the context of the COVID-19 pandemic, the figures for 2020 look set to be the lowest for many years. The number of asylum applications in January and February were low, but in line with those from 2019. However, the number dropped to almost half in March, and in April only 35 applications were registered (UDI 2020a).

Figure 7.23 Asylum applications, 2009–2020[1]



[1] The figures for 2020 only cover the period from January to April.
Source: Norwegian Directorate of Immigration (UDI)

For Country Group 3, there are several factors that indicate that the network effect may be weaker than we have assumed. First, the rules on family reunification have been tightened. Those reuniting with someone with a refugee status must now

[32] See www.udi.no/statistikk-og-analyse/statistikk/

apply within one year of the reference person being granted permission to stay in order to be exempt from the requirement concerning the reference person's income. Family migrants of refugees make up around 20 percent of all family immigrants to Norway. Family migration among refugees is discussed in detail in Dzamarija and Sandnes (2016). Since 2005, more than 10 000 family migrants (of all kinds) have arrived annually, and more than half have come from countries in Country Group 3.

In our model, the network effect is captured by the number of immigrants from Country Group 3 already living in Norway. As we will show in Figures 7.34 and 7.35, growing numbers of immigrants from this group are tending to stay in Norway for longer periods of time. It is not certain whether the network effect remains strong after immigrants have lived in the destination country for many years, some of them even having arrived as children. If the network effect diminishes with duration of stay, our estimates for the future effect will be too high.

One element that can also push immigration below that anticipated is the emergence of wars and conflicts. Hægre et al. (2013) analyze various driving factors that are associated with an increased likelihood of armed conflict. They find that demographic variables, education levels and the degree of poverty all bear significance, with their predictions suggesting that the number of armed conflicts will significantly decrease as we head towards 2050, primarily due to an expected reduction in poverty in many countries.

In previous years, our projections have not accounted for the expected age development in the three country groups, which was itself an additional source of uncertainty. Given how migration propensities are closely tied to age schedules, an increasingly elderly population in many regions of the world should result in lower rates of migration. Moreover, it could also have an effect in increasing domestic demand for labour, as the working age population falls as a share of the total population. As noted above, this year's projection now includes expected age developments in the three country groups (Figures 7.10, 7.12 and 7.14).

Taken together, it is clear that migration projections are inherently uncertain, and often far more uncertain than those of the other demographic components. The uncertainty usually increases the further into the future we look. However, due to this year's COVID-19 pandemic, it has been especially challenging to formulate even short-term migration assumptions in this year's projection. How long this crisis will last, and how fast the world will get back to relative normality, is still unknown. In our projections, we have assumed a return to relative normality in terms of migration by 2022. Given the changing influence of different health and economic crises on demographic behaviour, we reiterate that our projections are more uncertain than usual, and particularly in the short- and medium-term.

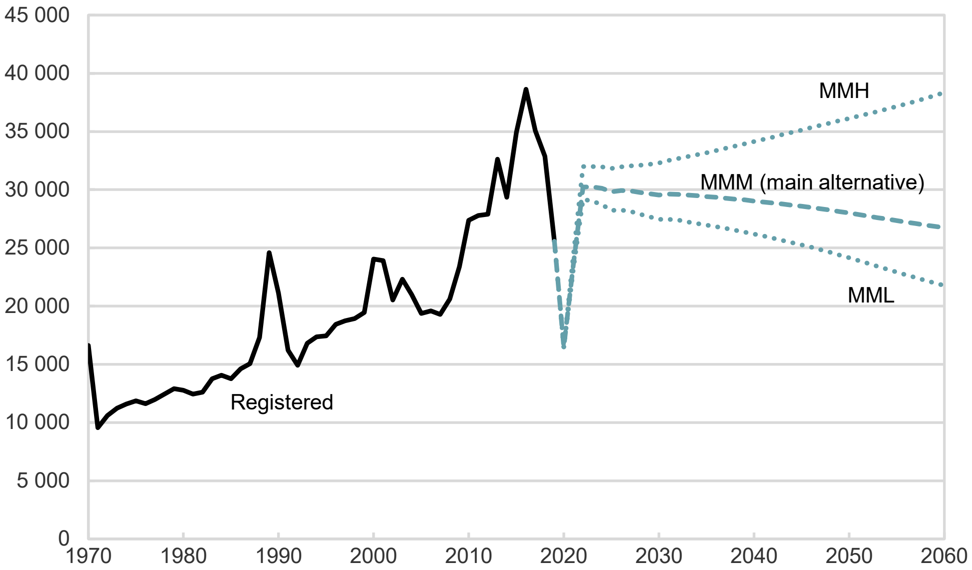
7.6. Emigration from Norway

Emigration in population projections is calculated using emigration probabilities (see Chapter 4, Section 4.3 for details). Due to the COVID-19 pandemic, emigration from Norway has been lowered by 50 percent for 2020 and 25 percent for 2021.

As shown in Figure 7.9, non-immigrants have the lowest propensity of emigrating, followed by immigrants from Country Groups 3, 2 and lastly, 1. Emigration is highest in the first few years following immigration to Norway and decreases with duration of stay (Pettersen 2013, Skjerpen et al. 2015). Consequently, high immigration one year will lead to higher emigration in the years that follow. We normally only apply the medium emigration assumptions.[33] The variations in the emigration figures in the different immigration alternatives, as well as the other commonly used alternatives, are thus a result of the different population figures that the same emigration probabilities are applied to.

Figure 7.24 shows projected emigration from Norway, in three alternatives. The high and the low alternatives refer to high (MMH) and low (MML) immigration. As is evident in this figure, we project a fairly stable emigration, albeit gradually declining, from around 30 000 to around 27 000 per year in 2060, in the main alternative. In the low immigration alternative, we assume a more pronounced decline in the emigration, to around 22 000 in 2060. In contrast, around 38 000 are projected to emigrate in 2060 in our high immigration alternative.

Figure 7.24 Emigration from Norway, registered 1970–2019 and projected 2020–2060 in three alternatives

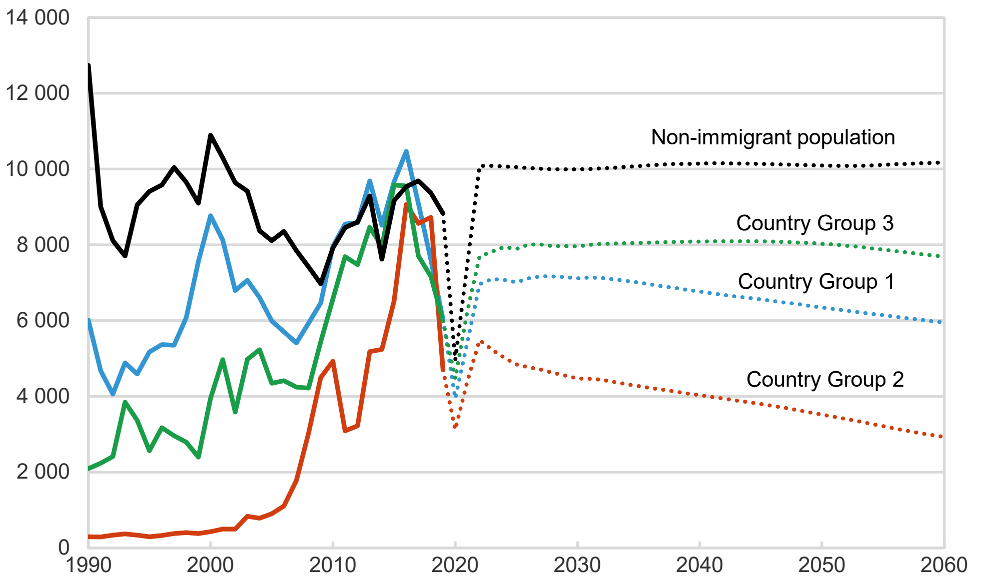


Source: Statistics Norway

As stated, emigrations are more common among immigrants than among non-immigrants (Pettersen 2013, Skjerpen et al. 2015). As the population at risk is so much larger for non-immigrants, the absolute numbers are nevertheless not that different. This is evident if we compare the registered number of emigrations in Figure 7.25 with the rates of emigrations shown in Figure 7.9. From Figure 7.25 we see an expected decline in the emigration of immigrants from Country Groups 1 and 2, due to the expected lower immigration in these groups in the future. Immigrants from Country Group 3 are expected to see relatively stable numbers of future emigrations, although the number of immigrants from this country group is expected to increase towards 2060. The emigration numbers are expected to remain fairly stable also for non-immigrants. The latter group also includes persons born in Norway to two immigrant parents, and is expected to increase markedly in size before 2060.

[33] We also make assumptions where the number of emigrations is equal to that of the immigrations (MME), as well as assumptions of no migration (MM0, i.e. no in- or out-migration, the borders are kept closed). We do not make low or high emigration assumptions.

Figure 7.25 Emigration from Norway for immigrants from three country groups and the rest of the population, registered 1990–2019 and projected 2020–2060, main alternative (MMM)



Source: Statistics Norway

Emigration numbers are also uncertain. Changes in Norwegian immigration regulations, with more temporary residence permits and more withdrawals of permits, may contribute to an increase in emigration. This might also be the case for the newly implemented dual citizenship, which took effect 1 January 2020 (www.udi.no/en/word-definitions/dual-citizenship/). It is, however, difficult to know whether the effects will be sizeable.

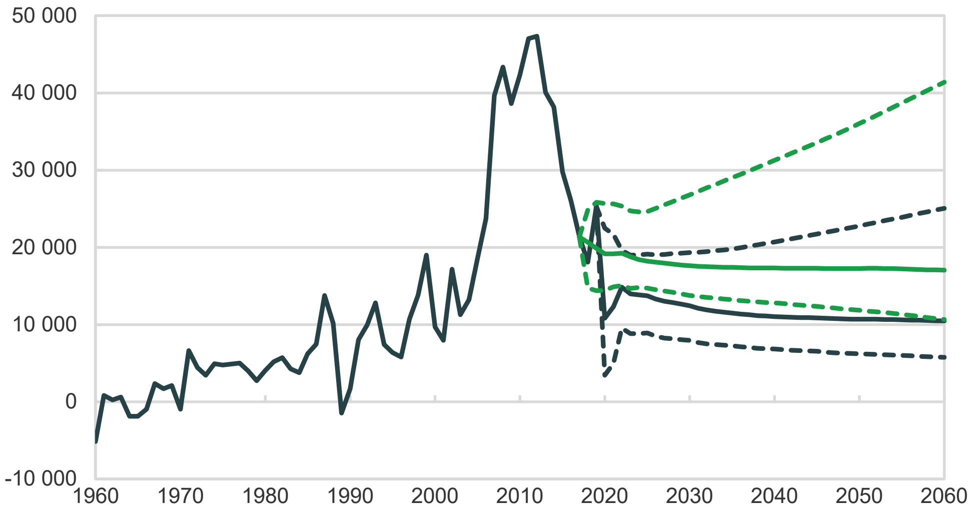
This can also be the case if conflicts and wars end, making it more attractive for refugees and their families to return to their country of origin. The ageing of the population in the countries of origin can also cause migrant workers to move back because of an increased demand for labour or a need to assist older family members. Developments in the EU – and any changes the practice of freedom of movement – could also have a major impact on emigration.

7.7. Net migration

Net migration is calculated by deducting the emigrations from the immigrations for the year. Prior to 2011, specific assumptions about future net migration were made, but as of today net migration is simply a calculation based on the assumed gross immigrations and emigrations.

The projected net migration for the 2020 projections is shown in Figure 7.26, together with the net migration we projected in 2018. The current projection is generally lower than in the previous projection, for all alternatives. This is primarily due to lower immigration, which in turn is linked to a change of forecasting models where we this year forecast immigration for three age groups for the three country groups. The reduced forecast of immigrants in Norway also leads to a somewhat weaker network effect. Furthermore, there is a slightly stronger catch-up in income per capita in the sending areas in this year's projection than in the 2018 projection, due to revisions of historical data. In the projection this year, net migration in the main alternative is 10 000-15 000 per year for most of this century, and roughly 5 000 fewer than in the projection made in 2018.

Figure 7.26 Total net migration, registered and projected in the 2018 (green) and 2020 (black) projections in three alternatives, 1960-2060

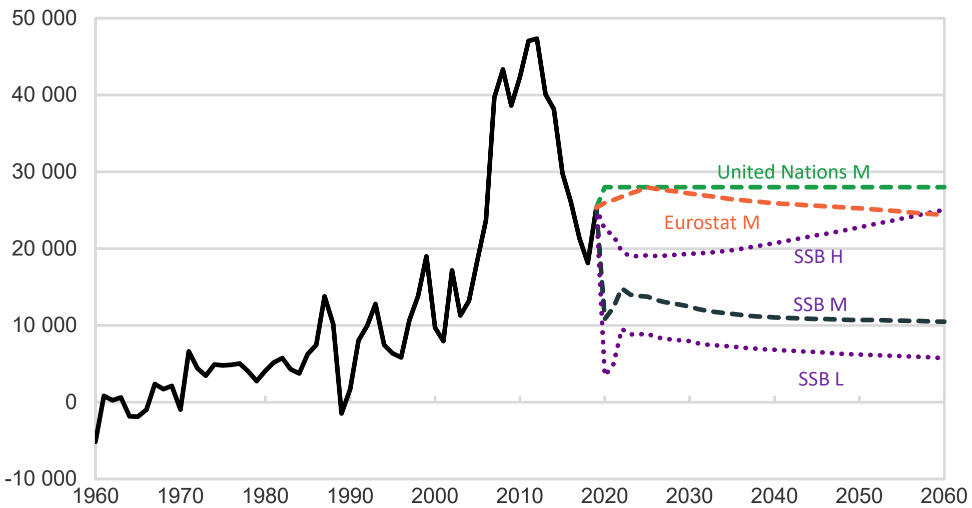


Source: Statistics Norway

7.8. Migration projections from an international perspective

Both Eurostat (2020) and the United Nations (2019) publish their own net migration projections for Norway. However, these are produced in only one alternative each, i.e. a medium-variant (United Nations) and a baseline scenario (Eurostat). The United Nations publishes estimates for five-year periods, with the calculated figures suggesting a yearly net migration of 28 000 (140 000 for a five-year period). They assume a constant net migration until 2100 for Norway. Eurostat publishes estimates at five-year intervals, and intervening values have been linearly interpolated to get annual figures. In short, Eurostat expects a declining net migration for Norway, ending at around 24 000 in 2060, and 21 000 in 2100. As can be seen from Figure 7.27, the projections from both the United Nations and Eurostat are fairly similar to Statistics Norway's *high* immigration alternative (MMH). Statistic Norway's main alternative (MMM) is markedly lower.

Figure 7.27 A comparison of net migration projections from the United Nations, Eurostat and Statistics Norway, registered 1960-2019 and projected 2020-2060 in five alternatives[1]



[1] The medium-variant is shown for United Nations (M), whereas the baseline scenario (M) is shown for Eurostat. Statistics Norway's (SSB) net migration figures are shown in the main (M), low immigration (L) and high immigration (H) alternatives.
Source: Statistics Norway

7.9. Accuracy of the last projection

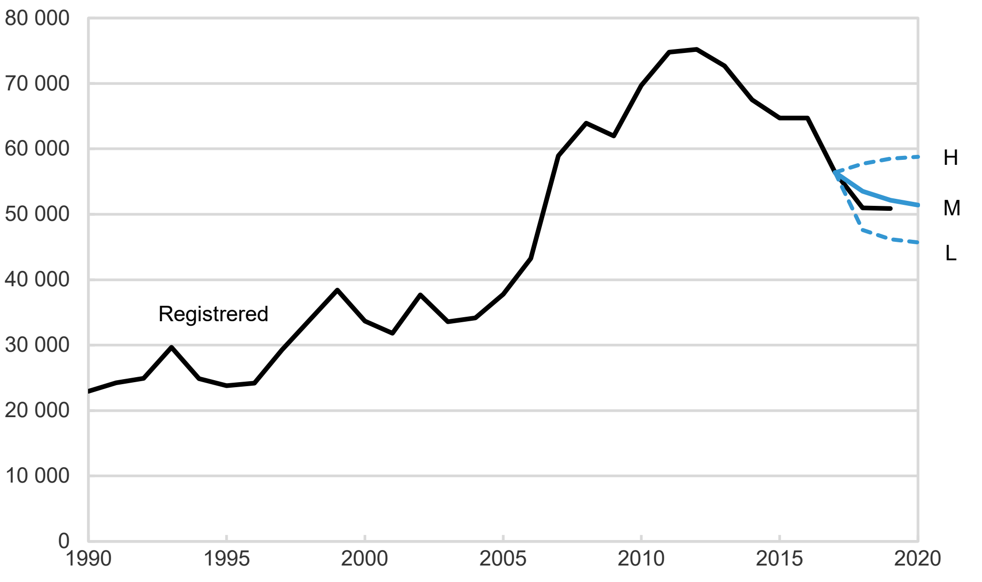
The last population projection was published in June 2018. It assumed a lower immigration and population growth than the 2016 projection (see Chapter 1, Figure 1.25). By studying the accuracy of previous projections, we can form an impression of the short-term uncertainty that characterizes the immigration projections, and perhaps learn valuable lessons for future projection rounds.

In this section, we assess the short-term accuracy of the 2018 projections. A thorough review of the accuracy of previous population projections is given in Rogne (2016). Unfortunately, this publication is only available in Norwegian.

Figures 7.28-7.30 show the registered immigration, emigration and net migration in 2018 and 2019, compared to what was projected in the main (MMMM), low (LLML) and high (HHMH) national growth alternatives in 2018.[34] The registered figures show that immigration to Norway in 2018 was somewhat lower than what was assumed in the medium alternative, and closer to what was assumed in the low alternative. For 2019, however, the actual figure was closest to that assumed in the medium alternative. The deviation was only around 1 300, which is a relatively small deviation after two years, as compared to deviations in previous rounds.

At the country group level, immigration was slightly lower than our medium assumption projected for Country Groups 1 and 3, whereas it was in line with the high assumption for Country Group 2. All discrepancies were fairly minor compared to historical deviations from previous projection rounds, also in absolute numbers. Immigration was, however, lower than projected for non-immigrants.

Figure 7.28 Immigration to Norway, registered 1990–2019 and projected in the 2018 projection

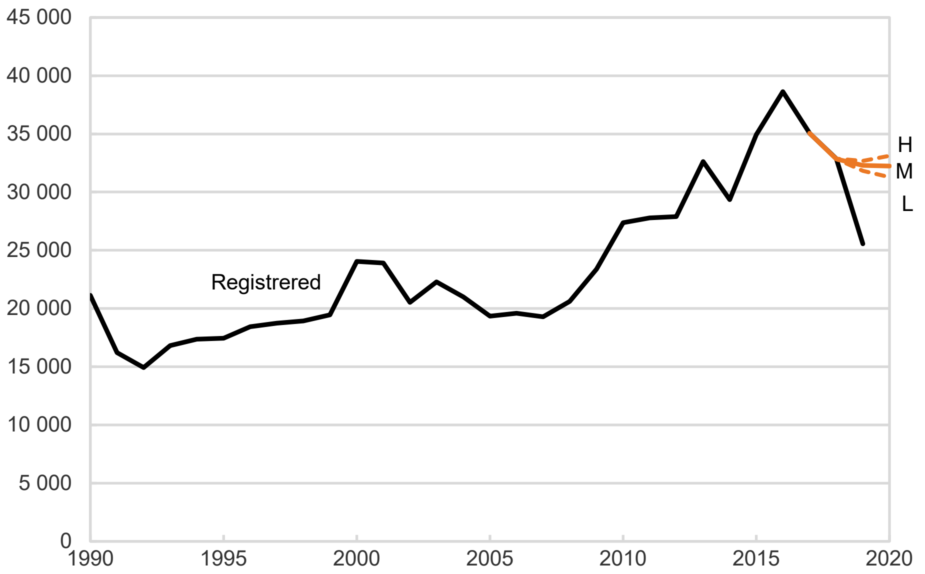


Source: Statistics Norway

Registered emigration was lower than we projected, for both 2018 and 2019, as shown in Figure 7.29. Part of the reason for the deviation in 2019, which appears particularly large, is the changes in the administrative out-registrations, as mentioned in Box 7.3. At the country group level, emigration was projected too high for all country groups, all years, with the exception of Country Group 1 and the non-immigrants in 2018 (which were projected spot on) and Country Group 2 in 2018 (which was projected too low).

[34] The 2018 projections included also internal migration, and four letters were therefore used. The third letter refers to internal migration in cases where four letters are used. See Chapter 3 for details.

Figure 7.29 Emigration from Norway, registered 1990–2019 and projected in the 2018 projection

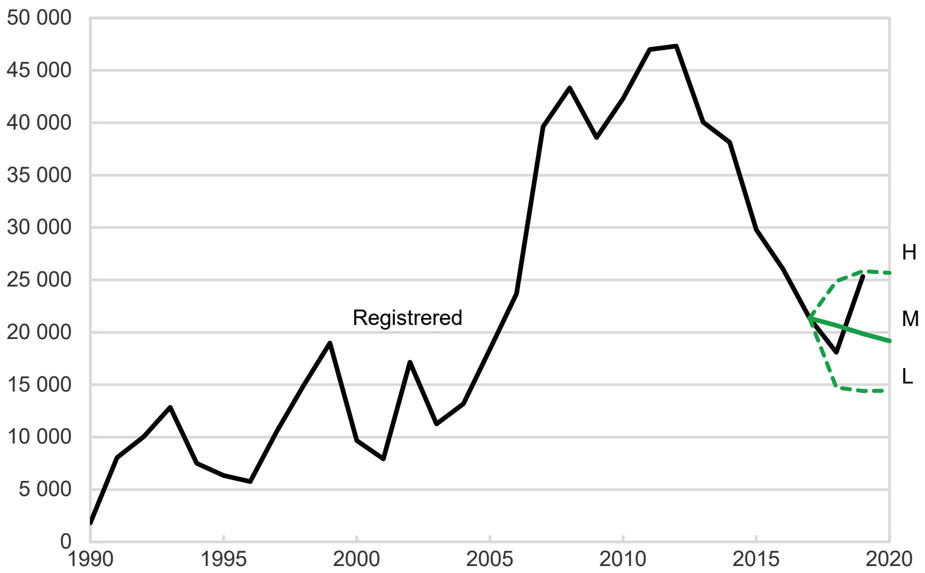


Source: Statistics Norway

For 2018, we projected both higher immigration and higher emigration, as compared to what was registered. As such, the net migration was less affected than the individual migration components this year. As can be seen in Figure 7.30, the actual net migration was most similar to the main alternative in 2018, whereas it was most similar to the high alternative in 2019.

If we look at the different country groups, actual net migration was as projected in 2018 and a bit on the high side in 2019 for Country Group 1. For Country Group 2, it was fairly in line with the projected figure in 2018, whereas it was much higher than projected in 2019 (see Box 7.3). For Country Group 3, the net migration was in line with projected figures both years. For the non-immigrant group, net migration was lower than projected in both 2018 and 2019.

Figure 7.30 Net migration, registered 1990–2017 and projected in the 2018 projection



Source: Statistics Norway

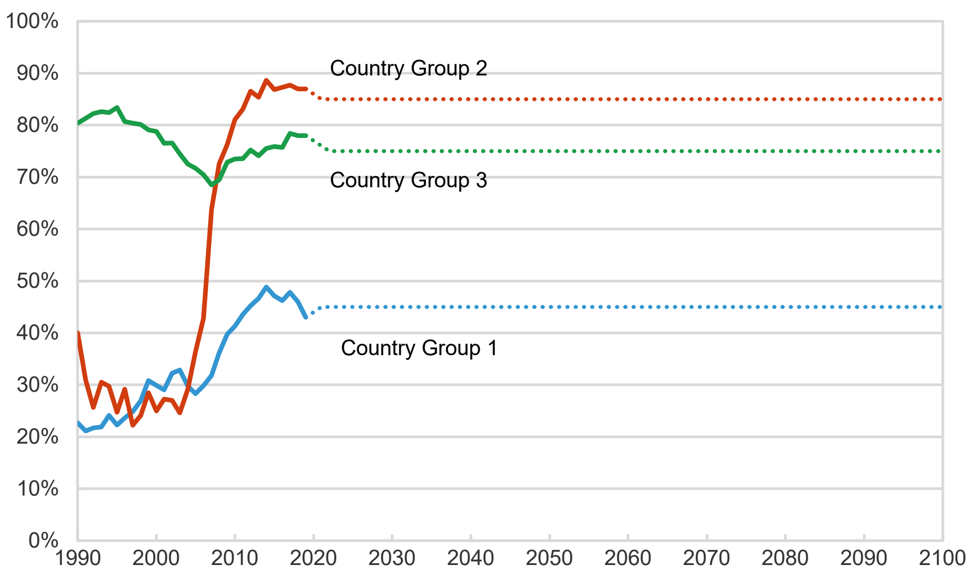
7.10. Norwegian-born with two immigrant parents

From the projections of immigration and emigration (together with assumptions for future fertility and mortality) one may also derive estimates of the future number of immigrants and Norwegian-born children with two immigrant parents who will live in Norway.

To calculate how many of the future inhabitants will be Norwegian-born children with two immigrant parents, we also need assumptions about how large a proportion of immigrant women's children will have a father who is also an immigrant. These latter assumptions are based on projections of observed trends for each of the country groups, as shown in Figure 7.31.

In recent years, the proportion has been highest for women from Country Group 2, with almost 90 percent of the children born to immigrant women having an immigrant father. There was a strong growth in this proportion after the eastward expansion of the EU in 2004, but the growth has stopped in recent years. We have reduced the future share slightly, to 85 percent, as future immigrants will have had more experience of living in Norway and will have become more closely integrated into the Norwegian society. Among women from Country Group 1, the proportion who have children with other immigrants has stabilized or slightly decreased. On the one hand, there is reason to believe that a rising share of immigrants in Norway will result in a continued high proportion of immigrant women who have children with immigrant men. We have therefore increased the proportion slightly for Country Group 1 (from today's 43 percent to 45 percent). Conversely, we do not expect the current high level observed for Country Group 2 to persist throughout the remainder of the century. We therefore assume that the proportion for Country Group 2 will fall slightly (to 80 percent), while for Country Group 3 we expect the proportion to remain at levels comparable to those seen currently, albeit slightly reduced (75 percent).

Figure 7.31 Proportion of children born to an immigrant woman, where the children's fathers also are immigrants, for three country groups, registered 1990–2019 and projected 2020-2100

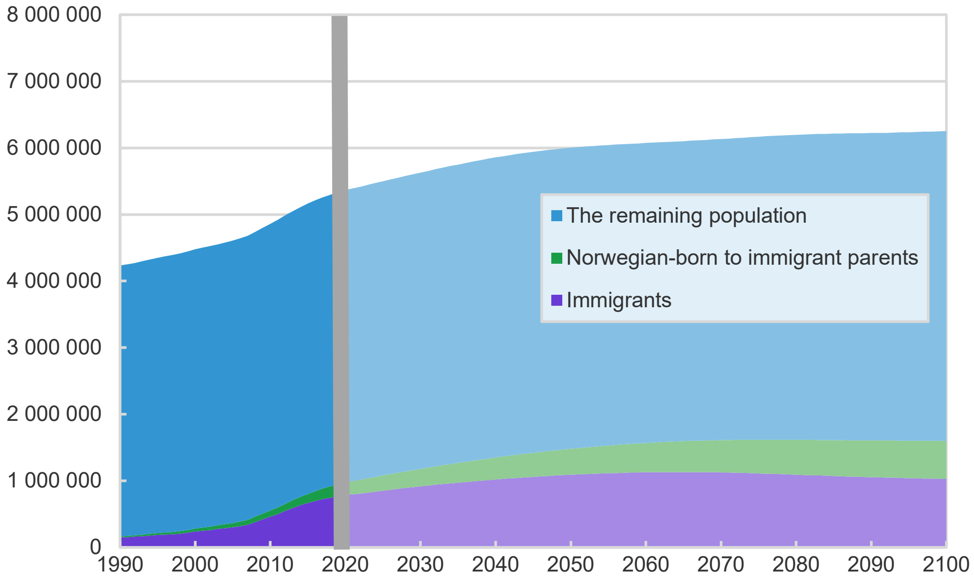


Source: Statistics Norway

7.11. Immigrants and their descendants in the years ahead

Figure 7.32 shows the development in absolute numbers for immigrants, Norwegian-born to two immigrant parents and the rest of the population in the main alternative. In this alternative, the number of immigrants is expected to increase from today's 790 000 to around 1.13 million shortly after 2060, before it declines to 1.03 million in 2100.

Figure 7.32 Immigrants, persons born in Norway to two immigrant parents and the rest of the population, registered 1990–2020 and projected 2021-2100, main alternative (MMM)

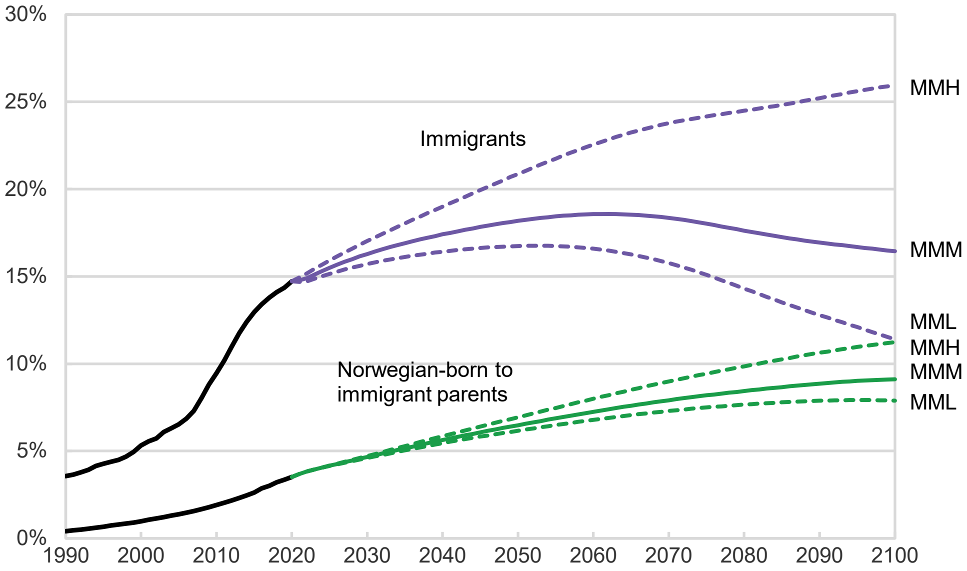


Source: Statistics Norway

Today, immigrants make up 14.7 percent of the population in Norway, while Norwegian-born to two immigrant parents constitute 3.5 percent. How high these proportions will be in the future largely depends on future trends in immigration and emigration. Figure 7.33 show this development in the main alternative, as well as in the alternatives for high and low immigration.

In the main alternative, the proportion of immigrants increases to 19 percent by 2060, whereas the Norwegian-born to two immigrant parents increase to 7 percent. In the high alternative for immigration, the proportions will be higher: 23 percent of the population will be immigrants by 2060, and 8 percent will be Norwegian-born to two immigrant parents. In the low alternative for immigration, the proportions will be 17 percent and 7 percent by 2060, respectively. After 2060, immigrants begin to decline as a proportion of the population, and by 2100, immigrants will, in the main alternative (high and low immigration alternatives in parentheses), comprise 16 (11-26) percent. The Norwegian-born children to two immigrants will, however, continue to increase, and are projected to comprise 9 (8-11) percent in 2100.

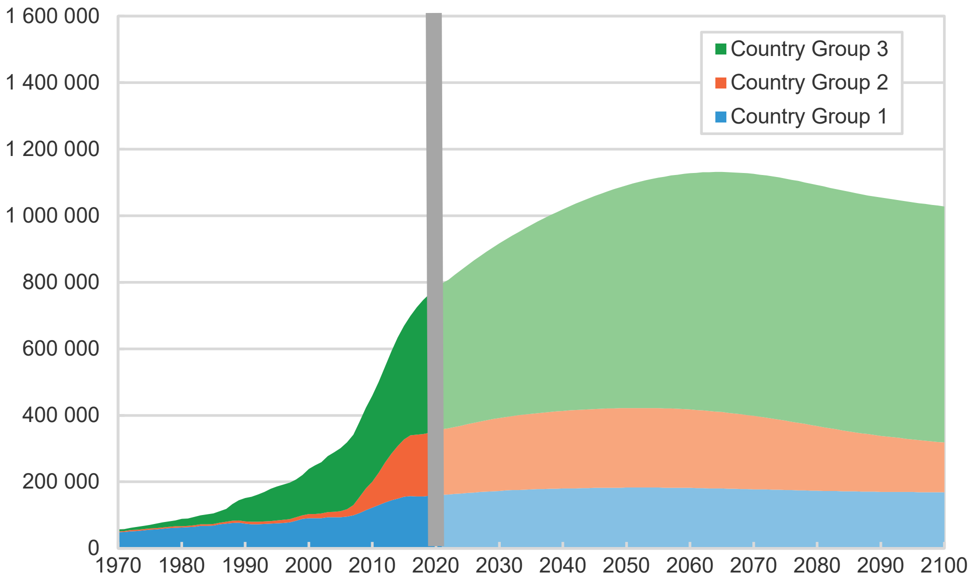
Figure 7.33 Proportion of immigrants and Norwegian-born to two immigrant parents, registered 1990–2020 and projected 2021–2100 in three alternatives



[1] The alternatives are main (MMM), low immigration (MML) and high immigration (MMH)
Source: Statistics Norway

As was shown in Figures 7.18-7.20, we project a decline in immigration from all country groups going forward in our medium alternative, which contrasts earlier projections. In Figure 7.34, we show the number of immigrants from the three different country groups in Norway, in the main alternative. In 2020, immigrants from Country Groups 1, 2 and 3 comprised 161 000, 195 000 and 434 000 persons, respectively. In 2060, the corresponding figures are 182 000 (160 000-228 000), 236 000 (206 000-294 000) and 710 000 (590 000-978 000), with the high and low immigration alternatives in parentheses. The number of immigrants from Country Groups 1 and 2 declines quite markedly before 2100 and comprise 169 000 and 150 000 persons in 2100, respectively, in the main alternative. The number of immigrants from Country Group 3 continues to increase to around 728 000 before 2075 and then declines to about the 2060 level in 2100. In the low immigration alternative Country Group 3 peaks before 2060, with about 592 000 persons and then decreases to about 402 000 in 2100. In contrast, the number of immigrants from this country group increases during the entire projection period in the high immigration alternative and reaches 1 million shortly after 2060 and grows further to around 1.5 million in 2100.

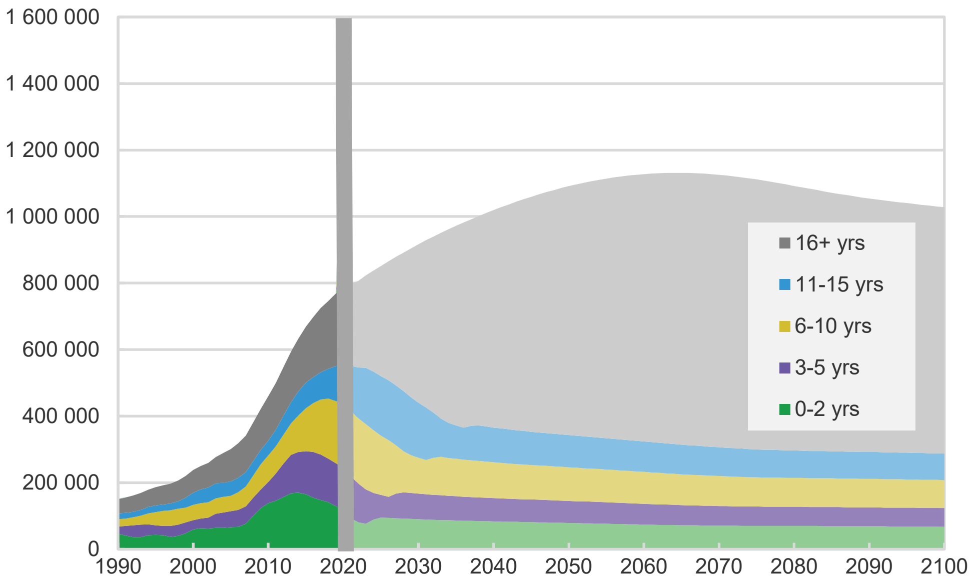
Figure 7.34 Immigrants resident in Norway, by country group, registered 1970–2020 and projected 2021–2100, main alternative (MMM)



Source: Statistics Norway

The probability of emigration usually decreases with duration of stay. Generally speaking, the longer a person has been living in Norway, the less likely he/she is to emigrate. Consequently, when immigration is relatively low, immigrants who have lived in Norway for a long time comprise the group that grows the most, as shown in Figure 7.35. Today, less than 30 percent of immigrants have stayed in Norway for more than 15 years, whereas in 2060 this share will have more than doubled, to 70 percent.

Figure 7.35 Immigrants in Norway by duration of stay, registered 1970–2020 and projected 2021–2100, main alternative (MMM)

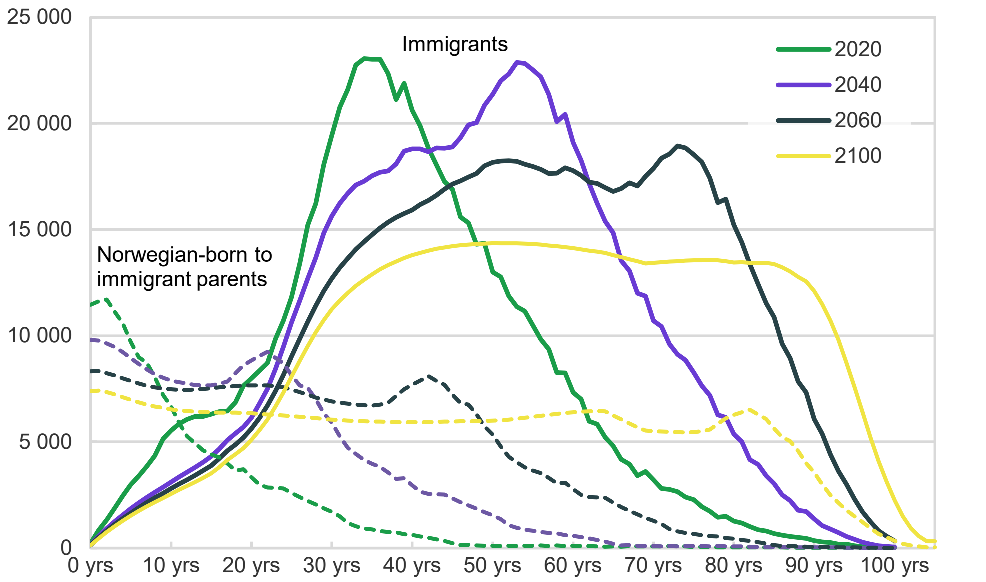


Source: Statistics Norway

We also predict a clear ageing of immigrants in Norway, as the number of immigrants does not increase in all age groups (see also Figure 1.19). In the main alternative (MMM), the number of immigrants in younger age groups is projected to decline in the coming years. Population growth among immigrants in Norway is confined to age groups above 40 years in 2040, and above 45 years in 2060, as shown in Figure 7.36. The projected increase in the number of immigrants in the oldest age groups (i.e. age 70 or older) is particularly striking, with the trend expected to continue throughout this century.

Today, most Norwegian-born to two immigrant parents are young, as indicated by the green dotted line in Figure 7.36. There will continue to be a large number of young children in this group, but future growth will primarily be among the older age groups.

Figure 7.36 Immigrants (solid lines) and Norwegian-born to two immigrant parents (dashed lines) by age, registered 2020 and projected in 2040, 2060 and 2100, main alternative (MMM)



Source: Statistics Norway

All of the figures and estimates shown in this chapter are associated with a degree of uncertainty. Estimates of future immigration are often regarded as the most uncertain element of a population projection. In our work, every aspect entails uncertainty to some extent: Be it in the building and estimation of the econometric model, or in the estimates of future economic growth, unemployment and population trends. All of the other assumptions we have made – such as emigration probabilities and the distribution of immigrants by age and sex – are also encumbered with uncertainty. This of course also bears relevance to our projections of how many immigrants and Norwegian-born to two immigrant parents who will live in Norway in the future. However, as with the population more broadly, we are fairly confident that the immigrant population in the future will be considerably larger and older than it is today.

7.12. Summary

Due to travel restrictions and other circumstances related to the COVID-19 pandemic, we expect particularly low immigration in 2020 and 2021. From 2022 onwards, we project that annual immigration will decline from around 45 000 (39 000-52 000) to around 37 000 (18 000-84 000) in 2100. The projected emigrations depend partly on the immigrations. In the main alternative, annual net migration remains stable at around 10 000-12 000 up to 2100.

Since we have assumed higher immigration than emigration throughout the projection period in our main alternative, we project a continued increase in the number of immigrants in Norway. Until 2060, the number of immigrants will increase from around 790 000 to near 1.13 million. This corresponds to a more than 40 percent increase. The number of Norwegian-born to two immigrant parents will increase from around 190 000 today to around 440 000 in 2060, which is a more than doubling.

The number of immigrants does not increase in all age groups. In the main alternative, the number of immigrants in younger age groups is projected to decline in the coming years. Population growth among immigrants in Norway is confined to age groups above 40 years in 2040, and above 45 years in 2060. The projected increase in the number of immigrants in the oldest age groups (i.e. age 70 or older) is particularly striking, with the trend expected to continue throughout this century.

8. Uncertainty and sources of error and quality

In general terms, a *projection* refers to the calculation of some estimates at a future date. A population projection is defined as 'calculations which show the future development of a population when certain assumptions are made about the future course of population change, usually with respect to fertility, mortality and migration' (United Nations 2018). Population projections show how populations would develop provided that the assumptions on fertility, mortality and migration remained true over the projection period. In other words, population projections answer the question: What would the size and structure of the population look like if assumptions hold?

The usual time horizon of population projections is of a few decades ahead, up to a century. The Norwegian national projections project the population up to and including 2100. However, as the uncertainty increases substantially with time, we primarily focus on the period up to 2060 in most of our communication. This is also the period for which most users need information for planning, etc.

Various alternatives are normally created in population projections, showing different trajectories for possible future developments. The different alternatives are based on assumptions about future developments, usually formulated for three demographic components: Fertility, mortality and migration. As such, population projections are a type of 'what-if' analysis. Based on various assumptions or scenarios about fertility, mortality and migration developments, projections can provide different trajectories for future development (Eurostat 2018, United Nations 2018).

Population projections are not the same as population forecasts. A population forecast aims to provide users with what is believed to be the most plausible development of a future population size and composition, while population projections can seemingly contain fairly implausible and purely theoretical alternatives, e.g. no migration or constant life expectancy. Other relevant concepts include plans, which are used for a desired development, and scenarios, which are used as a description of a possible development, policy or action plan linked to certain assumptions (de Beer 2011).

The main purpose of population projections is to help society understand population dynamics and contribute to the debate on future social change. However, they can also be used as a starting point for policy changes if the developments that emerge are not deemed desirable. The future is not only something to be discovered, it can also be viewed as something to be created (Romaniuk 2010). As such, population projections can be useful planning tools. They can be used as a means for influencing the future, and thus trigger outcomes that may themselves influence population dynamics.

Estimates of future populations are inherently uncertain. This applies to the size of a future population as well as its changing composition. While uncertainty increases with time, population structures are normally associated with a large degree of persistence characterised by demographic momentum. After all, the majority of the population will be one year older and have remained in their locations by the next year. As such, projecting the population can prove to be more fruitful and reliable than predicting or forecasting more volatile trends associated with economic dynamics, structures and events. With that said, despite the relatively good performance of population projections within limited time horizons, their accuracy is adversely affected by unpredictable events such as wars, economic crises, health crises, and natural disasters. For example, the sudden surge in the number of births (the post-war baby boom) and its abrupt end two decades later (the baby bust) were largely unforeseen (United Nations 2018). The COVID-19 pandemic presents a compelling example of the implications that global health crises can have on both the national and global economy, freedom of movement, and the everyday behaviour of individuals. While we know that international migration has been, and will continue to be, greatly affected in the short term, the unprecedented scale of the pandemic means we have little information from which to inform our assumptions in the medium term. Moreover, while Norway has been able to avoid some of the worst effects in terms of excess mortality, other nations have experienced far higher mortality rates along with serious crises in the functioning of their health and social systems. Meanwhile, from the perspective of fertility, it is difficult to know if there will be a sharp fertility decline as experienced in previous pandemics, and if any associated delay in childbearing might result in a subsequent short-term boom in the years following the pandemic, as was seen in the aftermath of the Spanish influenza pandemic of 1918 (Mamelund 2004).

As such, there will always be discrepancies between the projected and the registered total population as well as among the population subgroups. The main reason for this is that we cannot accurately predict the future development of the fertility, mortality and/or international migration components (see Section 8.1 below). For the total population, immigration is currently the largest source of uncertainty. However, fertility, mortality and emigration can also end up rather different from that projected, as illustrated in the previous chapters. In recent years, mortality has declined steadily and thus the impact on errors in the projections has usually been minor. For the respective cohorts, the uncertainty is greatest for the cohorts that are not yet born at the time of projection, as we need to make assumptions about future fertility. Lastly, we know that the uncertainty of estimates of the future population and its composition increases the longer into the future we project.

Discrepancies in percentages are typically greatest for smaller groups (e.g. various immigrant groups) broken down by age and sex. The calculated population figures for smaller groups should therefore be interpreted more as trends rather than as a reflection of precise numbers.

As a consequence, we generally recommend that those formulating planning decisions consider adjusting the results of the projections to account for conditions that are not reflected in the model. There may be indicators that signify the housebuilding situation, job losses or the emergence of transportation projects or other conditions that are likely to influence the populations in the future. Our results will not reflect such events unless they are already reflected in the demographic rates and thereby the assumptions about fertility, mortality, and/or international migration.

In this chapter, we will review three main sources of uncertainty: Demographic assumptions, model specifications and official statistics. Then we will briefly describe our ongoing quality assurance work, before concluding with a description of the factors we consider relevant for producing and publishing high-quality population projections.

8.1. Assumptions about the demographic components

There is a marked uncertainty about whether the assumptions used in making the population projections will accurately reflect future demographic trends. This uncertainty is referred to as 'uncertainty of the future'. This type of uncertainty increases with time. It includes uncertainty about whether events will occur, such as the implementation of policies affecting demographic levels and trends.

The projection results are very sensitive to the assumptions that are used for each of the demographic components. This is demonstrated by the marked discrepancies in the results from the different alternatives in Statistics Norway's projections, as well as in the differences between these projections and those for Norway from other institutions, such as Eurostat (2020) and the United Nations (2019).

Before a new set of projections is made, analyses are conducted on historical trends and possible future developments in each of the components fertility, mortality, immigration and emigration. These analyses are discussed by researchers in the respective fields, both within Statistics Norway and externally. An advisory board group is consulted for most components. The process of determining the assumptions is discussed in more detail in Chapters 5-7.

Over the past decade, future immigration has proven to be the most difficult component to project. This is also likely to be the case in the years ahead. Fertility, mortality and emigration can also be very different from what was projected. For this reason, we make alternative assumptions for each component. This is described in more detail in Chapters 4–7.

In order to illustrate the uncertainty inherent in population projections, alternative assumptions are made for the three main components: fertility, life expectancy and immigration. Each projection alternative is described by three letters in this order, where the alternatives are: M for medium; L for low; H for high; C for constant; E for zero net migration; and 0 for no migration. C is only used for life expectancy and immigration, whereas 0 is only used for immigration. Our main alternative is denoted MMM, reflecting the fact that the medium alternative is used for all components. LLL and HHH denote low and high national population growth respectively. These latter alternatives are, however, considered less realistic, as all components are projected to take on relatively extreme values throughout the entire course of the projection period. In order to demonstrate how the age structure may be affected by different developments in the various components, we also provide alternatives for strong (LHL) and weak (HLH) ageing.

The plurality of alternatives highlights the uncertain nature of population projections by making it clear that there is not just one possible outcome for the future, but, rather, multiple possibilities. We thus provide our users with alternative, internally consistent futures that can be compared, thus furthering the understanding of the sensitivity of the projected results to variations in the assumptions, where some assumptions are more plausible than others, but where those that are less plausible are nevertheless useful as a hypothetical case for use in policy-driven discussions. Such comparisons provide a form of sensitivity analysis and may prove helpful in guiding potential interventions or policy developments.

As stated, the different assumptions may be combined in different ways to produce different alternatives, which may be realistic to varying degrees. What characterizes all the alternatives is that a smooth development is often assumed in the components. For example, we do not assume extreme highs and lows in immigration from one year to the next, although this does often happen. Since we have little information about these short-term fluctuations, we choose to project a smooth trajectory that cuts through irregularities. Such assumptions will in themselves be unrealistic, but the idea is that the negative and positive fluctuations will balance out in the longer term. Irregular trajectories, however, are included in the stochastic projections in Chapter 9.

8.2. Model specifications

Structural uncertainty refers to uncertainty related to limitations in our understanding of population dynamics and in our capacity to model them (United Nations 2018). Typically, parts of the population projection methodology are immune to structural uncertainty. One example here is the cohort-component model, which is employed in the Norwegian projections. In this type of model, the demographic equation consists of exact relationships between population growth and the components of growth (excess of births and net migration). However, structural uncertainty comes into play when modelling these components and projecting them into the future.

Models are simplifications of reality, and as such may only capture a few key mechanisms. This means that there are a multitude of other conditions that affect population development and which are not considered. The strength of the national population projection model, BEFINN, is that it differentiates the population based on immigration characteristics and duration of stay. Other characteristics that may also affect demographic behaviour, but which are not included, include education, health and family situation. Furthermore, our current model only allows for one emigration alternative, but as there is uncertainty associated also with emigration, including for instance high and low emigration assumptions ought to be considered for future projection rounds.

The official Norwegian population projections are deterministic. One consequence of this is that the models do not generate formal uncertainty estimates and prediction intervals. As such, we cannot quantify the statistical uncertainty associated with the different alternatives resulting from the projections. The assumptions for the various components used in deterministic projections determine the outcomes of the different alternatives, as evidenced by the variations between the different alternatives and the disparities between projections by other institutions.

Stochastic projections for Norway are not currently produced on a regular basis, but this year a stochastic projection based around the deterministic main alternative has been produced as an additional product. This projection is presented in the next chapter. For historical comparisons, interested readers are referred to Keilman et al. (2002) and Foss (2012).[35]

The deterministic approach has often been viewed as an unsatisfactory way of assessing and communicating the uncertainty of population projections (e.g. Keilman et al. 2002, Romaniuk 2010, de Beer 2011). The main limitations voiced include:

- The deterministic approach does not adequately reflect the uncertain nature of population projections
- Because no probabilities are associated with the different parameters of the inputs, it is not possible to provide a probabilistic interpretation of the results of deterministic alternatives. It is also not possible, without revising the

[35] Lee and Edwards (2002) observed that users tend to perceive probabilistic projections merely as improved high and low prediction intervals, despite their potential for more detailed and sophisticated analysis. Consequently, it is doubtful that providing probabilistic projections will lead to markedly better decision making if there is no accompanying increase in knowledge about how to use such projections. Furthermore, publishing measures of probability may convey a misleading sense of precision and may not be justifiable in view of the past performance of projections (Lutz et al. 2004). However, recent experiences are more promising. Statistics New Zealand has published official probabilistic population forecasts since 2012. The shift from using a deterministic approach to using a probabilistic approach is less difficult to make than might be expected, as reported by Dunstan and Ball (2016). The authors mention a number of benefits that the producers and users of New Zealand's probabilistic forecasts have noticed since such forecasts were first published in 2012.

specification of the alternatives, to modify the width of the high–low interval for some specific purposes. These characteristics may limit the usefulness of deterministic variants for planning purposes.

On the other hand, the publication of multiple deterministic alternatives underlines the fact that the future does not have just one possible path. It also provides a simple way to communicate the plausible range of future demographic trends given what is currently known (Romaniuk 2010).

8.3. Errors in official statistics

The third source of uncertainty relates to the inaccuracy of the data used to construct the projection, such as the baseline population and the observed rates used to choose the assumptions.

The population statistics on which the population projections are based comprise persons registered as resident in the National Population Register, i.e. persons who live in Norway permanently or who intend to have their fixed place of residence in Norway for at least six months and who are legally residing in Norway. Nordic nationals have been granted residence permits automatically since 1956. The same now applies to nationals of EFTA/EEA countries. There are some people staying in Norway who are not included in the statistics, however, for example people working on short-term contracts or people staying in Norway without a permit. Consequently, it is the *de jure* population and not the *de facto* population that is projected.

Norway has administrative registers covering the entire population. The registers are up to date and generally considered to be of high quality. Consequently, errors from official statistics constitute a minor source of error in the projections compared with those of many other countries. Such errors nevertheless exist. One example is the delay in the registering of emigrations in the National Population Register, as there is not much incentive for individuals to notify the authorities of their departure (Pettersen 2013). The implication is that some people who no longer live in the country remain in the register. Such issues create a discrepancy between the actual and the registered population at the national level, but also impact on the age structure and death rates.

As stated in Chapter 1, net migration in the observed data is artificially elevated for 2019 due to reduced administrative out-registrations of emigration in the National Population Register, administered by the Norwegian Tax Administration, during the latter half of 2019. This resulted in around 5 000 fewer administrative out-migrations compared to previous years. The missed out-registrations pertained primarily to immigrants from Country Group 1 and 2, and these are likely to be administratively out-registered during 2020 and 2021. As shown in Chapter 7, our current emigration assumptions are based on the last decade of registered emigrations. Consequently, fluctuations in the base period will impact future emigration assumptions, but also result in larger discrepancies for the coming years as the postponed out-registrations eventually will be registered.

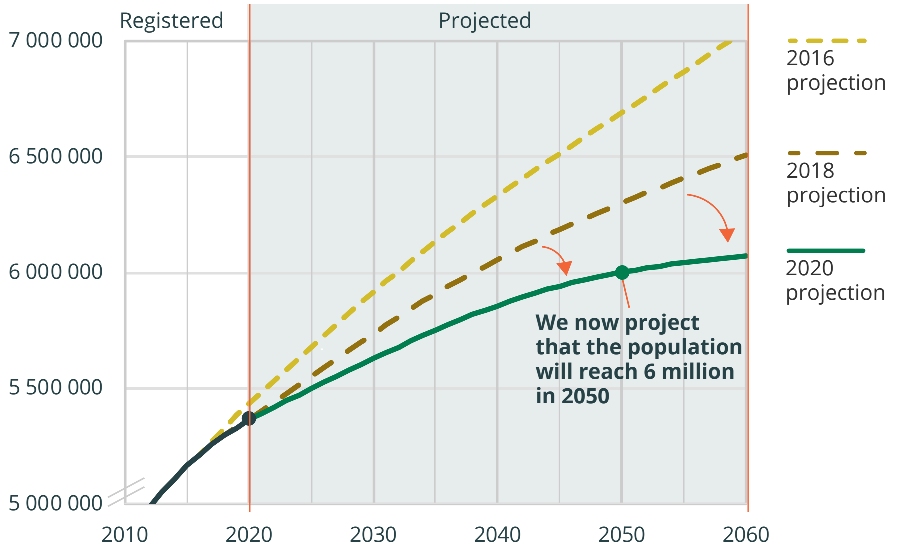
8.4. Quality assurance

We employ several methods to assure the quality of the Norwegian population projections. In short, we review past trends in fertility, life expectancy, immigration and emigration. We also evaluate previous short- and long-term projections, and compare the projections produced by Statistics Norway with those produced for Norway by the United Nations and Eurostat. To ensure transparency, we document the data and methods we employ. We publish the results from 15 alternative projections and highlight the uncertainty associated with population projections. This year, we also provide a stochastic projection to formally assess uncertainty in future population size and structure. In addition, we compare the results of the stochastic projection with those of the deterministic projections. Finally, we examine the degree to which the various results we publish are used, and attempt to clarify issues that arise from interaction with users.

Review of past trends

Before a new set of projections is made, we analyse the historical trends in fertility, mortality, immigration and emigration. An overview of historical developments and trends is therefore presented along with the publication of each new set of projections. In this report, a summary of the historical trends is provided in Chapters 1, 5, 6 and 7, with the change between recent projections in terms of the total population estimates shown in Figure 8.1.

Figure 8.1 Projected population from the 2016, 2018 and 2020 population projections, main alternatives



Source: Statistics Norway

Historical evaluations

Repeated comparisons of projected values with historical estimates reveal the limitations of population projections and inform users about what can reasonably be expected from them. Engaging in this exercise also enables Statistics Norway to reflect on the source of past inaccuracies, serving as a basis for improving future projection assumptions and methodologies.

The quality of the projection figures is evaluated by comparing the projected results with registered population figures for subsequent years as these become available. We also compare our projections with earlier projections. We do this for both the individual components and the different estimates that result from the models. As an example, we investigate how the projected fertility (measured by the total fertility rate) compares to what was empirically shown to actually occur, but we also examine the number of projected and actual new-borns and deviations in these figures. The results are published with the release of new population projections, as well as in summary reports on population development, most recently for example in *Economic view of the year 2019* (Statistics Norway 2020e). Longer-term evaluations of national projections are also available: For projections published in the period 1969-2000 in Keilman and Pham (2004), and for projections since 1996 in Rogne (2016).

Errors are typically greatest (in percentage terms) for small population sub-groups (e.g. estimates by short duration of stay in Country Group 2 among older age groups), wherein small numbers are often characterised by large annual fluctuations. For the respective cohorts, the uncertainty is greatest for cohorts that are not yet born at the time of projection, as we need to make assumptions about future fertility. The mortality decline has been consistent in recent years, so its impact on errors in the projections is minor. An exception is among the very oldest elderly population, where mortality is pronounced and the future course is more difficult to predict. For the population as a whole, immigration has comprised the largest source of uncertainty since the EU enlargement in 2004, but emigration also represents a challenge to the accuracy of our projections. As shown in Table 8.1, in 2019 the largest discrepancy between registered and projected figures related to net migration. Lately, the decline in fertility has also resulted in a discrepancy between registered and projected births, and the deviation in the number of births was larger than that for immigration in 2019, in our main alternative, as shown in Chapter 1, Table 1.3.

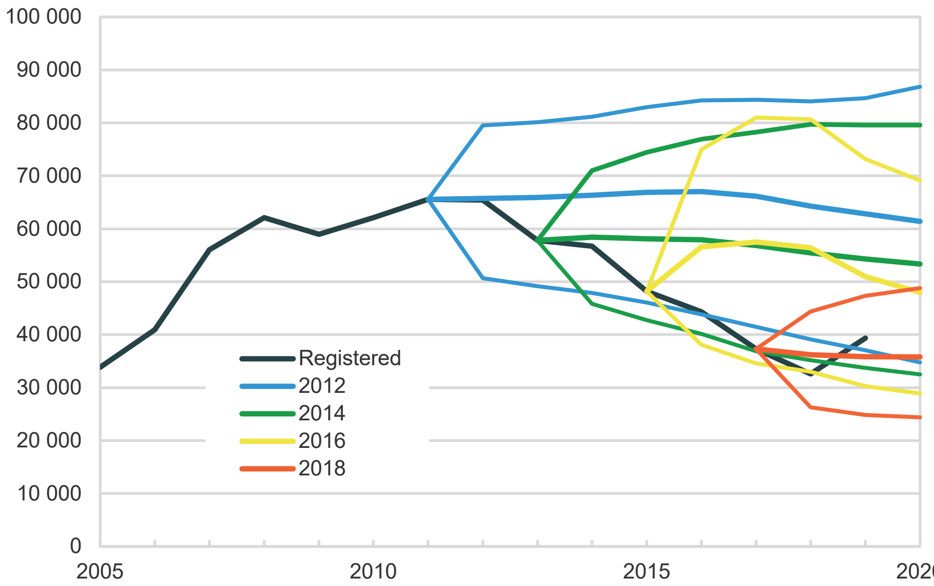
Table 8.1 Short-term comparisons, projected and registered figures for 2019 in three alternatives[1]

	Births	Deaths	Net migration	Pop. growth	Pop. Dec 31
Registered	54 495	40 684	25 427	39 368	5 367 580
Main (MMMM)	56 700	40 700	19 900	35 800	5 367 650
Low national growth (LLML)	52 700	42 300	14 400	24 800	5 346 800
High national growth (HHMH)	60 600	39 100	25 800	47 300	5 387 300
Deviation (MMMM)	2 200	-3	-5 500	-3 500	71
Deviation (LLML)	-1 800	1 600	-10 900	-14 500	-20 800
Deviation (HHMH)	6 100	-1 500	500	8 000	19 800

[1] In the 2018 projections, four letters were used to denote the various alternatives, as regional projections were also made. The third letter represents internal migration. It was produced in two alternatives (M and 0). The actual figures for births, deaths and net migration do not exactly sum up to the population growth figures. As such, population growth is defined as the change in population size from 1 January one year to the same date the following year. Rounded figures are shown for projected numbers, to underscore the uncertainty. However, all deviations are calculated using exact projected and registered figures.
Source: Statistics Norway

Figure 8.2 portrays the discrepancies between registered and projected figures for population growth in three alternatives (main, high national growth and low national growth). As can be seen from the figure, the real growth was lower than what was projected in the low national growth scenario both in 2012 and 2014. However, the growth has never been higher than the projected high growth scenario.

Figure 8.2 Short-term annual population growth in three alternatives, registered and projected in three alternatives, 2005-2020



[1] The three alternatives are main, low national growth and high national growth.
Source: Statistics Norway

International comparisons

We compare Norwegian projections with those made for Norway by, for example, Eurostat and the United Nations. We do this both for the assumptions we employ, as well as for the final results. Examples of such comparisons may be found in Chapters 1, 5, 6 and 7 in this report.

Documentation of data, methods, assumptions and models

Transparency is a vital part of assuring quality in the population projections. Our goal is to make it easy for users to find information and documentation about our national population projections. Our website includes links to data in StatBank Norway, both for current and previous projections. Here we have also published a StatBank guide for our users, but this is currently only available in Norwegian. We also create publications, such as this report, which show the assumptions underlying the projections we make, as well as the models used to project the future. These are published both in Norwegian and English. Although our primary users are Norwegian speakers, it is important that we also publish our methods, assumptions and results in English so that other countries and international users and/or researchers have the opportunity to give constructive criticism on our work (United Nations 2018, Eurostat 2018). As such, this is considered to be a part of our quality assurance work.

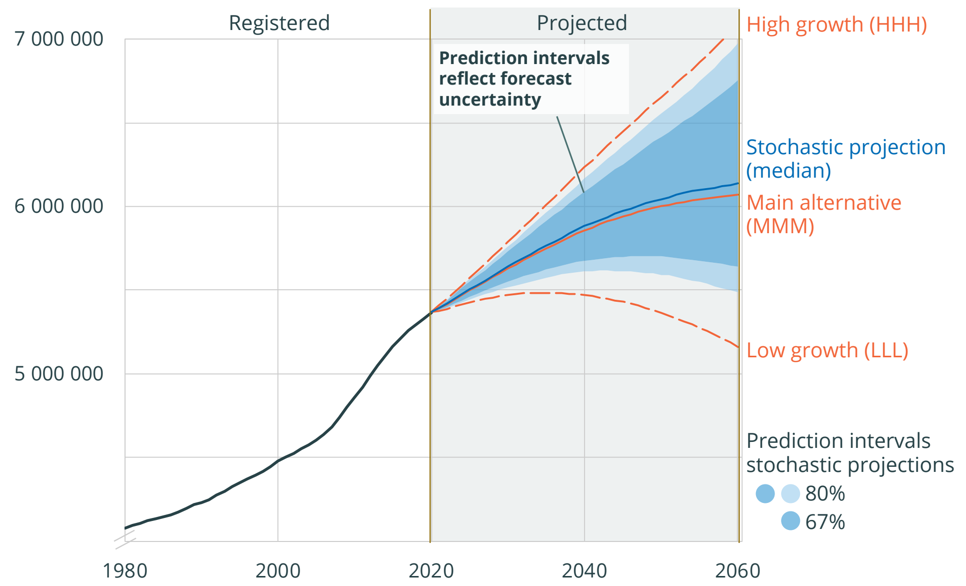
Communication of uncertainty

At Statistics Norway, we primarily use words to convey the general idea of uncertainty. In general, verbal expressions are more easily remembered than numerical expressions and are better adapted to lay audiences (Kloprogge et al. 2007). We attempt to use conditional phrasing when we present our results. Furthermore, we ensure that we incorporate additional information regarding the uncertainty of the results, both in the oral and written communication with users. We publish results from 15 alternative projections, thus underlining the inherent uncertainty associated with population projections in general. In addition, we attempt to distinguish empirical and projected numbers clearly in our communication, for instance by using different colours in graphs, and by consistently rounding off projected numbers.

This year a stochastic projection has been produced based on the medium assumptions applied in the main deterministic projection. Some results from this projection are included in a StatBank table (https://www.ssb.no/en/statbank/table/12890). In addition, Chapter 9 explains the methods used and outlines the main results from this projection.

From the perspective of the total population, the median from the stochastic projection is slightly higher (around 65 000) than the main alternative (MMM) estimate for 2060 (Figure 8.3). The 80 percent prediction interval illustrates an uncertainty ranging from 5.5-7.0 million, while the 67 percent prediction interval ranges from 5.6-6.8 million. In contrast, the deterministic high and low national growth alternatives range from 5.2 million to 7.1 million in 2060. In providing estimates from a stochastic projection alongside the main deterministic projection, we hope to offer a more detailed understanding of the inherent uncertainty associated with projecting populations into the future. At the same time, the relative agreement in estimates between the two models is also useful in supporting the conclusions we draw from this year's projection.

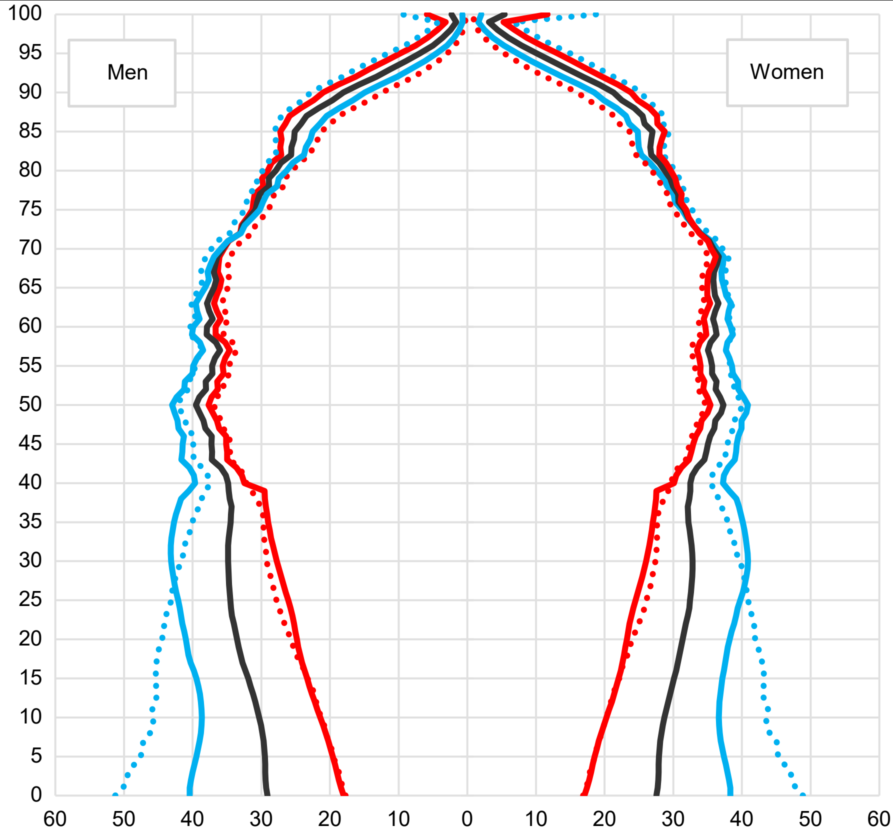
Figure 8.3 Comparing projected total population size based on the deterministic and stochastic projections, registered 1980-2020 and projected 2021-2060[1]



[1] Projected total population size according to the main alternative (MMM), the low (LLL) and high (HHH) national growth alternatives, as well as the median (50th percentile) and the 67 and 80 percent prediction intervals from the stochastic projection. The 80 percent prediction interval corresponds to the light and dark blue shaded areas combined.
Source: Statistics Norway

Given the assumed changes in the future age structure of the population, it is also useful to compare the two models in terms of their projected age distributions. Based on estimates for 2060, Figure 8.4 provides a means of comparing the main alternative (MMM), and strong (LHL) and weak (HLH) ageing alternatives of the deterministic model, with the 80 percent prediction interval from the stochastic projections. The latter projections suggest that it is less than 80 percent likely that actual numbers of children and adolescents (up to 20 years of age) in 2060 will be between low and high numbers given by alternatives LHL and HLH. Young children in particular are very difficult to predict with large precision, i.e. with narrow prediction intervals. Though it should be noted that the upper bounds of the stochastic projection would require a very high future fertility rate, since the TFR in 2060 for the weak ageing alternative is 1.94. For the elderly too, the margins defined by LHL and HLH are narrow, compared to the 80 percent prediction intervals, but here differences are much smaller than for young children. Note that the curves for alternatives LHL and HLH cross each other around age 72.

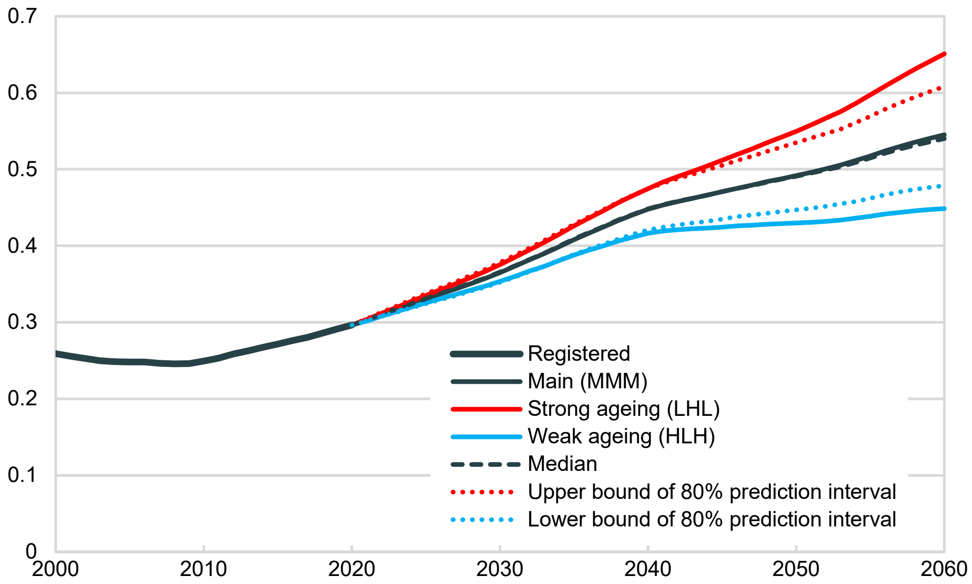
Figure 8.4 Age distribution by sex (in 1 000s) based on the deterministic and stochastic models, projected 2060[1]



[1] Solid lines refer to the deterministic projection: Main alternative (MMM) (black), the weak ageing alternative (HLH) (blue) and strong ageing alternative (LHL) (red). Dotted lines refer to the bounds of the 80 percent prediction intervals (lower bounds in red, upper bounds in blue) from the stochastic projection.
Source: Statistics Norway

As was noted in Section 1.2, we expect the age distribution to shift over the coming decades as a process of population ageing takes hold. As such, we assume the OADR (number 65+ years / number 20-64 years) will continue to increase in the future. This is apparent in Figure 8.5, which provides a comparison of the projected increase in the OADR according to the deterministic main (MMM), strong (LHL) and weak (HLH) ageing alternatives and the median and 80 percent prediction interval from the stochastic projection. An increasing OADR is apparent in all alternatives, though there are clear differences in the speed of this increase. As we would expect, uncertainty increases with time from the base year (i.e. 2020), with the largest difference being between the strong and weak ageing alternatives from the deterministic model.

Figure 8.5 Old age dependency ratios based on deterministic and stochastic models, registered 2000-2020 and projected 2021-2060[1]



[1] Projected OADR (number 65+ / number 20-64) based on the main alternative (MMM), weak ageing alternative (HLH) and strong ageing alternative (LHL), as well as the median and 80 percent prediction interval from the stochastic projection.
Source: Statistics Norway

User orientation

We attempt to foster a relationship with our users. The users should perceive our numbers as relevant, and we strive to provide numbers that coincide with the needs of users. Users can download all the figures we produce in the StatBank: https://www.ssb.no/en/folkfram. Users can easily get in touch with us by email: nasjfram@ssb.no. We are also available via telephone, and strive to present our methods and results publicly in relevant meetings. Lastly, we examine the degree to which the various results we publish are used by users and attempt to clarify issues that arise from interaction with users in subsequent releases.

8.5. Quality in the population projections

The quality of population projections is dependent on a multitude of factors. At Statistics Norway, our work to ensure the production and publication of high-quality population projections is guided by the following factors:

- **Independence, integrity and transparency:** Our population projections should be based on research, i.e. empirical analyses of the forces underlying demographic change. This is partly safeguarded through our contributions to the international projection environment. We endeavour to be an independent contributor to setting framework conditions for society, and we aim to produce transparent and well-documented projections in both Norwegian and English. This also includes communicating the uncertainty about projected numbers. Furthermore, our projections are not a reflection of a sought-after future development, i.e. they are not normative. Our projections merely reflect what is likely to happen if our assumptions hold and policies are not implemented to change the projected course.

- **User orientation, accessibility and relevance:** We provide timely and detailed information by offering annual numbers for the population (up to and including the year 2100) by one-year age group, sex, immigrant country background and duration of stay. We aim for our figures, and the dissemination and interpretation of them, to help set the agenda for discussions about future population changes. Users should perceive our numbers as relevant, and we strive to provide numbers that match user needs. We refer to the alternative that comprises the medium level of all components as the 'main alternative'. We nevertheless guide users who have specific hypotheses in mind to also consider other alternatives. As we publish multiple deterministic projection alternatives, we encourage users to consider a range of projection results rather than a single result, by comparing multiple alternatives. We always provide at least three alternatives to our assumptions (i.e. the L, M and H alternatives) when we provide figures directly for users.

- **Accuracy:** We strive to employ realistic assumptions in our main alternative, both in the short and long term, based on the knowledge available at the time of projection. The accuracy of previous projections is evaluated regularly in order to highlight areas where improvements may be useful and/or warranted. Lastly, we monitor the actual population change continuously, and should the future development differ to our assumptions in our main alternative, we guide users as to which of our alternatives diverge the least from actual population figures, explaining why our main alternative may not be the best option depending on their intended use.

  Whereas inaccuracies in the short term are likely to emerge from either faulty assumptions and/or unpredictable trend shifts, which we as projection makers attempt to minimize, inaccuracies in the longer term may emerge from different sources. Long-term projections may be used to amend policies to avoid certain future population developments and/or changes. If the inaccuracies are a result of such policy changes, they might be a result of strategies we have not attempted to project. If projections have been used as a political tool to strive for a different population development, inaccuracies between the projected and registered population size and structure are viewed, from our side, as unproblematic.

8.6. Summary

Population projections are intended to serve as a basis for better decision making in democracies. Independence and impartiality in population projections are vital to fulfilling this demanding role (United Nations 2018). Users of population projections expect results that are independent and impartial, and these are principles that are followed by Statistics Norway. A transparent approach can help preserve and even promote these principles.

The accuracy of a projection depends on many factors that are difficult or impossible to anticipate. In this chapter, we have described three types of uncertainty: i) 'uncertainty of the future'; ii) structural uncertainty; and iii) uncertainty related to the data. In the Norwegian setting, the 'uncertainty of the future' is considered to have the greatest influence. As such, we choose to end this chapter by reminding ourselves and our users that Statistics Norway's projections do not describe an inevitable outcome – they merely show how the Norwegian population would develop if the assumptions on fertility, mortality and immigration remained true over the projection period.

9. A probabilistic forecast for the population of Norway

Nico Keilman[36]

9.1. Why probabilistic?

As has been noted throughout this publication, the population development in future years is uncertain. We cannot be sure that population size in 2060 indeed will be 6.1 million, as projected in the main alternative (MMM) of Statistics Norway's population projection. In reality, the numbers may very well be different from those in the main projection variant. However, certain trends are more probable than others. A population number around 6 million is more likely than one around 10 million. To get an idea of *how much* more likely the former number is, compared to the latter, we require a *probabilistic* population forecast, as opposed to the deterministic one presented in earlier chapters. In those chapters, uncertainty in future demographic developments is expressed by means of variant projections, assuming high or low values for future fertility, life expectancy, and immigration. The correct interpretation of these variant projections is that they represent scenarios of possible future demographic developments. Assume that total fertility will increase to 1.9 children per woman in 2060 (rather than 1.7 as it is in the main alternative), that life expectancy of men and women will grow further to reach 91.3 and 93.2 years, respectively, in 2060 (rather than 88.9 and 90.9 years), while net immigration will amount to 25 000 that year (and not 10 500). If this were the case, the population size would be expected to reach 7.1 million, the so-called high national growth alternative, resulting in approximately 1.0 million more people than is projected in the main alternative (MMM) for 2060.

This chapter presents the outcomes of a probabilistic population forecast for the population of Norway, broken down by age and sex. It should be noted that this forecast is a supplement to the deterministic projections presented in previous chapters. The forecast period is from 2020 to 2060. Results up to 2100 are available upon request (see Section 9.3). Uncertainty is large in the very long run, in particular for the youngest age groups and for the oldest-old. For the furthest forecast horizons, there is little useful information in the results.

The probabilistic forecast in this section was calibrated against the main alternative (MMM) of the deterministic projections. We used from that variant the set of annual age-specific rates for fertility and mortality (for men and women), and numbers for net migration broken down by age and sex. Next, we added a random error to each of those variables. Each random error was drawn from a specific probability distribution. This resulted in one possible future development ('trajectory') for the population of Norway, and its age-sex distribution, for the years 2020-2100. The procedure was repeated 3 000 times, and the 3 000 trajectories were stored. The stochastic model that assigns random values to each model parameter for fertility, mortality, and net migration is known as the Scaled Model of Error (see Alho and Spencer 2005). An important characteristic of that model is that it can take into account various types of correlations between vital rates and migration numbers. The model deals with autocorrelation (when mortality is higher than expected in one year, it is probably higher than expected the following year too), with correlation across ages (when fertility is lower than expected for women aged 30, it is likely to be lower than expected in adjacent ages too), and correlation between men and women (for mortality). Section 9.4 provides further details.

[36] During the project, I received useful comments from the following persons at Statistics Norway: Brita Bye, Ådne Cappelen, Aslaug Hurlen Foss, Dennis Fredriksen, Rebecca Folkman Gleditsch, Erling Holmøy, Øyvind Langsrud, Stefan Leknes, Sturla Løkken, Dinh Quang Pham, Terje Skjerpen, Nils Martin Stølen, Astri Syse, and Michael Thomas. None of them can be held responsible for the views expressed in this chapter.

Probabilistic forecasts are important for users who require knowledge of long-term demographic developments, for instance pension funds or life insurance companies. A pension fund is interested in the chance that current and future retirees and employed persons will be alive for a given number of years. For the near future, the demographic developments of the country as a whole are quite clear. However, to design sustainable pension systems requires knowledge about possible demographic trends some four decades ahead, or more. The pension fund will face problems when retirees live longer than expected. A life insurance company is interested in the same type of information, but its risk profile goes in the opposite direction: Clients who live shorter than expected imply larger costs for the company. As such, probabilities for long or short life times, among certain sub-groups of the population, are important factors for these institutions.

Note that a probabilistic forecast does *not* give more accurate outcomes than a deterministic one; instead, it gives more information. It informs the user about the extent to which the forecaster thinks that real demographic developments will differ from the forecast, and how likely such deviations are. As we will see in Section 9.3, the deviations and their respective likelihoods differ strongly across age groups and over time.

The probabilistic forecast presented here is not the first attempt to quantify uncertainty in future demographic developments for Norway. The first such forecast dates back to around the turn of the century (Keilman et al., 2001, 2002). Following this, the so-called UPE-project produced probabilistic population forecasts for the period 2003-2050 for 18 European countries, including Norway. Section 9.4 provides more details about this project. Meanwhile, Foss (2012) published a probabilistic forecast for the years 2011-2060. The results presented here are an update of that forecast. It should also be noted that, since 2014, the United Nations Population Division publishes biennial probabilistic forecasts for all countries of the world; see https://population.un.org/wpp/Graphs/Probabilistic/POP/TOT/578.

The publication of probabilistic forecasts is established practice among meteorologists (cf. the weather forecast for Oslo https://www.yr.no/place/Norway/Oslo/Oslo/Oslo/long.html) and among economists, cf. forecasts by the Bank of Norway of the consumer price index and the Bank's policy interest rate (Bank of Norway 2020). For many decades, demographers have also called for such forecasts, with Keyfitz (1981) arguing: 'Demographers can no more be held responsible for inaccuracy in forecasting population 20 years ahead, than geologists, meteorologists, or economists when they fail to announce earthquakes, cold winters, or depressions 20 years ahead. What we can be held responsible for is warning one another and our public what the error of our estimates is likely to be.'

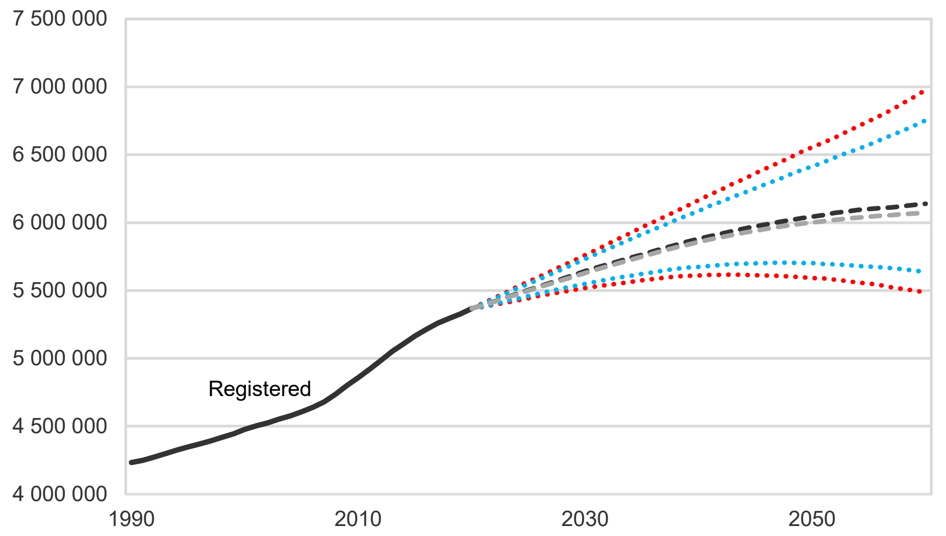
9.2. Main results: Ageing is certain

As noted above, the probabilistic forecast resulted in 3 000 simulations. Each simulation represents one possible realisation of the future population pyramid of Norway. The simulations differ from each other because of random variations in fertility, mortality, and net migration. An important assumption is that the volatility in annual age-specific rates for fertility, for mortality of men and women, and for total net migration numbers in the future will be the same as it was in the past. Thus, for each output variable of interest there are 3 000 values. These can be plotted in a histogram, which approximates the (unknown) predictive distribution of that variable. Below we summarise the predictive distributions by showing the median value as well as prediction intervals with assumed probability content of 80 and 67 percent. The prediction intervals are computed by using the appropriate percentiles of the (simulated) predictive distributions: 10th and 90th percentiles for the 80 percent prediction interval and 16.7th and 83.3rd percentiles for the 67 percent (two-thirds) interval.

As an example, the 80 percent interval for total population size in 2060 stretches from 5.5 to 7.0 million, while the median value is 6.1 million; see Figure 9.1 to be discussed later. The interpretation is as follows, caused by random factors, there is not just one possible demographic future for Norway, but many. Some of those are more likely than others. Our best guess is 6.1 million: A population size *above* 6.1 million is equally likely as one *below* 6.1 million. Eighty percent of all possible futures will reveal a total population size between 5.5 and 7.0 million. The 67 percent prediction interval, which stretches from 5.6 to 6.8 million, has a similar interpretation. Compared to the 80 percent interval, the 67 percent interval is relatively narrow, because the chance that it will cover the real (but unknown) population size is relatively low (two-thirds, or odds of two to one). For the 80 percent interval, the chance is 80 percent (odds of four to one).

Below we give plots with prediction intervals for total population size and the old age dependency ratio for the years 2021-2060, as well as for the population pyramids in years 2030, 2040, 2050, and 2060. The underlying numbers are available in the StatBank (https://www.ssb.no/en/statbank/table/12890). Users who are interested in an explicit assessment of the uncertainty in future demographic developments thus have the option to use upper and lower bounds of the intervals, in addition to the median numbers.

Figure 9.1 Total population size, registered 1990-2020 and projected 2021-2060, with lower and upper bounds of prediction intervals[1]

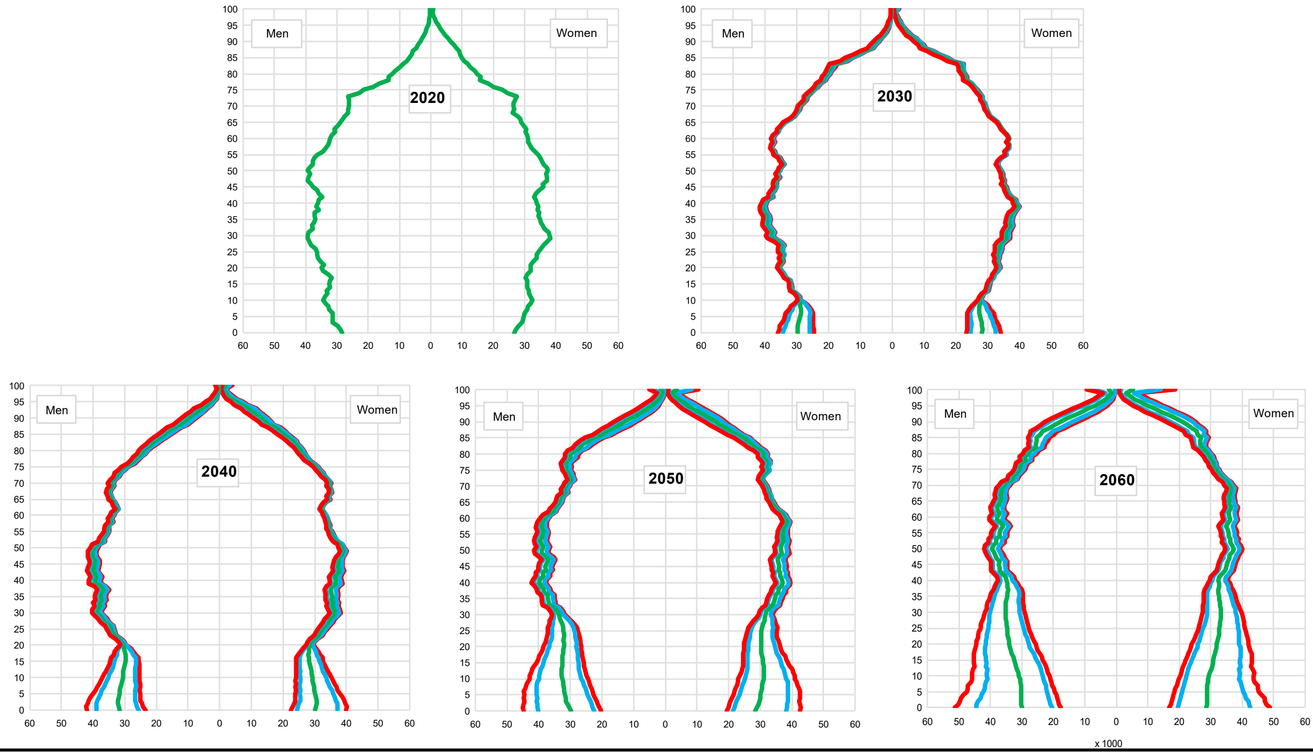


[1] 80 percent prediction interval bounds in red, 67 percent prediction interval bounds in blue, median value of predictive distribution in black. The dashed grey line represents the main alternative (MMM) of the deterministic forecast.
Source: Statistics Norway

Figure 9.1 shows that prediction intervals widen rapidly as we move forward in time. This is what one could expect: It is more difficult to predict total population forty years ahead than just five years ahead. Looking at the median, our best guess is a population increase from the current 5.4 million to around 6.1 million persons in 2060. The main variant of the deterministic projection described in previous chapters is very close to our median. The small differences are caused by slightly different expressions for handling competing risks in the two models. The intervals in Figure 9.1 are not symmetric around the median: A population size 2 million persons *above* the median, although extremely unlikely, is still more probable than one that is 2 million persons *below* the median.

Note that Figure 9.1 (as well as Figures 9.2 and 9.3, to be discussed later) shows annual prediction intervals, revealing, for each year, the interval that will cover the population size with 80 (or 67) percent probability. These intervals should *not* be interpreted as meaning that there is an 80 percent certainty that the future population will remain within the bands at all times. Rather, their interpretation refers to an 80 percent certainty for each given year. The prediction intervals in Figure 9.1 are thus termed annual (or more generally, punctual) prediction intervals. As such, these intervals are useful for users who require forecast results for a single year. When one is interested in a probability forecast for a period of two or more years, one needs results in the form of a *prediction band*. The interpretation is as described above: It is 80/67 percent certain that population size will remain within the prediction band at all times. A prediction band for two or more years is wider than the prediction interval for a single year during this period, and therefore is often (depending on the number of years in the period and the autocorrelation of the variable in question) much wider.

Figure 9.2 Population pyramids (in 1 000s), registered 2020 and projected for selected years, with lower and upper bounds of prediction intervals[1]

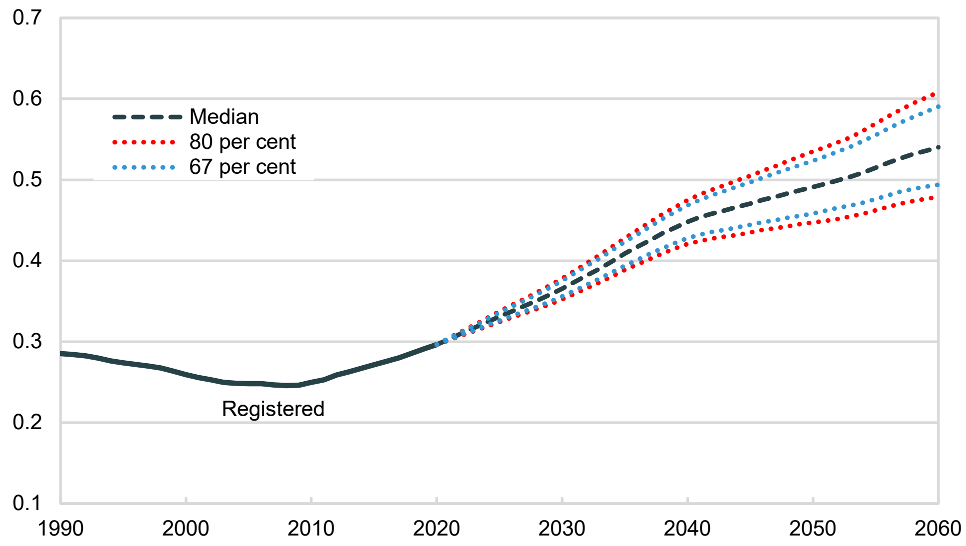


[1] 80 percent prediction interval bounds in red, 67 percent prediction interval bounds in blue, median value of predictive distribution in green.
Source: Statistics Norway

Figure 9.2 shows how the age distribution of men and women may change to 2060, and how uncertainty differs between age groups. During the first few decades, roughly until 2040, prediction intervals are very narrow, except for children born in 2020 or later. This means that predicted numbers for the adult population and the elderly are rather certain. However, uncertainty increases gradually both for young and old age groups. Prediction intervals in 2050 and 2060 for men and women aged 70 and over appear narrow, but that is because the numbers involved are rather small. Indeed, when we analyse the *relative* width of the prediction intervals (interval width divided by median value), we find that uncertainty expressed this way for the elderly is as large as uncertainty for young children. Age groups primarily affected by international migration (e.g. age groups 20-60 in 2040, 30-60 in 2050, 40-60 in 2060) have very narrow intervals.

The median curves in Figure 9.2 clearly show a continuous increase in the number and the share of the elderly in the population. Population ageing has been observed for many decades already; it is also an important feature of the deterministic projection results in Chapter 1. Our best guess is that it will continue, but how certain are we that this is correct? Figure 9.3 shows prediction intervals for an often-used indicator of ageing, namely the old age dependency ratio (OADR). This indicator relates the number of elderly to the number of persons in working ages. We computed the OADR as the ratio of the number of persons aged 65+ to the number of persons aged 20-64; see also Sections 1.2 and 6.6.

Figure 9.3 Old age dependency ratios, registered 1990-2020 and projected 2021-2060, with lower and upper bounds of prediction intervals



[1] 80 percent prediction interval bounds in red, 67 percent prediction interval bounds in blue, median value of predictive distribution in black.
Source: Statistics Norway

The graph suggests that we can be quite certain that ageing will continue to 2060, but we do not know how rapidly this trend will develop. At present, there are approximately three persons of working age for every elderly person (OADR = 0.30). It is very likely that the ratio will increase. The median value in 2060 is 0.54, but odds are four to one (80 percent prediction interval) that the ratio will be between 0.48 and 0.60, indicating roughly two persons in working ages for every elderly person – slightly more than two for the lower bound, a bit less than two for the upper bound. In the very long run, the median stabilises at a value just over 0.6 from around 2080 (numbers not shown here). The prediction intervals become progressively wider. The simulations show 80 percent intervals for the OADR equal to [0.49, 0.76] in 2080, [0.44, 0.82] in 2090, and [0.40, 0.87] in 2100.

9.3. Detailed results in StatBank

The StatBank contains lower and upper bounds for the annual prediction intervals for the numbers of men and women by one-year age groups (0-100+) in years 2030, 2040, … 2090, 2100. The interval bounds are given as percentiles of the predictive distribution. The lower and the upper bounds of the 80 percent prediction interval correspond with the 10th and the 90th percentiles, respectively. For the lower and upper bounds of the 67 percent interval, the percentiles are 16.7 and 83.3, respectively. Median values (50th percentiles) are also available in the StatBank.

Users who are interested in prediction intervals for other variables than those given in this section, for example the mean age of the population, or the share of the elderly, need more detailed results in the form of the 3 000 simulations. These are available upon request.

9.4. Method

The Scaled Model of Error

We have used Alho's Scaled Model of Error, with parameter estimates based on findings of the project 'Uncertain Population of Europe – UPE'. The purpose of that project, executed during the years 2003-2005, was to calculate probabilistic population forecasts for Norway and 17 other European countries. The starting point was the population in each country, broken down by sex and age as of 1 January 2003, while the forecasts stretched to 2050. An explicit goal of the project was to quantify prediction uncertainty in such a way that it reflected historical variations in fertility, mortality and international migration. The method used in the UPE-project was Alho's Scaled Model of Error, with the associated simulation program PEP (Program for Error Propagation). The model is based on the traditional cohort-component method (CCM), but adds random errors to each CCM parameter. It assumes that errors in fertility and mortality rates are normally distributed in the log-scale, while errors in net migration numbers are normal in the original scale. The Scaled Model of Error requires settings for the variances of these distributions, as well as a number of auto- and cross-correlations. More information is available on the UPE-website (http://www.stat.fi/tup/euupe/index_en.html). See also Alders et al. (2007), Alho et al. (2008) and Alho and Spencer (2005).

Parameter settings

Variances and correlations in the UPE-project were based on various types of information. First, for each of the 18 countries, a set of time series models was constructed for key variables for fertility, mortality, and migration. Extrapolating the time series models resulted in prediction intervals for each of the three variables. Next, the intervals were adjusted, sometimes considerably, to reflect errors in historical population forecasts as well as expert views on whether current levels or current trends would persist. Finally, they were transformed into variances and correlations needed for the Scaled Model of Error. See Alho et al. (2008) for details.

In the current project, the starting point was the set of UPE-parameters for Norway. Empirical trends in total fertility, life expectancies of men and women, and numbers for net migration for the years 2003-2019 were compared with prediction intervals for these variables from UPE. The comparisons showed rather wide intervals for mortality and net migration. This led us to reduce the auto-correlations for age-specific mortality and net migration, compared with UPE-values.[37]

A second adjustment was to double standard deviations of annual errors in age-specific vital rates and net migration numbers for the first few years (2020-2023) of the forecasts. At the time of writing (May 2020), it is unclear what the impact of the COVID-19 pandemic will be on demographic behaviour in Norway. It may take some years before an effective vaccine is available, or before a sufficiently large share of the population has developed immunity otherwise. The *assumed* COVID-19 impact on fertility, mortality, and international migration is included in the main alternative (MMM) of the deterministic projections. However, the uncertainty around these expected trends is large. As such, this is reflected in large standard deviations of annual random errors in age-specific vital rates and net migration numbers.

[37] Autocorrelations were reduced from 0.05 to 0.02 for age-specific death rates, and from 0.56 to 0.3 for net migration. See Alho and Spencer (2005) for details about the UPE-settings.

10. Conclusions

The results of the national population projections 2020 show lower population growth than in previous projections, combined with stronger ageing. Nevertheless, there is still population growth in Norway throughout the century in our main alternative, from around 5.4 million today to 6.1 million in 2060. This is mainly due to positive net migration. We expect more births than deaths until 2050, before the situation reverses. Nevertheless, we expect an increasing number of elderly aged 65 years and above: It will double by 2075, from today's 940 000. The share of people aged 80 and above will more than triple by 2060 (from 230 000 to around 720 000). The number of persons in their 90s and 100s will also increase dramatically, from 45 000 to around 210 000, which corresponds to an almost fivefold increase. In about 10 years, and for the first time, there will be more elderly (65+ years) than children and teenagers (0-19 years) in Norway, and by 2060 this number will increase to 500 000 if our main alternative is realised.

Our main assumption (low and high in parentheses) is that the total fertility rate will remain stable at the current level (1.5) until 2025, before rising again and stabilizing at around 1.7 (1.3-1.9). Life expectancy is also expected to rise, from today's 81.2 years for men and 84.7 years for women, to 89 (86-91) and 91 (88-93) years in 2060, and 93 (90-97) and 95 (91-98) years in 2100. Immigration is expected to decline somewhat: In 2019, there were just over 50 000 immigrations to Norway. Due to travel restrictions and other circumstances related to the COVID-19 pandemic, we expect particularly low immigration in 2020 and 2021. From 2022 onwards, we project that annual immigration will decline from around 45 000 (39 000-52 000) to around 37 000 (18 000-84 000) in 2100. The projected emigrations depend partly on the immigrations. In the main alternative, the annual net migration will remain stable at around 10 000-12 000 until 2100.

This year a stochastic projection has been produced based on the medium assumptions applied in the main deterministic projection. From the perspective of the total population, the 50th percentile from the stochastic projection is slightly higher (around 65 000) than the main alternative estimate for 2060, while the 80 percent prediction interval illustrates an uncertainty ranging from 5.5-7.0 million. This compares to the deterministic high and low national growth alternatives, which range from 5.2 million to 7.1 million in 2060. In providing estimates from a stochastic projection alongside the main deterministic projection, we hope to offer a more detailed understanding of the inherent uncertainty associated with projecting populations into the future. At the same time, the relative agreement in estimates between the two models prove useful in supporting the conclusions we draw from this year's projection.

Regardless of the methodological approach, population projections are inherently uncertain. The uncertainty usually increases the further into the future we look, and the figures are even more uncertain in projections of smaller population sub-groups. Future immigration is subject to the largest degree of uncertainty, but fertility, mortality, and emigration can also end up different to what is projected. Due to the COVID-19 pandemic, it has been extremely challenging to make assumptions this year – even for the near future. Users need to bear this in mind when they employ different alternatives of the 2020 projections in their work, also short term.

For more information about the projected population and population changes, see https://www.ssb.no/en/folkfram. Detailed figures for the projected population and population changes are available in Statistics Norway's StatBank (https://www.ssb.no/en/statbank/).

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Appendix A: Definition of country groups

Countries included in the three country groups:

Country Group 1
Sweden, Denmark, Finland, Iceland, Faeroe Islands, Greenland, United Kingdom, Ireland, Isle of Man, Channel Islands, Netherlands, Belgium, Luxembourg, Germany, France, Monaco, Andorra, Spain, Portugal, Gibraltar, Malta, Italy, Holy See, San Marino, Switzerland, Liechtenstein, Austria, Greece, Cyprus, Canada, United States, Bermuda, Australia and New Zealand.

Country Group 2
Estonia, Latvia, Lithuania, Poland, Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Slovenia and Croatia.

Country Group 3
All remaining countries, e.g. those in Africa, South and Central America and the Caribbean, Asia (excluding Cyprus), Oceania (excluding Australia and New Zealand), and all non-EU member states in Eastern Europe. Also stateless people are included in this group.

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