Statistisk sentralbyrå
Statistics Norway

Norway's 2022 national population projections

Results, methods and assumptions

TALL SOM FORTELLER

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RAPPORTER / REPORTS

2022/28

In the series Reports, analyses and annotated statistical results are published from various surveys. Surveys include sample surveys, censuses and register-based surveys.

Published: 5 July 2022

ISBN 978-82-587-1552-5 (printed)
ISBN 978-82-587-1553-2 (electronic)
ISSN 0806-2056

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Preface

This report presents results from the 2022 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, 30 May 2022

Linda Nøstbakken

Abstract

The 2022 national population projections show lower population growth 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 and 6.2 million in 2100. This is mainly due to positive net migration. We expect more births than deaths until approximately 2050, after which the situation reverses. There will be an increasing number of older persons in the population, with the number of people aged 70 years or above expected to almost double by 2060. By 2100, more than 25 percent of the population will be aged 70 years or over, according to the main alternative. Within a decade, the main alternative suggests that the population will be composed of more older persons (65+ years) than children and teenagers (0-19 years).

The results of population projections depend on the assumptions used for the underlying demographic components. We 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, we project 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 the use of the medium level assumption for all three components.

The main alternative suggests that the total fertility rate (TFR) will decline in the short run, from its current level (1.55 children per woman) to 1.5 by 2025. TFR is then assumed to stabilise at around 1.7 (low fertility alternative 1.3, high fertility alternative 1.9). Life expectancy is assumed to increase throughout the century. For men, the medium assumption projects an increase from 81.6 years in 2021, to 89 (low 86, high 91) years in 2060 and 94 years (low 90, high 97) in 2100. For women, we assume an increase from 84.7 years in 2021 to 91 (low 89, high 93) years in 2060 and 95 (low 92, high 97) years in 2100. Immigration is expected to increase in the short term due to the arrival of refugees fleeing the war in Ukraine. In the medium assumption, we project immigration to Norway to increase from 53 000 in 2021 to 67 000 in 2022 (low 54 000, high 95 000). From this peak, we assume a sharp decline before the assumptions settle on more stable long-run trajectories. From 2025, we assume that immigration to Norway will decline from around 43 000 (low 35 000, high 52 000) to around 35 000 (low 15 000, high 81 000) in 2100. The projected emigrations depend partly on the immigrations. In the main alternative, we project net migration to rise from almost 20 000 in 2021 to around 37 000 in 2022 (low 24 000, high 65 000). From 2025, the main alternative projects a broadly stable net migration of around 11 000-12 000, annually.

This report documents how the national population projections are produced, using Statistics Norway’s 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. The report starts out by providing an overview of the main results, before a more detailed presentation and discussion of the assumptions for the different demographic components (fertility, life expectancy and international migration) is given.

Population projections are inherently uncertain. The uncertainty usually increases the further into the future we look. Due to the ongoing war in Ukraine, it has been especially challenging to formulate immigration assumptions this year – even for the short term. Users must bear this in mind when they employ the different alternatives of the 2022 national population projections.

Sammendrag

I de nasjonale befolkningsframskrivingene for 2022 er det lavere befolkningsvekst kombinert med en sterkere aldring for befolkningen. Modellen fremskriver befolkningsvekst i Norge ut århundret, hvor hovedalternativet er en økning fra cirka 5,4 millioner i dag, til 6,1 millioner i 2060. Framskrivingen stopper i 2100, hvor befolkningen har blitt 6,2 millioner. Befolkningsveksten er hovedsakelig drevet av positiv nettoinnvandring. Vi forventer flere fødte enn døde (fødselsoverskudd) fram til cirka 2050, da situasjonen snur og vi får et fødselsunderskudd. Det vil bli flere eldre i befolkningen, og antallet personer som er 70 år eller eldre forventes å nesten dobles innen 2060. Mer enn 25 prosent av befolkningen vil være 70 år eller eldre i 2100 ifølge hovedalternativet. Ifølge hovedalternativet vil befolkningen bestå av flere eldre (65 år +) enn barn og unge (0-19) i løpet av de neste ti årene.

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 (K); null nettoinnvandring (E); og null inn- og utvandring (0). Til sammen framskriver Statistisk sentralbyrå befolkningen i 15 kombinasjoner av disse M-, L-, H-, K-, 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.

I våre hovedalternativ (lav og høy i parentes) antar vi at fruktbarheten (SFT) vil gå ned fra sitt nåværende nivå på 1,55 barn per kvinne, til 1,5 i 2025. SFT antas deretter å stabilisere seg på rundt 1.7 (lav 1.3, høy 1.9). Forventet levealder er forventet å øke gjennom hele århundret. For menn gir hovedalternativet en økning fra 81,6 år i 2021 til 89 (lav 86 år, høy 91 år) år i 2060 og 94 (lav 90 år, høy 97 år) i 2100. For kvinner forventes en økning fra 84,7 år i 2021 til 91 (lav 89 år, høy 93 år) år i 2060 og 95 år (lav 92 år, høy 97 år) i 2100 med hovedalternativet. Innvandring er forventet å øke på kort sikt på grunn av flykninger som kommer til Norge på grunn av krigen i Ukraina. I hovedalternativet antar vi at innvandringen til Norge vil øke fra 53 000 i 2021 til 67 000 i 2022 (lav 54 000, høy 95 000). Fra denne toppen i innvandringen antar vi en sterk nedgang før forutsetningene lander på en mer stabil trend på lang sikt. Fra 2025 forventer vi at innvandringen til Norge vil synke fra cirka 43 000 (lav 35 000, høy 52 000) til cirka 35 000 (lav 15 000, høy 81 000) i 2100. De fremskrevne utvandringene avhenger delvis av antallet innvandringer. I hovedalternativet forventer vi at nettoinnvandringen vil øke fra cirka 20 000 i 2021 til 37 000 i 2022 (lav 24 000, høy 65 000). Fra 2025 fremskriver vi i hovedalternativet en stabil nettoinnvandring på rundt 11 000-12 000 årlig.

Rapporten dokumenterer hvordan de nasjonale befolkningsframskrivingene er laget ved hjelp av Statistisk sentralbyrås BEFINN-modell. Befolkningen er fremskrevet etter alder og kjønn fram til 2100. Innvandrere inndelt i tre landgrupper, norskfødte barn med to innvandrerforeldre og resten av befolkningen er fremskrevet som separate grupper. Rapporten tar først for seg hovedfunnene av modellen, før en mer detaljert presentasjon og diskusjon av forutsetningene for de ulike demografiske komponentene (fruktbarhet, forventet levealder og migrasjon) blir forklart.

Befolkningsframskrivinger er i utgangspunktet usikre. Denne usikkerheten øker normalt jo lenger inn i framtiden vi ser. På grunn av den pågående krigen i Ukraina har det vært spesielt vanskelig å formulere våre forutsetninger knyttet til migrasjon, også på kort sikt. Brukere må huske på dette når de bruker de ulike alternativene fra 2022-framskrivingene, både på kort og lang sikt.

Contents

1. Main results – national population projections

Pronounced ageing, lower population growth and a growing number of older immigrants are the main results from the 2022 national population projections.

The results of Statistics Norway's 2022 national population projections show lower population growth 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 6.2 million in 2100. This is mainly due to positive net migration. In the main alternative, we expect more births than deaths until approximately 2050, after which the situation reverses. There will be an increasing number of older people in the population, with the number of persons aged 70 years or above expected to almost double by 2060. By 2100, more than 25 percent of the population will be aged 70 years or over, according to the main alternative. Within the coming decade, the main alternative suggests the population will be composed of more older persons (65+ years) than children and teenagers (0-19 years). By 2060, there will be more than 550 000 older persons than children and teenagers (Figure 1.2), a number that increases to almost 850 000 by 2100.

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

The national population projections are produced using Statistics Norway's BEFINN model (described in Chapter 3). 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 different scenarios for the future development of the population. As such, several alternative projections are developed, with different combinations of assumptions. Each projection is described using three letters (H=high, M=medium, L=low) in the following order: 1) Fertility; 2) Life expectancy; and 3) Immigration.

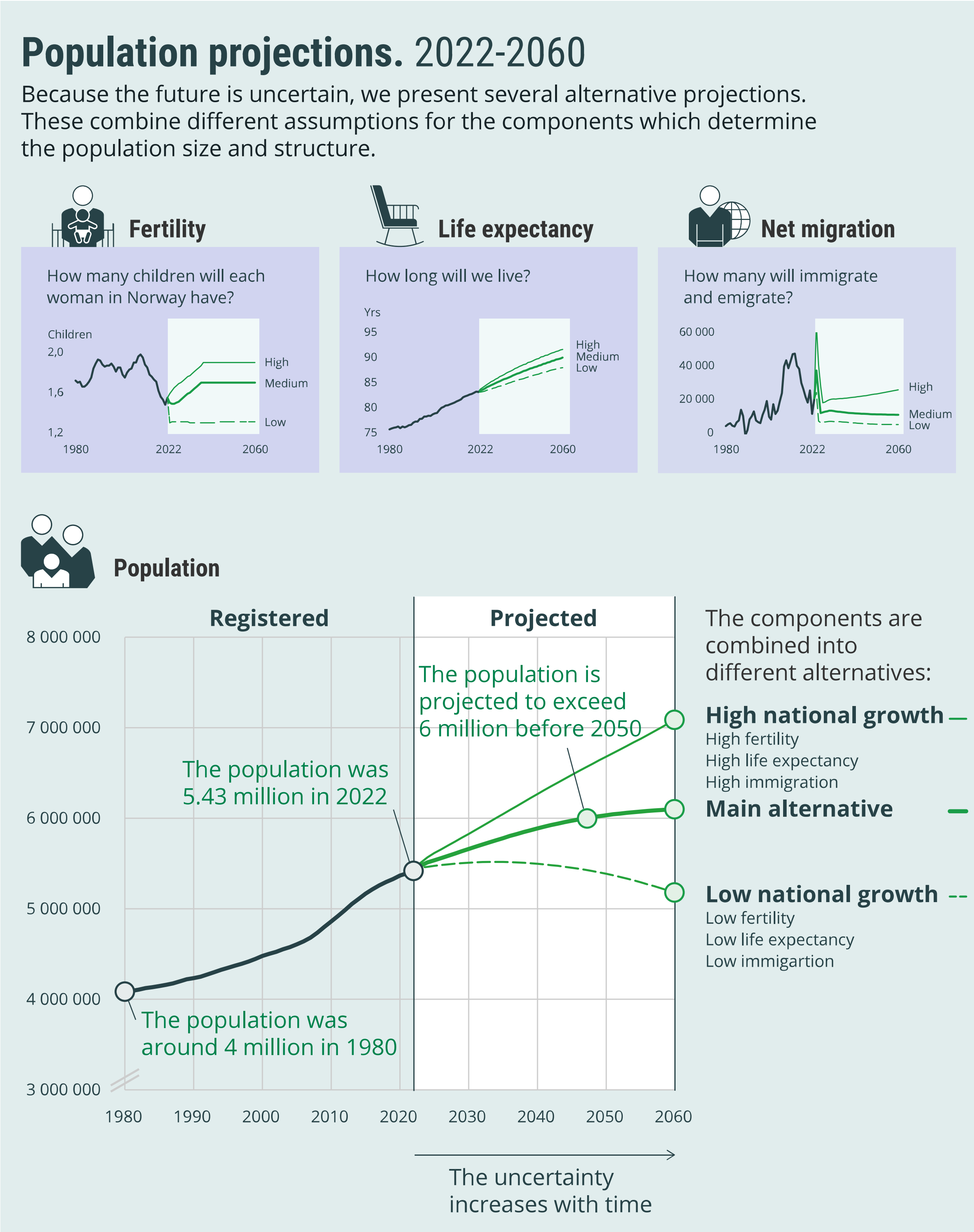
The main alternative, MMM, uses the medium level for each of the three components. These medium level assumptions are those that we consider to be the most plausible. The assumptions can be combined in a variety of ways. As an example, the LHL alternative describes a population trend with low fertility,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

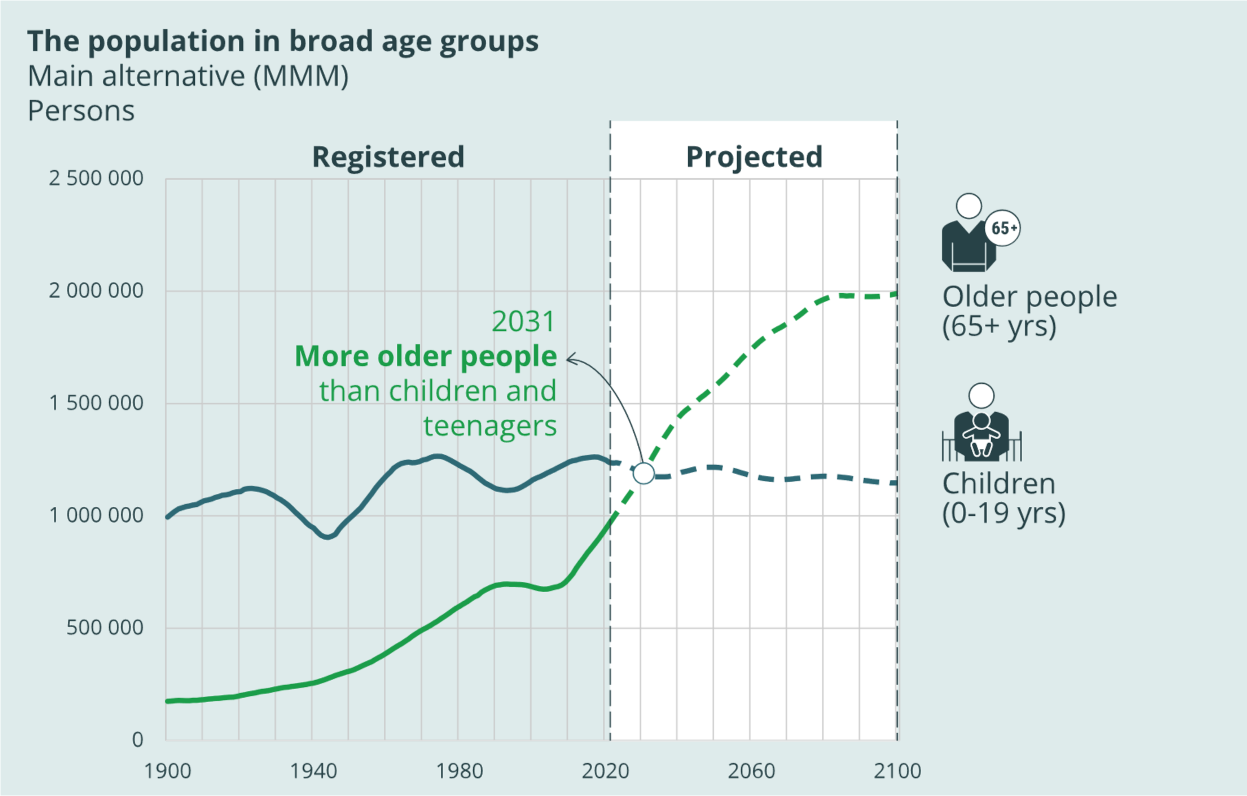
As population projections are uncertain, different scenarios are provided. Population growth varies considerably according to these different scenarios. For instance, by 2060, the population ranges from 5.2 million in the low national growth scenario to 7.1 million in the high national growth scenario (Figure 1.1). However, all alternatives indicate a pronounced ageing of the population in the years to come.

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



Source: Statistics Norway

Figure 1.2 A comparison of the number of older persons versus children and teenagers, registered 1900-2022 and projected 2023-2100



Source: Statistics Norway

As shown in Table 1.1, our medium assumption (low and high in parentheses) is that the total fertility rate (TFR) will decline from its current level, 1.55 children per woman, to 1.5 by 2025. TFR is then assumed to rise and stabilize at around 1.7 (low 1.3, high 1.9). Life expectancy is expected to increase throughout the century. For men, the medium assumption projects an increase from 81.6 years in 2021, to 89 (low 86, high 91) years in 2060 and 94 years (low 90, high 97) in 2100. For women, an increase, from 84.7 years in 2021, to 91 (low 89, high 93) years in 2060 and 95 (low 92, high 97) years in 2100 is assumed. Immigration is expected to increase in the short term due to the arrival of refugees fleeing the war in Ukraine. In the medium assumption we assume that immigration to Norway will increase from 53 000 in 2021 to 67 000 in 2022 (low 54 000, high 95 000). From this peak, we assume a sharp decline across all alternatives, before the projections settle on their more stable long-run trajectories. From 2025, we assume that immigration to Norway will decline somewhat, from around 43 000 (low 35 000, high 52 000), to around 35 000 (low 15 000, high 81 000) in 2100. The projected emigrations depend partly on the immigrations. In the main alternative, we project net migration to rise from almost 20 000 in 2021 to around 37 000 in 2022 (low 24 000, high 65 000). From 2025, the main alternative projects a broadly stable net migration of around 11 000-12 000 annually.

Table 1.1 Population projections 2022, key figures of the assumptions[1]

	Registered 2021	Medium (M) assumption	High (H) assumption	Low (L) assumption
Total fertility rate, children per woman	1.55			
2025		1.50	1.67	1.31
2040		1.70	1.90	1.30
2060		1.70	1.90	1.31
2100		1.71	1.90	1.31
Life expectancy at birth, men	81.6			
2025		82.5	83.1	81.8
2040		85.6	87.0	83.9
2060		88.9	91.0	86.4
2100		93.7	96.5	89.7
Life expectancy at birth, women	84.7			
2025		85.5	86.0	84.9
2040		88.1	89.4	86.7
2060		90.9	92.7	88.8
2100		94.6	96.9	91.9
Yearly immigrations	52 966			
2025		42 900	51 700	35 300
2040		39 600	54 900	29 900
2060		36 200	63 000	23 400
2100		35 000	80 900	15 100
Yearly emigrations[2]	33 327			
2025		30 600	33 600	28 800
2040		28 000	33 000	24 700
2060		25 400	36 200	19 800
2100		22 900	45 800	13 100

[1] The figures for registered life expectancy are calculated slightly differently in the population projections than those published in the official statistics on life expectancy (see Box 6.1). 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 on migration.
[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 present the main results from the 2022 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.

1.1. Lower population growth

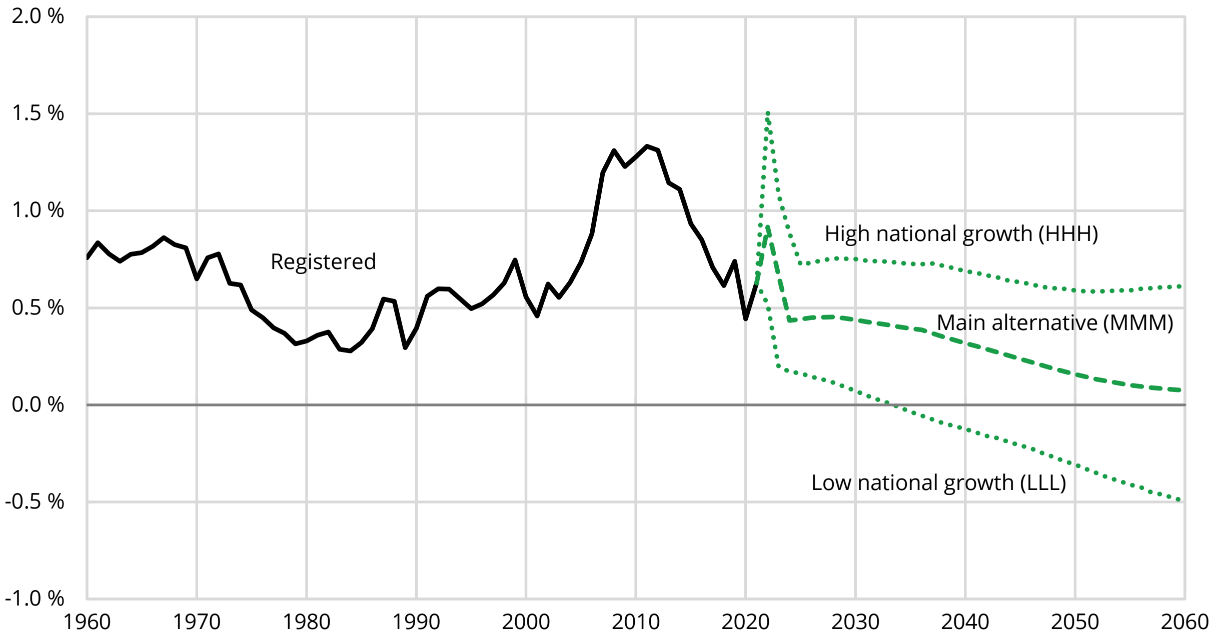
Population growth has slowed markedly over the last few years. In the population projections' main alternative (MMM), population growth continues to decelerate throughout this century. In 2060, the annual growth is assumed to be approximately 0.1 percent in the main alternative, compared to 0.6 percent 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 at a similar rate as today, with an annual growth rate of 0.6 percent in 2060.

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. Annual growth in 2020 was just 0.4 percent as a result of the considerable restrictions on travel and relocation associated with the COVID-19 pandemic.

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, while emigration saw only a 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 being of an age when it is common to have children, this resulted in many births. High immigration was also a contributory factor, with immigrant women tending to have raised levels of fertility in the initial 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 1960-2021 and projected 2022-2060 in three alternatives

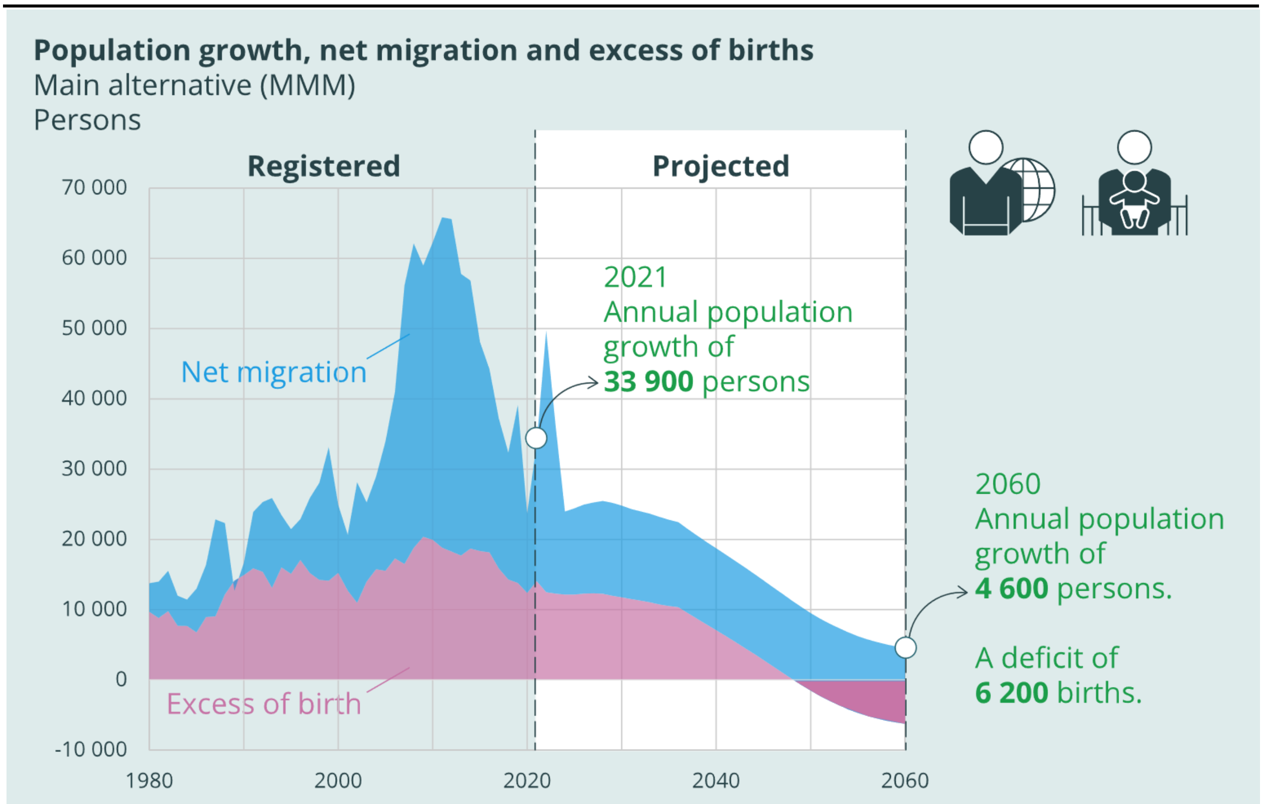


Source: Statistics Norway

In the short term, we expect an increase in immigration resulting from the war in Ukraine and the subsequent arrival of refugees. Our *ad hoc* adjustments for this situation are described in more detail in Chapter 7. However, following this initial peak, we expect somewhat lower levels of 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 reach ages 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, 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 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 to the 1950s, net migration was negative. However, for much of the last two decades, 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 1980-2021 and projected 2022-2060[1]

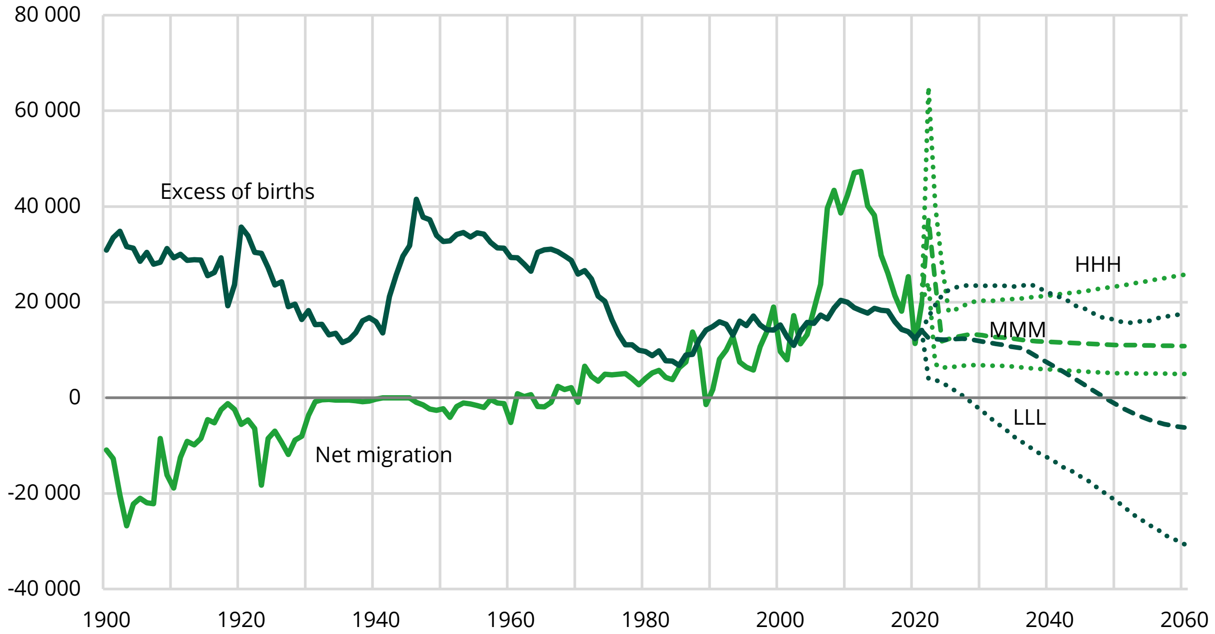


[1] Excess of births is number of births minus number of deaths. Net migration is immigrations minus emigrations.
Source: Statistics Norway

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 for much of the period after 2040. 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.

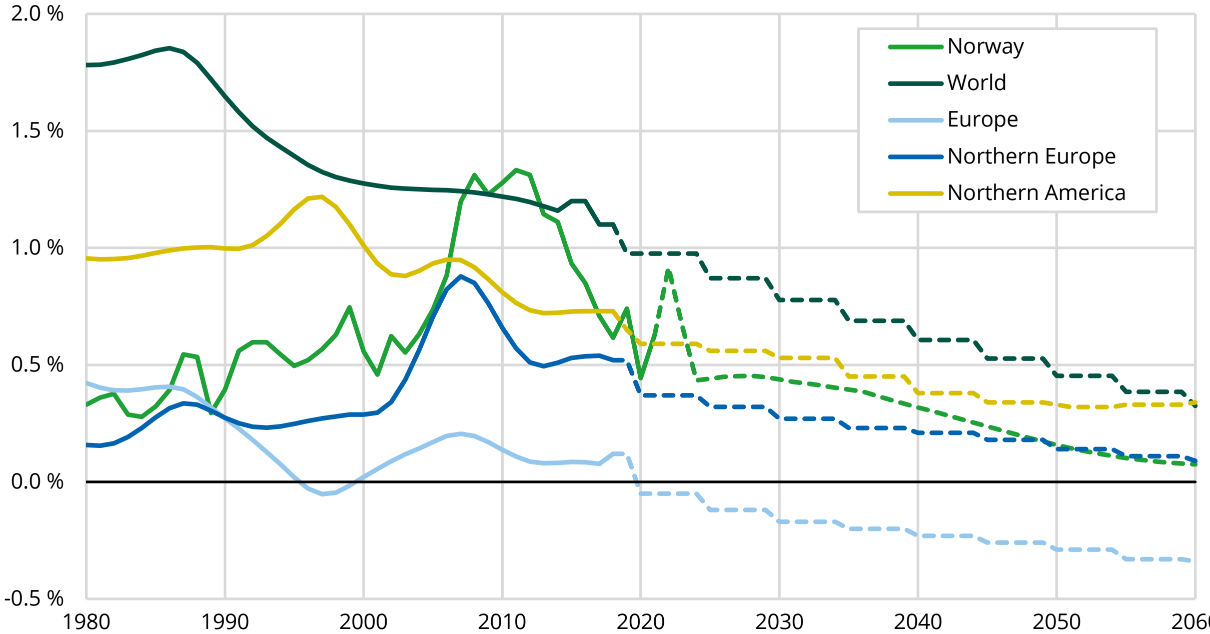
Although future population growth will be somewhat lower than in the last 10-15 years, growth in Norway will nevertheless be high compared with many other countries, not least in Europe. Figure 1.6 shows the percentage growth in Norway compared to what has been registered and projected by the United Nations for other parts of the world. In Europe, several countries already have a 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 annual population growth for Norway is higher than that of Northern Europe, slightly lower than that of Northern America, and considerably lower than that projected for the entire global population.

Figure 1.5 Excess of births and net migration, registered 1900-2021 and projected 2022-2060 in three alternatives[1]



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

Figure 1.6 Population growth as a percentage, registered 1980-2019 and projected 2020-2060 for other parts of the world, registered 1980-2021 and projected 2022-2060 for Norway[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

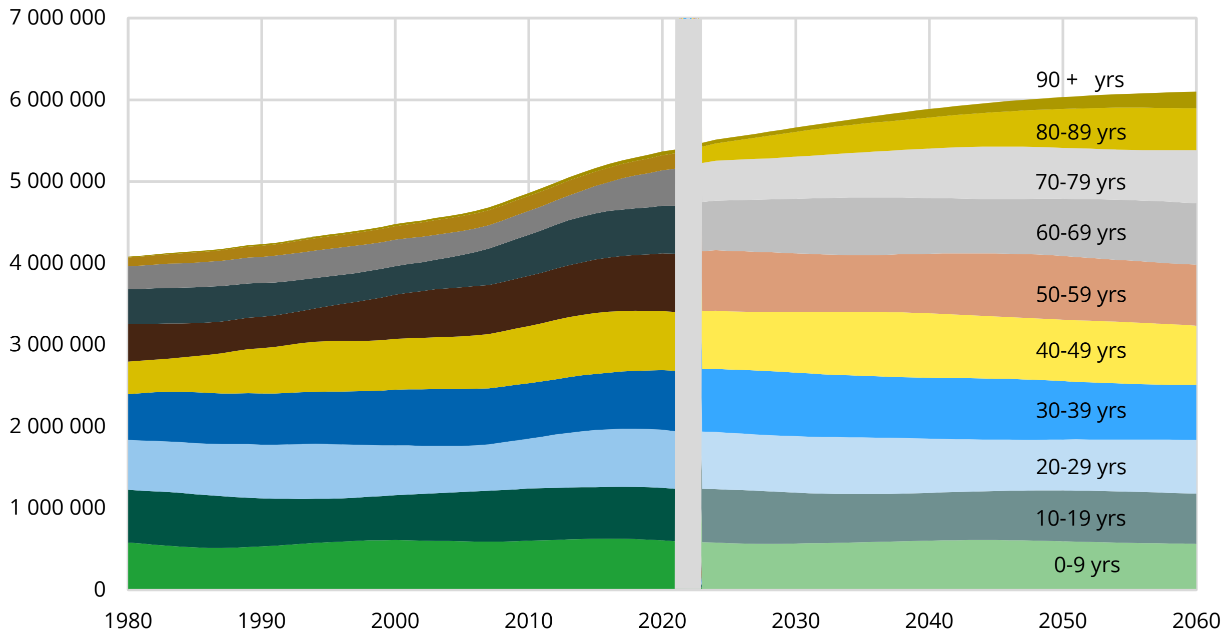
1.2. Strong ageing

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. Over the last decade we have witnessed historically low numbers of births, historically high life expectancies and immigration that has typically trended downwards. Overall, this resulted in a more pronounced ageing than we have seen in prior periods. The process of population ageing is projected to continue in the years to come.

A more than doubling of the older age population

Both the number and proportion of older people will increase significantly in the future. According to the main alternative, the population aged 70 or older will more than double by 2065 and include more than 1.6 million individuals by 2100. Their share of the total population will also increase, from 13 percent today, to more than a quarter of the population by 2075. 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 be almost triple the size by 2060, according to the main alternative. This means an increase from approximately 240 000 today, to almost 720 000 by 2060. Meanwhile, the number of persons aged 90 or older approaches 210 000 by 2060.

Figure 1.7 The population by age, registered 1980-2022 and projected 2023-2060, main alternative (MMM)

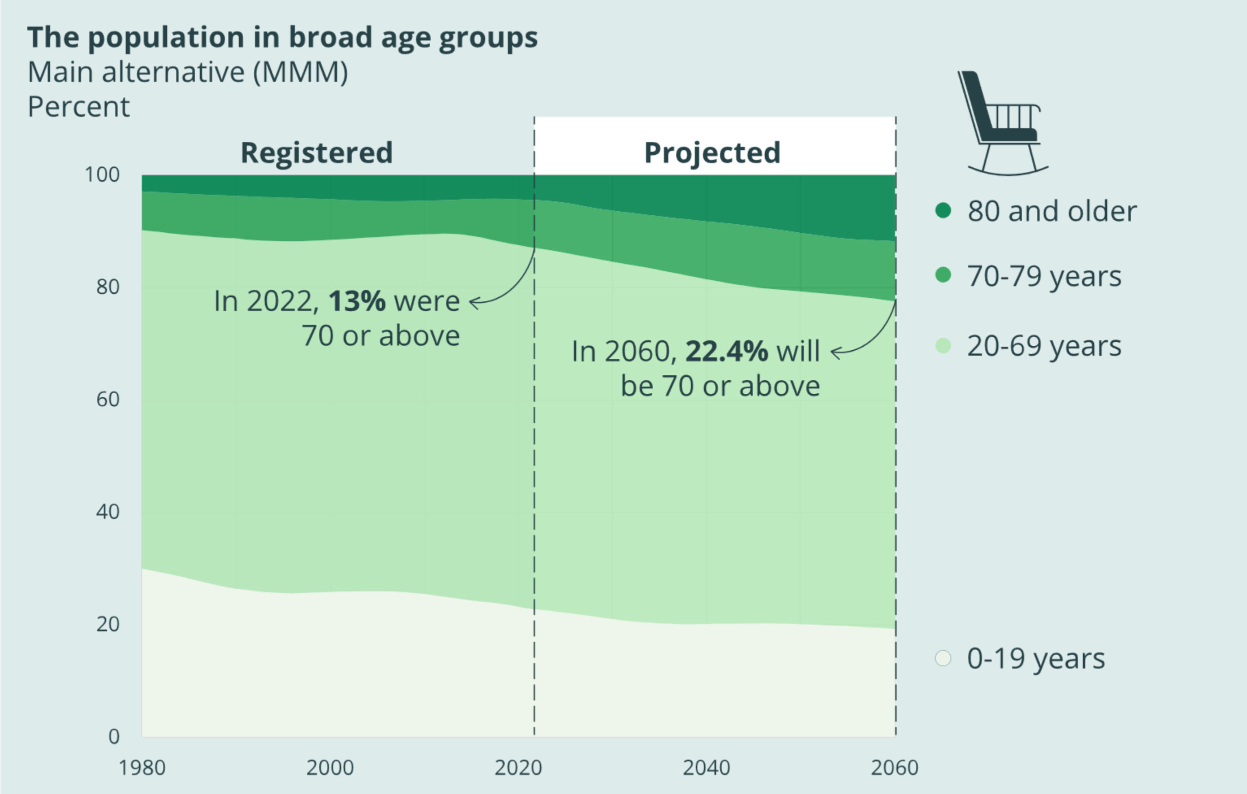


Source: Statistics Norway

Figure 1.7 presents the population divided into 10-year age groups and shows that the oldest age groups are expected to grow the most. While the number of people below age 70 will remain stable in the future, there is a sharp increase among the over 70s, and especially among the oldest old (90+). 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 in the coming decade. The main alternative suggests that the population aged 20-64 will increase from 3.20 million in 2022 to a high of 3.29 million in the early 2030s, before gradually falling back to 3.18 million by 2060.

As shown in Figure 1.8, the increase is also considerable when measured as a share of the population. Today, every eighth person (13 percent) in Norway is aged 70 or over. By 2060, it 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 older persons (70+) to decrease around 2010.

Figure 1.8 Percentage share of the population in four broad age groups, registered 1980-2022 and projected 2023-2060



Source: Statistics Norway

Table 1.2 Older persons 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	%
2022	5 425 270	704 621	13.0	240 293	4.4	46 558	0.9
Main							
2040	5 887 600	1 090 100	18.5	484 400	8.2	104 600	1.8
2060	6 101 200	1 368 600	22.4	716 700	11.7	205 500	3.4
2100	6 195 300	1 646 900	26.6	998 700	16.1	377 600	6.1
Strong ageing							
2040	5 601 100	1 129 700	20.2	516 200	9.2	119 100	2.1
2060	5 415 400	1 451 600	26.8	799 700	14.8	258 200	4.8
2100	4 303 800	1 620 500	37.7	1 082 900	25.2	481 200	11.2
Weak ageing							
2040	6 161 700	1 049 000	17.0	451 900	7.3	91 000	1.5
2060	6 837 900	1 287 800	18.8	635 400	9.3	159 500	2.3
2100	8 665 500	1 727 900	19.9	936 300	10.8	287 900	3.3

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

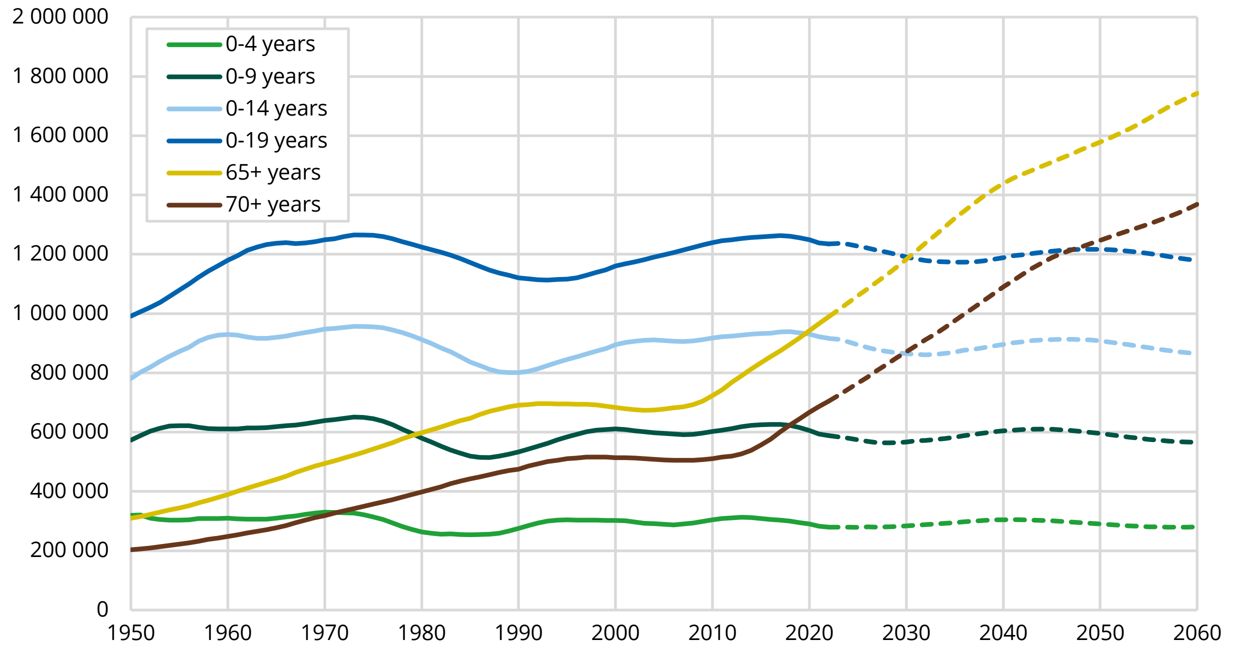
Population projections are made in several alternatives, with different assumptions about fertility, mortality, and immigration. These assumptions can be combined so that we get an alternative with strong ageing – where fertility is low, life expectancy high and immigration low – and an alternative with 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. Even in the case of weak ageing, we still expect the group aged 70 years or above to increase, both in absolute and relative terms, but at a slower rate, with around 1.3 million (19 percent) in 2060 (i.e.

80 000 fewer persons than in the main alternative). The group aged 80 or older will also increase more slowly, to 640 000 (9 percent) (again with 80 000 fewer than in the main alternative). In the strong ageing alternative, there are approximately 80 000 more people in both groups than in the main alternative, with absolute numbers of around 1.5 million for people aged 70 or over (27 percent) and 800 000 for people aged 80 or above (15 percent).

More older persons than children and teenagers

Historically, Norway has always had more children and teenagers than older persons. This will cease to be the case soon. As shown in Figure 1.9, the number of young people is expected to remain fairly stable, while the number of older people will continue to grow rapidly. Within the next 10 years, our main alternative suggests that there will be more persons aged 65 or older than children and teenagers (0-19 years), with the trend towards an ever-older population set to continue throughout the century. The main alternative suggests that those aged 70+ will outnumber children and teenagers by 2050. By 2060, the population aged 65+ will outnumber the population of children and teenagers by more than half a million.

Figure 1.9 The number of children and teenagers in four age groups versus the number of older persons in two age groups, registered 1950-2022 and projected 2023-2060, main alternative (MMM)



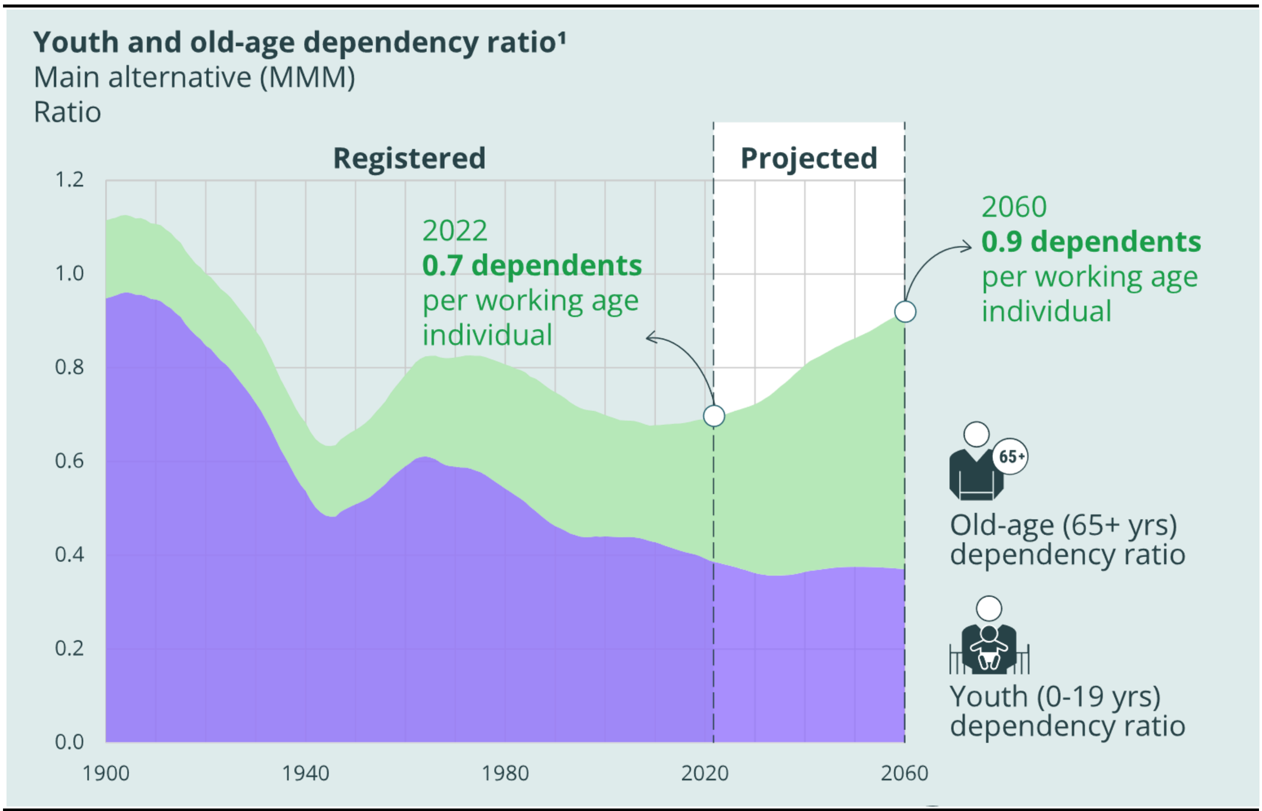
Source: Statistics Norway

Dependency ratio

The expected ageing of the population will strongly influence the old age dependency ratio (OADR). This measure shows the ratio of the number of older persons to the number of persons in working ages. As such, it provides a rough approximation of the 'burden' associated with the old age population, 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 retirement age in Norway (65.5 years for both sexes combined), according to the Norwegian Labour and Welfare Administration (NAV 2022).[1] The average retirement age was 66.0 years for women and 65.0 years for men in the first quarter of 2022. According to NAV, there were around one million people receiving a retirement pension by the end of March 2022.[2] This represents an increase of almost 19 000 when compared to March 2021. 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.

Figure 1.10 Total, old age and youth dependency ratios, registered 1900-2022 and projected 2023-2060[1]



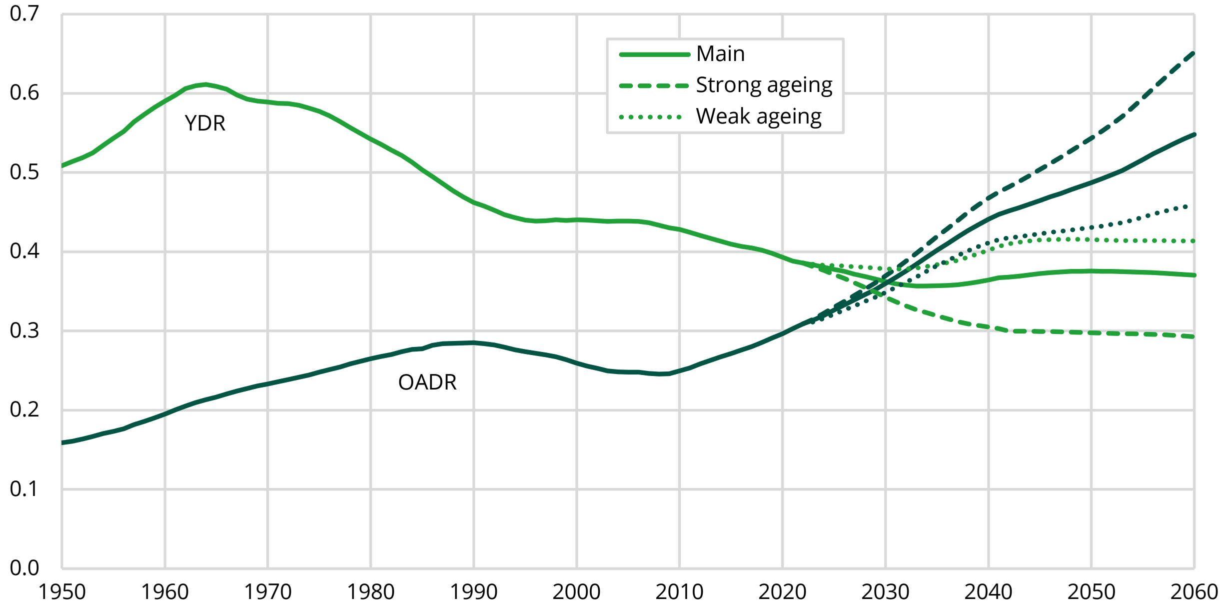
[1] The dependency ratio is the number of young (0-19 years) and/or old (65+) divided by the number of working age persons (20-64 years).
Source: Statistics Norway

High dependency ratios imply a society with a large number of young or old people in relation to the number of people of working age. Figures 1.10 and 1.11 show the development in these two dependency ratios. Currently, the youth dependency ratio is slightly higher than the old age dependency ratio: Every person of working age must on average support 0.4 younger persons and 0.3 older persons. However, after 2030, 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 younger persons and 0.5 older persons. 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 comfortably exceeds 0.4 in 2060, even in the weak ageing alternative. In the strong ageing alternative, it rises to above 0.6.

[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] Following the introduction of the pension reform in 2011, individuals may choose when they want to take out their retirement pension, within the age range 62-75 years. The pension can be freely combined with work without a reduction to the pension. As such, some pensioners continue to work. This is most common among the youngest pensioners, 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.

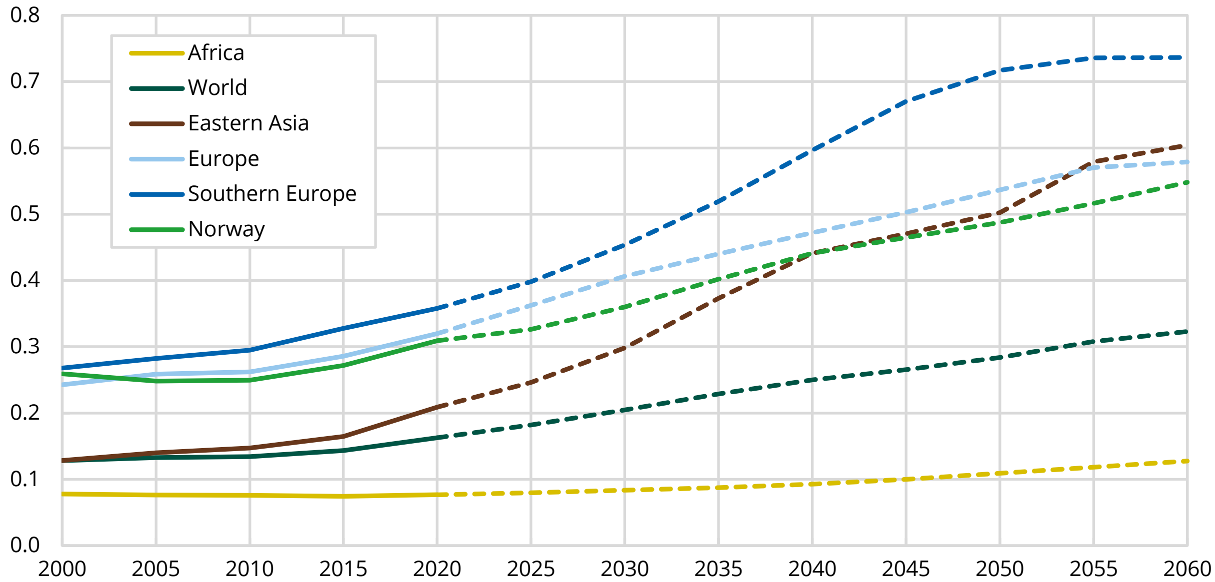
Although the OADR will increase markedly in Norway, the challenges associated with a relative decline in the working age population and the relative rise in the older age population will be much greater elsewhere. Figure 1.12 shows that Norway has a lower OADR than the European average, with Southern 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 1.11 Youth and old age dependency ratios, registered 1950-2022 and projected 2023-2060 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

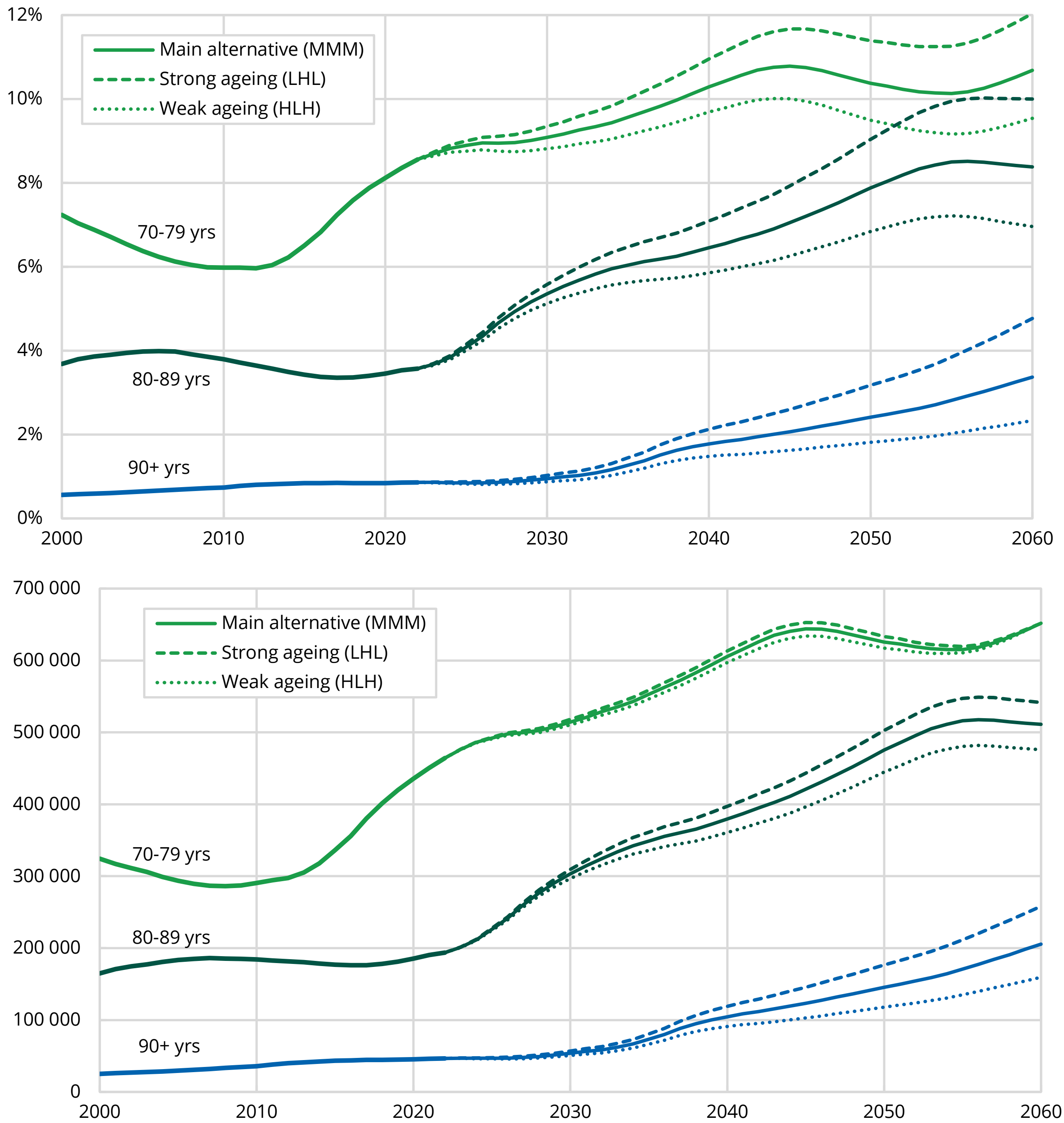
Figure 1.12 Old age dependency ratios, registered 2000-2020 and projected 2021-2060 for selected world regions and registered 2000-2022 and projected 2023-2060 for Norway[1]



[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's 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, registered 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. 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 2000-2022 and projected 2023-2060 in three alternatives



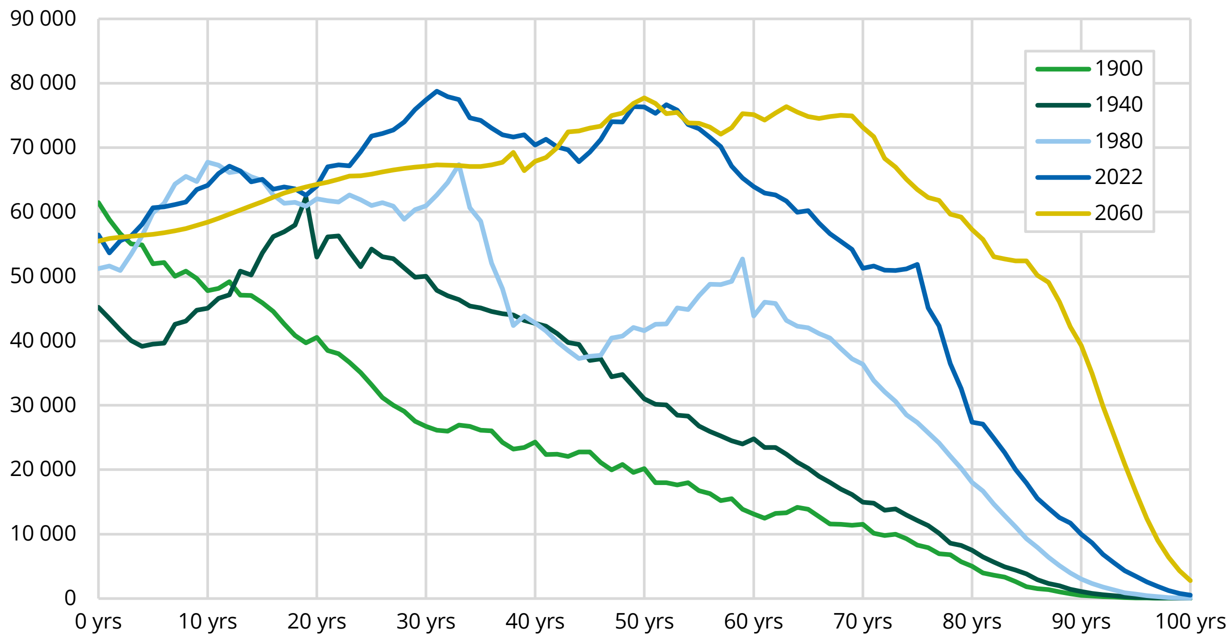
Source: Statistics Norway

The age structure

The average age in Norway has increased every year for which we have figures. By 2022, the population had an average age of almost 41 years. In only two years, the average age has increased by half a year. Since 2020, we have observed a decline of almost 18 000 in the number of children aged under 10. At the same time, the number of persons aged 75-79 has increased by almost 32 000, and this group is also where we find the largest increases in percentage terms. This is largely a consequence of the post-war baby boom generations moving through the age schedule. With that said, the number of people aged 20-64 has also increased since 2020, by around 24 000. Thus, we see only a marginal increase in the OADR (number 65+ years / number 20-64 years), from 0.30 in 2020 to 0.31 in 2022.

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 more than a century, the number of Norway's youngest inhabitants has barely changed. In the older age groups, however, we observe a marked growth.

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



Source: Statistics Norway

Figure 1.14 also demonstrates the relative size of different birth cohorts. On the 2022 line (dark blue), we see a local peak at age 75. 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 (at age 33). This cohort remained the largest through the 1950s and 1960s, until international migration and mortality took effect and the 1969 birth cohort emerged as the largest. Today, the 1990 cohort is the largest. In the coming decades, the 1990 cohort will remain Norway's largest, until the cohort born when fertility last peaked, in 2009, eventually overtakes.

Population pyramids

Figure 1.15 shows four different population pyramids. The first pyramid (top left) shows the age and sex distribution of the population 42 years ago, in 1980. We observe the local peaks mentioned above. More strikingly, however, is the young age structure. The pyramid has a broad base, and a narrow top. The 2022 population pyramid (top right) shows that the population has aged considerably, although there are still relatively few in the very oldest of old ages. When we look four decades 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 a larger share of people in the older age groups than the weak ageing alternative (HLH), where fertility, mortality and immigration are all high. Indeed, the weak ageing alternative is characterised by larger numbers at the base of the pyramid. In contrast, the strong ageing alternative (LHL), where fertility, mortality and immigration are all low, shows a very top-heavy pyramid. The base is very narrow with few persons in the young age groups and older age groups dominating.

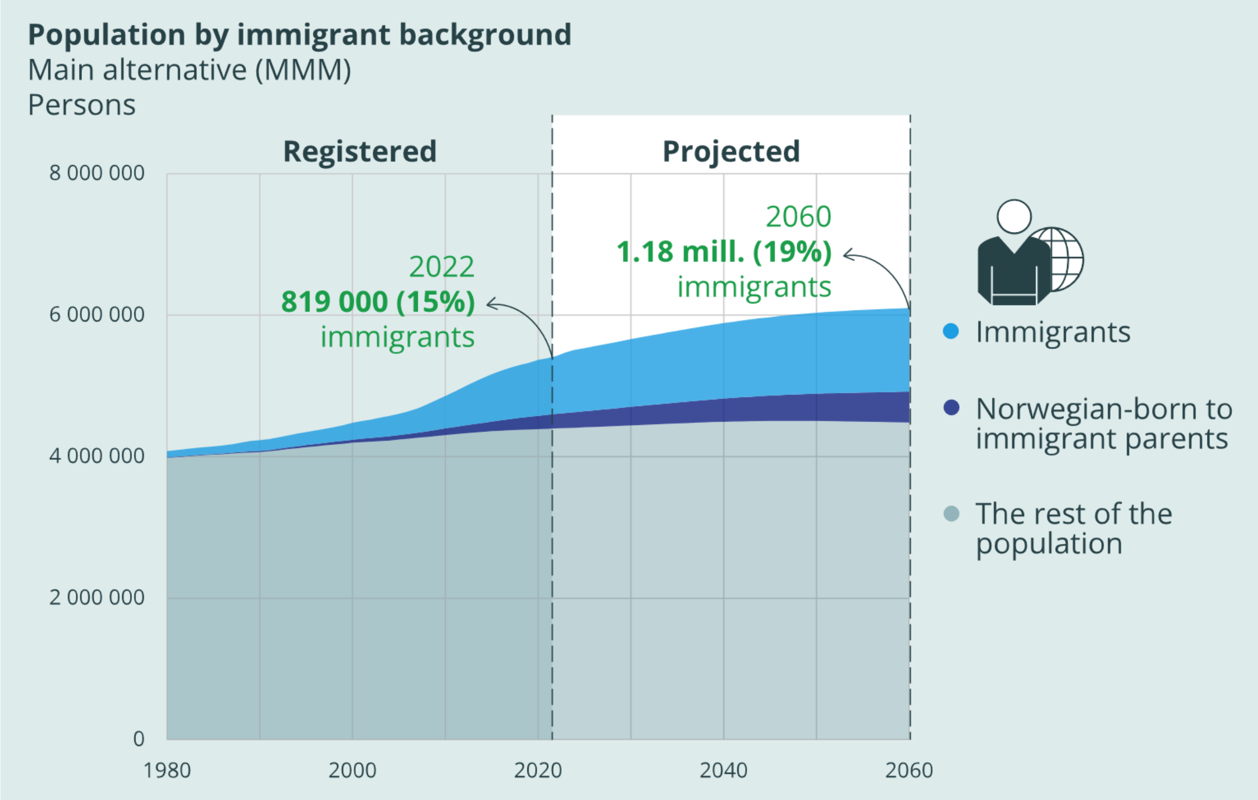
Figure 1.15 Population pyramids, 1980, 2022 and 2060, registered and projected in three alternatives[1]

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

1.3. 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 1.16 shows the population by immigrant background in the main alternative. Up to 2065, the number of immigrants will increase from around 819 000 today, to near 1.19 million. This corresponds to a 45 percent increase. The number of Norwegian-born to two immigrant parents will more than double, increasing from around 206 000 today, to around 440 000 by 2060.

Figure 1.16 The population in three groups by immigrant background, registered 1980-2022 and projected 2023-2060



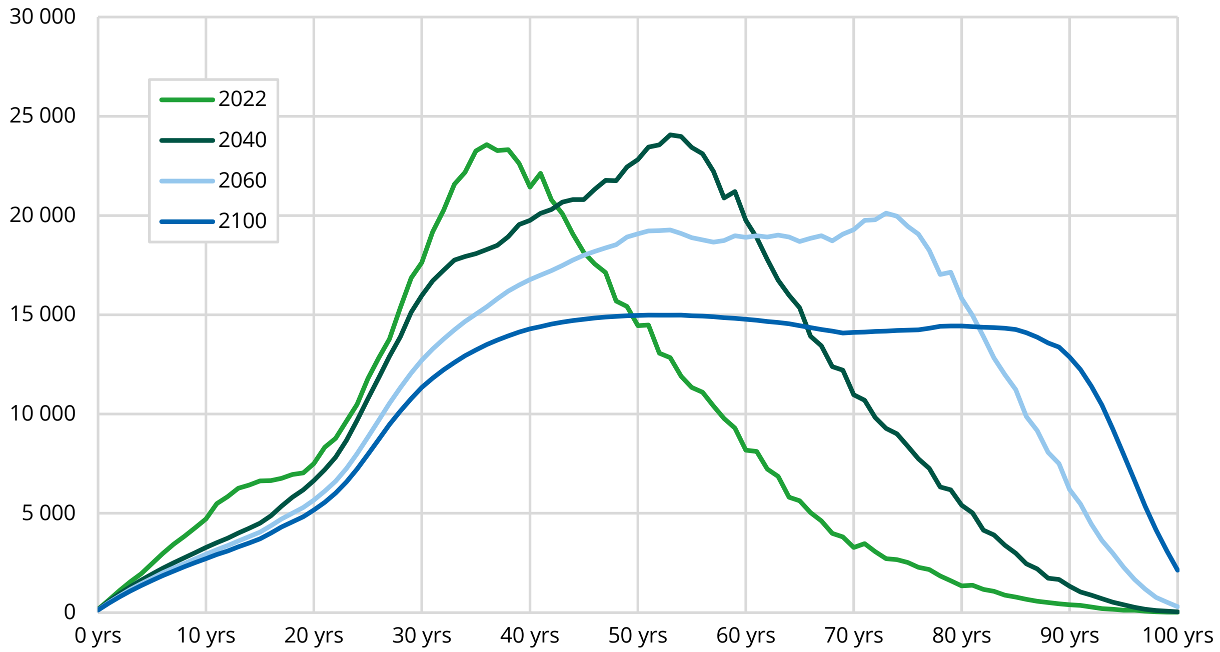
Source: Statistics Norway

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, above 45 years in 2060 and above 50 years in 2100, as shown in Figure 1.17. 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.

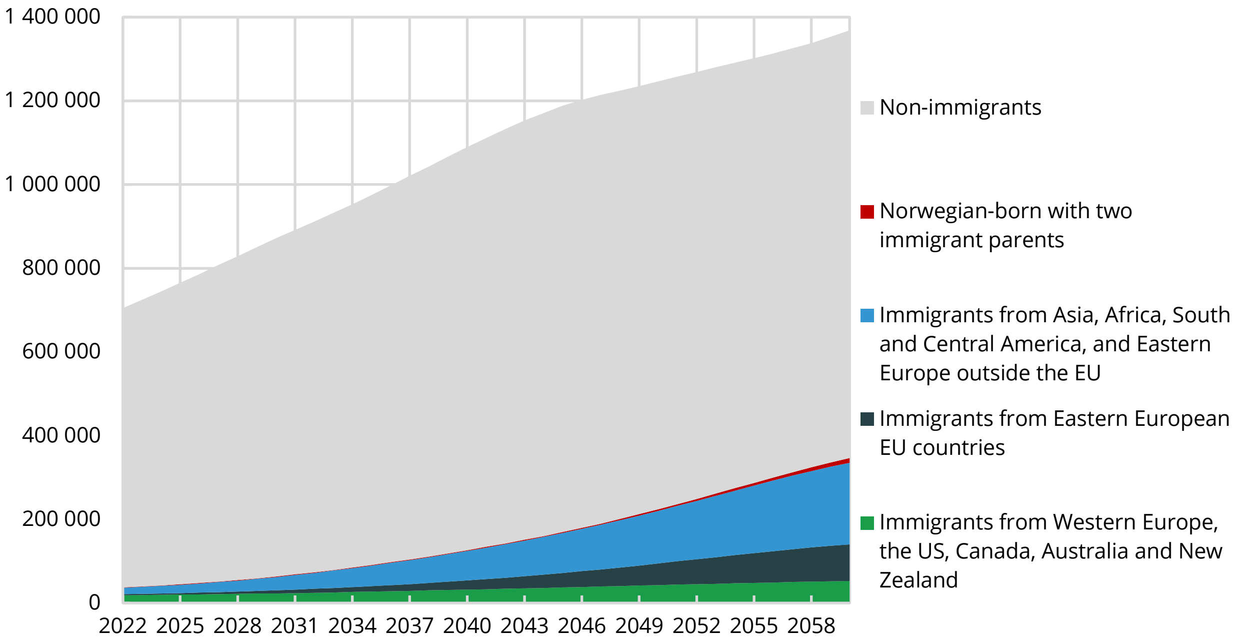
Today, there are very few immigrants in the oldest age groups in Norway. Just 5 percent of all persons aged 70 or over are immigrants. In the future, this share will increase substantially. According to the main alternative, by 2060 immigrants will account for almost 25 percent of the total population aged 70 and over. Figure 1.18 reveals 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. Norwegian-born to two immigrant parents will comprise a minor share of the older age population, representing just 0.7 percent of the population aged 70 and over in 2060.

Figure 1.17 Immigrants in Norway by age, registered 2022 and projected in 2040, 2060 and 2100, main alternative (MMM)



Source: Statistics Norway

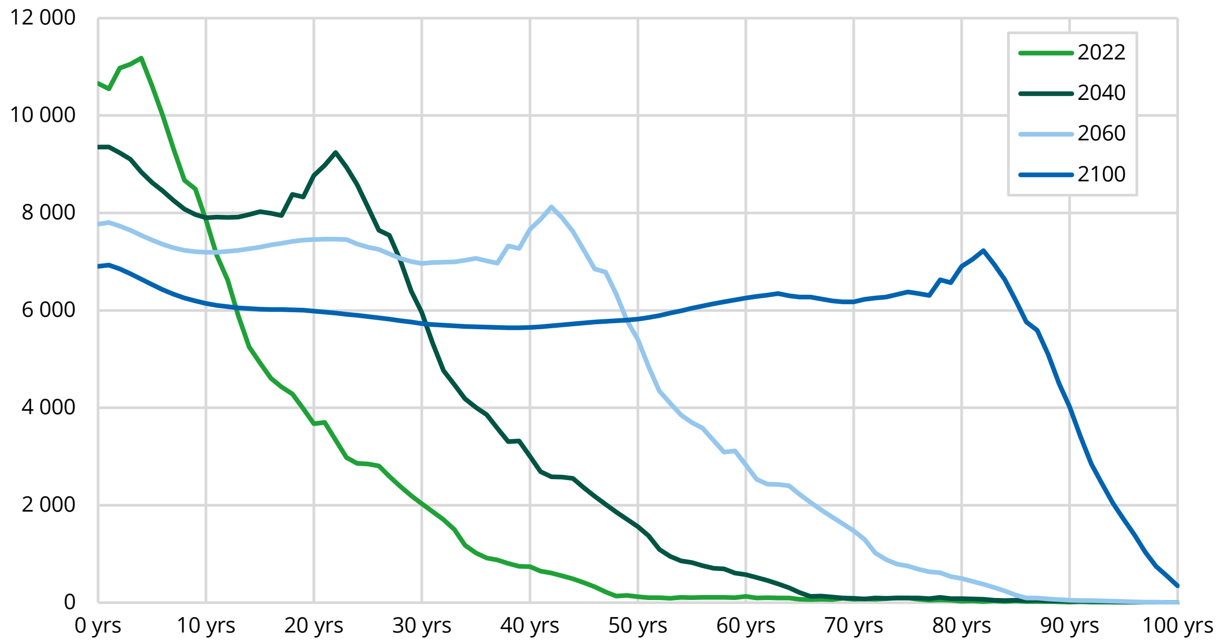
Figure 1.18 The population aged 70 and over by immigrant background, registered 2022 and projected 2023-2060, main alternative (MMM)



Source: Statistics Norway

One should note that many of the older immigrants will have lived in Norway for many years, and they themselves will have children. Figure 1.19 shows how the ageing of their children will occur more gradually, as they are younger to begin with. With that said, even among this group we will observe appreciable ageing by the end of the century. Chapter 7, on immigration and emigration, provides more information on the numbers of immigrants and descendants projected in Norway in the future, for example, by duration of stay and country group.

Figure 1.19 Norwegian-born children of immigrants in Norway by age, registered 2022 and projected in 2040, 2060 and 2100, main alternative (MMM)



Source: Statistics Norway

1.4. Changes from previous projections

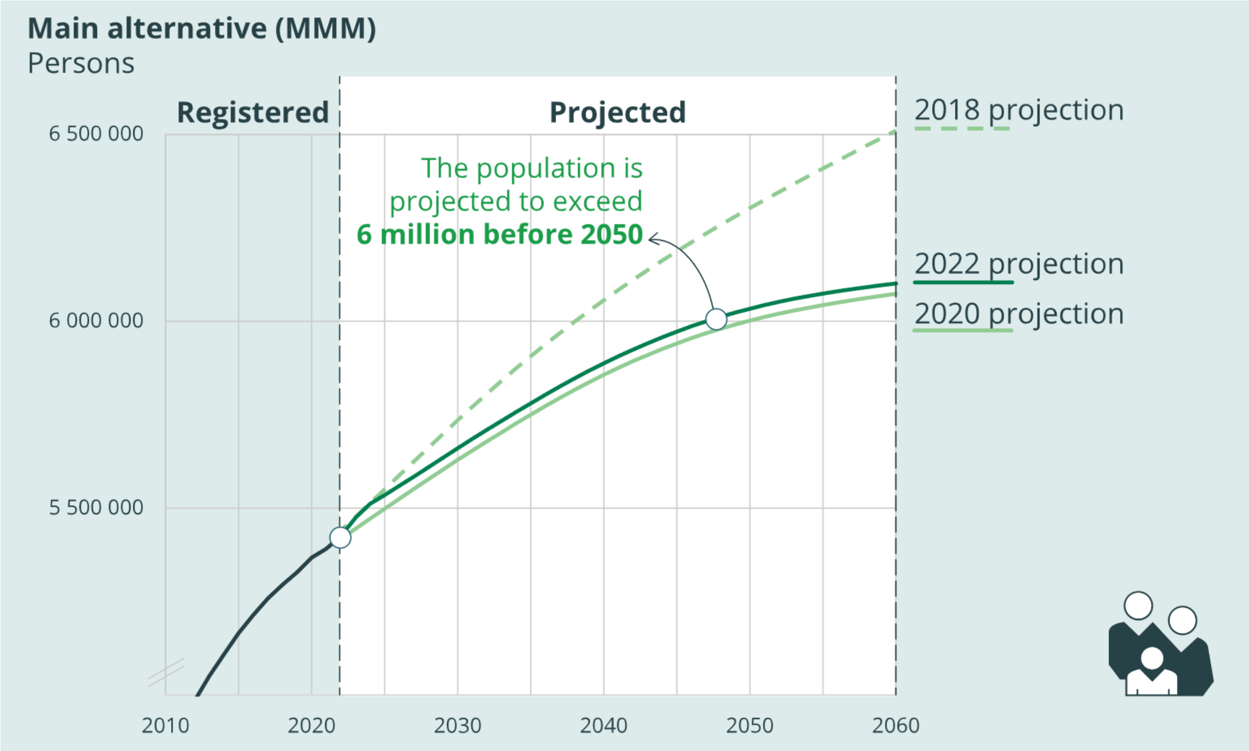
The projected population growth in Norway is not only lower than in the last ten-year period, it is also lower than what was reported in the projections published in June 2018. This is because the assumptions of both the projected immigration and the projected fertility are lower, at least in the longer run. The projected growth in the current projections is close to that published in June 2020 which, aside from different short-term *ad hoc* adjustments (relating to COVID-19 in the 2020 projections and the war in Ukraine in this projection round), had broadly similar long run assumptions. Figure 1.20 illustrates how the total population in the main alternative of the 2022 projections differs from that of the main alternatives from the two previous projections. The figure shows that in the 2018 projections, 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 the 2020 projections, the population was expected to reach 6 million in 2050, and the total population in 2060 was projected to be just under 6.1 million.

In this year's main alternative projection, the population reaches 6 million inhabitants just before 2050 and the total population is projected to be around 6.1 million in 2060. In the 2022 low national growth alternative, the population begins to decline around 2035 and is projected to be 5.2 million in 2060, never reaching the 6 million mark. In the 2022 high national growth alternative, we project pronounced growth, wherein the population reaches 6 million in the early 2030s and 7.1 million in 2060.

If we compare Statistics Norway's 2022 projections to the population projections for Norway made by the United Nations and Eurostat, we find that the projected total population in our main alternative is lower throughout the projection period than the main alternatives from the international agencies (Figure 1.21). 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 much higher long run net migration compared to our main alternative (see Chapter 7). The United Nations fertility assumptions are slightly higher than ours, whereas those from Eurostat are lower (see Chapter 5).

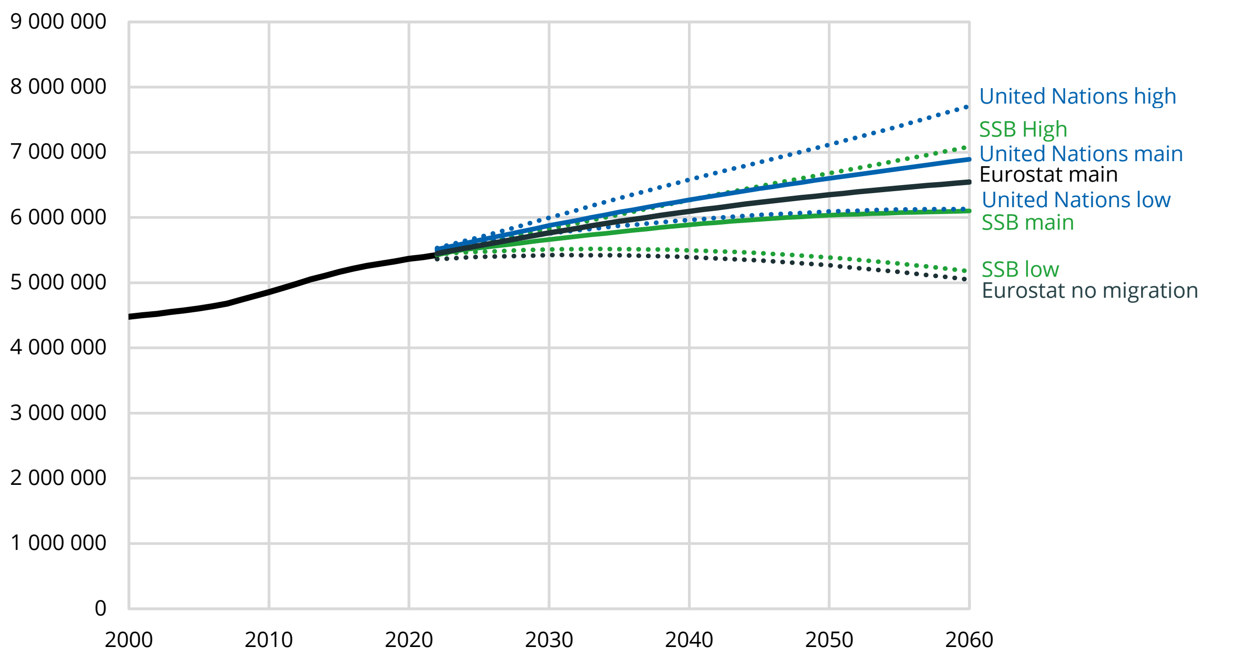
Statistics Norway projects lower mortality than both the United Nations and Eurostat (see Chapter 6), but the impact is minor for overall population figures.

Figure 1.20 Projected population from the 2018, 2020 and 2022 population projections



Source: Statistics Norway

Figure 1.21 Population in Norway, registered 2000-2022 and projected 2023-2060 by Statistics Norway, United Nations and Eurostat[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

1.5. Uncertainty

All projections of the future population and its composition are inherently uncertain. As shown in Figure 1.1, 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 age, sex 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 (Thomas et al. 2022). 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 our projections and those developed for Norway by other institutions. This is discussed in more detail in Chapter 8.

Accuracy of the 2020 national projection

We now have two years of observed data from which we can compare the estimates of the previous population projections, released in June 2020 (Table 1.3). In the main alternative, the population growth was overestimated by just 800 for the first year. However, by the second year, population growth was underestimated by 8 000. The deviation for the total population on 1 January 2022 was thus underestimated by 7 400 persons. The primary source of this deviation was underestimation of immigrations, which emerged as a result of a stronger than expected 'catch-up' effect once COVID-19 related travel restrictions were removed. Immigration was also underestimated in 2020, but to a similar extent to that of emigration, thus the projected number for net migration was very close to the registered number. The number of births was 1 600 lower than projected in 2020 and 1 600 higher than projected in 2021. We had projected a total fertility rate (TFR) of 1.52 in 2020 and 1.51 in 2021, whereas the TFR fell to 1.48 in 2020 before recovering to 1.55 in 2021. The number of projected deaths was accurate in 2020, with a deviation of around 200 deaths in total. In 2021 mortality was higher than projected, leading to 1 100 more deaths.

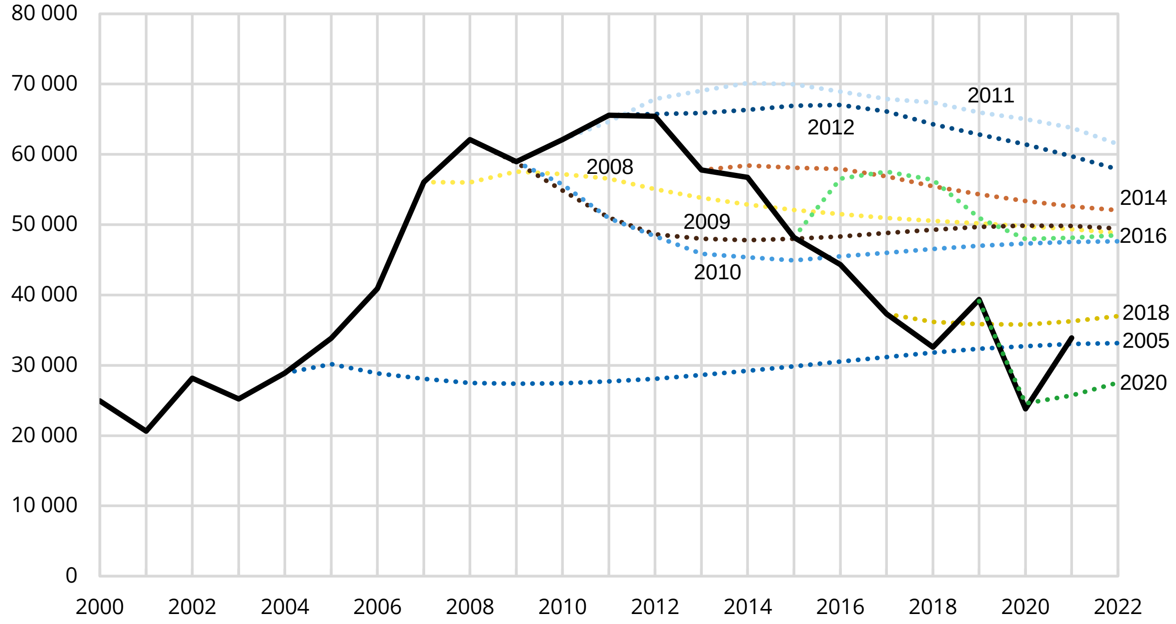
Table 1.3 2020 projections, comparing projected and registered figures for the first two years[1]

	2020			2021		
	Projected	Registered	Deviation	Projected	Registered	Deviation
Births	54 600	52 979	1 605	54 300	56 060	-1 727
Deaths	40 800	40 611	224	40 900	42 002	-1 064
Immigrations	27 300	37 052	-9 735	35 900	52 966	-17 020
Emigrations	16 500	25 834	-9 349	23 600	33 327	-9 710
Population growth	24 600	23 789	792	25 700	33 901	-8 177
Population at year-end	5 392 200	5 391 369	792	5 417 900	5 425 270	-7 393

[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 births, deaths, immigrations and emigrations 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 next. Rounded figures are shown for projected numbers to underscore the uncertainty. All deviations are calculated using exact projected and registered figures.
Source: Statistics Norway

Figure 1.22 shows the population growth in Norway, registered and predicted in main alternatives since 2005. While the population growth projected in 2005 was too low, the projected growth for recent years has been consistently higher than the corresponding realised growth in all projections produced since 2008. In the short term, the projected growth in 2018 remained reasonably close to the realised growth, while the population growth projected in the 2020 projections was close in the first year, before a larger discrepancy with the registered growth emerged in 2021.

Figure 1.22 Population growth in absolute numbers, registered (solid line) and projected 2005-2022, 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 projections. In this chapter we provide a general introduction to population projections followed by a more specific discussion of those produced by Statistics Norway. Chapter 3 describes the BEFINN model used to project the Norwegian population, while 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 (Chapters 5–7). In Chapter 8, we discuss the inherent uncertainty associated with population projections, both generally and more specifically with regards to sources of uncertainty in Statistics Norway's projections. Finally, we offer some brief conclusions (Chapter 9).

2.2. What are population projections?

Every two years, Statistics Norway projects the Norwegian population at the national and regional levels. For the 2022 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 projections 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, which are sourced from Statistics Norway's population statistics. The projection work is thus organised 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 projections. For more details on the workflow and technical solutions in the BEFINN model, 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 population projections. 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. With that said, 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

The main results of the national population projections are presented in a press release at https://www.ssb.no/en/folkfram. The StatBank (https://www.ssb.no/en/statbank/list/folkfram) provides 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 immigration category and 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[2]
Projected probability of death (per 1 000), by sex and age, in 3 alternatives	Probability of death	Lee-Carter/ARIMA

[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'.
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 website.

The projections are also used internally at Statistics Norway, for instance, as input in macro-economic models such as KVARTS, MODAG, DEMEC and SNOW, as well as in the microsimulation model MOSART. Beyond this, the national projections are used as input in BEFREG, the regional population projection model, and in the projection models LÆRERMOD and HELSEMOD.

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

2.7. Regulations

The regional and national population projections are 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 the implementation of a national programme for official statistics and the regional and national population projections are included in this programme (Statistics Norway 2021).

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 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 the 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 2022).

2.8. History

Previous population projections

Statistics Norway has produced national population projections regularly since the 1950s, with several models having been developed. Since 2005, the national population projections have utilised different versions of the BEFINN model. 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 2005, 2008, 2009 and 2010 projections. 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).

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, wherein they detailed 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/?de=Population+projections+&innholdstype=publikasjon-artikkel. In the period 1969–2002, thirteen sets of regional and national projections were published in the Official Statistics series.

Since 1996, the projections results have been published in the StatBank, where they can be accessed and downloaded by all users from the Statistics Norway website (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. (2020), Syse et al. (2018a), Tønnessen et al. (2016).

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. 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 a person immigrates to Norway and then emigrates from Norway, 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 between 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,

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

mortality and migration, we define age in completed years at the end of the year. In the general population statistics, 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. The BEFINN projection model

BEFINN employs the cohort-component method for the projection of the national population. 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 pre-2020 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 et al. 2021).

Data and methods

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

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

The population projections utilize aggregated individual-level data on population size, births, deaths and international migration from Statistics Norway's population statistics (BESTAT), collected from the Norwegian Tax Administration for the National Population Register. We employ data categorised 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 is useful for illustrating the cohort component method. 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 examples are indicated in blue in the table. A cohort can thus be followed through the projection period.[4]

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 their fertility. 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

[4] A cohort is a group of people who experience a common event during the same time period, such as a birth, marriage or graduation. In this report, we commonly refer to birth cohorts, i.e. people born in the same year.

birth which indicates a slight bias towards boys. An example of the children this pertains to is indicated in green in the table.

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

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.

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). Since 2008, an econometric model has been used to project future immigration (see Chapter 7). In this model, immigration is projected based on factors like income levels, unemployment, population size of sending country groups (in broad age groups), and prior immigration to Norway from the country groups, see Cappelen et al. (2015) and Tønnessen and Skjerpen (2020).

Multiple events during a calendar 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 the same year. An exception to this rule concerns new-born children: 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, 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, the number of deaths and emigrations are deducted, and the number of immigrations added.

Age at the beginning 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. For fertility, separate birth rates are assumed for immigrant women from three country groups and five duration of stay groups, while Norwegian-born daughters of two immigrant parents are assumed to have the same rates as the remaining population. For mortality, the same age and sex-specific probabilities apply to all groups, regardless of immigrant background (see Chapter 6). 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 regarding the proportion of children born to immigrant women who will 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 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 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. Nationals from these countries display relatively similar demographic behaviour for fertility and emigration. Moreover, few or no restrictions apply to their ability to live and work 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, while they are also the group of EU-member countries that have the largest relative income differences to Norway. The potential for migration to Norway is therefore relatively high for persons living in Country Group 2. *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). Persons 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 the previous 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 listed above.

3.3. Alternative projections

The results of a population projection depend on the assumptions 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.

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 Chapter 8. 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.

Table 3.2 Statistics Norway's population projection alternatives

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 users have a particular aim in mind or we explicitly state otherwise.
Source: Statistics Norway

4. Summary of assumptions

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

Table 4.1 A summary of the key assimptions[1]

	Registered 2021	Medium (M) assumption	High (H) assumption	Low (L) assumption
Total fertility rate, children per woman	1.55			
2025		1.50	1.67	1.31
2040		1.70	1.90	1.30
2060		1.70	1.90	1.31
2100		1.71	1.90	1.31
Life expectancy at birth, men	81.6			
2025		82.5	83.1	81.8
2040		85.6	87.0	83.9
2060		88.9	91.0	86.4
2100		93.7	96.5	89.7
Life expectancy at birth, women	84.7			
2025		85.5	86.0	84.9
2040		88.1	89.4	86.7
2060		90.9	92.7	88.8
2100		94.6	96.9	91.9
Yearly immigrations	52 966			
2025		42 900	51 700	35 300
2040		39 600	54 900	29 900
2060		36 200	63 000	23 400
2100		35 000	80 900	15 100
Yearly emigrations[2]	33 327			
2025		30 600	33 600	28 800
2040		28 000	33 000	24 700
2060		25 400	36 200	19 800
2100		22 900	45 800	13 100

[1] The figures for registered life expectancy are calculated slightly differently to 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 official 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 fertility for 16 different groups of women. In addition to calculating fertility for Norwegian-born women (i.e. non-immigrants), we 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 baseline 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 et al. 2021).

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. This data source, which is Statistics Norway’s version of the National Population Register, also contains information about women's backgrounds, i.e. whether they are immigrants or not, and how long they have lived in Norway. Data recording live births are also obtained from Statistics Norway's population statistics.

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 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.

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.

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
The remaining population is non-immigrant women, including those who are Norwegian-born with two immigrant parents. To calculate the baseline level for fertility among this group, ASFRs are calculated according to observed data for the last registered year (2021 in this projection round).

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 the 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]

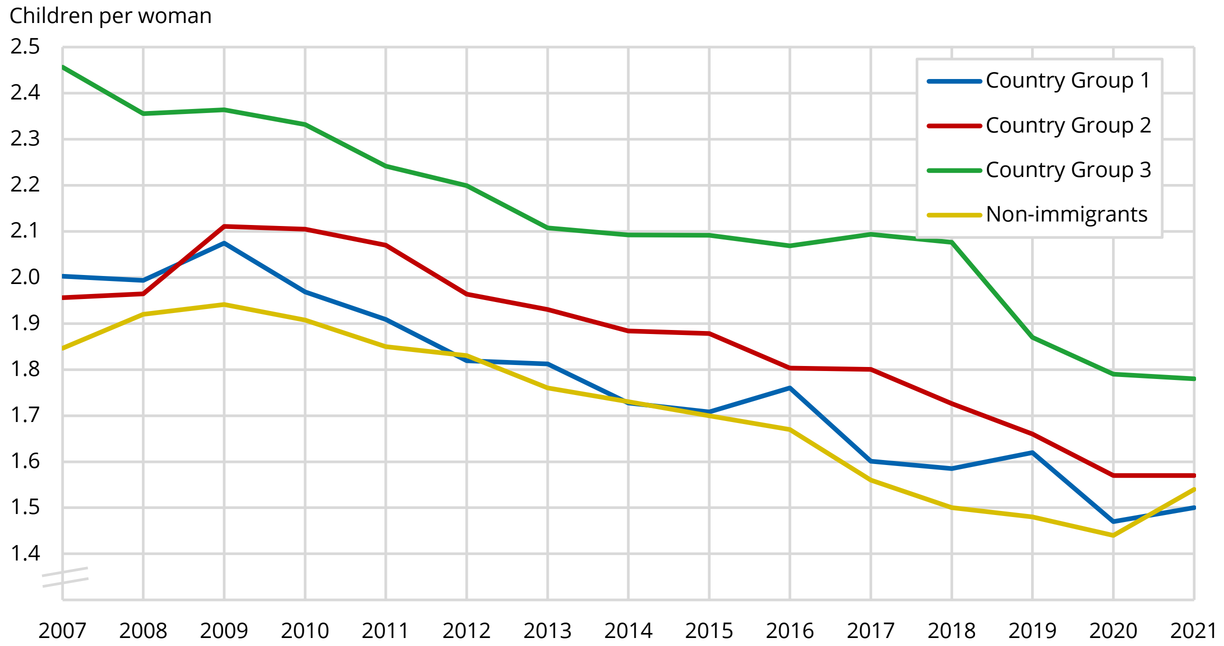
When we set the factors, the fertility of women with a Norwegian background (i.e. non-immigrant women, including those who are Norwegian-born with two immigrant parents) is used as the point of departure. For example, we can envisage the total fertility rate among this group of women to be 1.7 in 2040 – i.e. 10.4 percent higher than the 1.54 observed in 2021. The factor will then upwardly adjust the age-specific fertility rates for all groups of women, so that they are 10.4 percent higher in the year 2040 than in 2021. This means if women from Country Group 3 with a 4-6 years duration of stay had a TFR of 2.1 in 2021, the projected TFR of that group would be 2.32 in 2040, corresponding to a 10.4 percent increase.

Since the same factor is used for everyone, one might think that the differences in fertility between the immigrant women from each of the three country groups and the remaining women would be constant throughout the projection period. They are not. 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 also for how fertility will develop among immigrant women overall. As such, 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.

Based on expert input and assessments of fertility trends and the current development of birth numbers, our main alternative (MMM) suggests that the general decline in fertility observed since 2009 will continue until 2025, but at a slower pace (see Figure 4.2). Indeed, we assume that the fertility decline will end at approximately 1.5 children per woman. TFR is then expected to return to its current level by 2028, before gradually increasing to 1.7 by 2036. Thereafter, the main alternative assumes a broadly constant TFR, with small shifts relating to changes in the underlying demographics noted above. In the low fertility alternative, TFR is held broadly constant at 1.3 throughout the projection period, again with very small changes reflecting changes in the underlying demographics of the population. TFR in the high fertility alternative is expected to gradually increase from its current level, 1.55, to a level of 1.9 by 2037, after which it remains at this level.

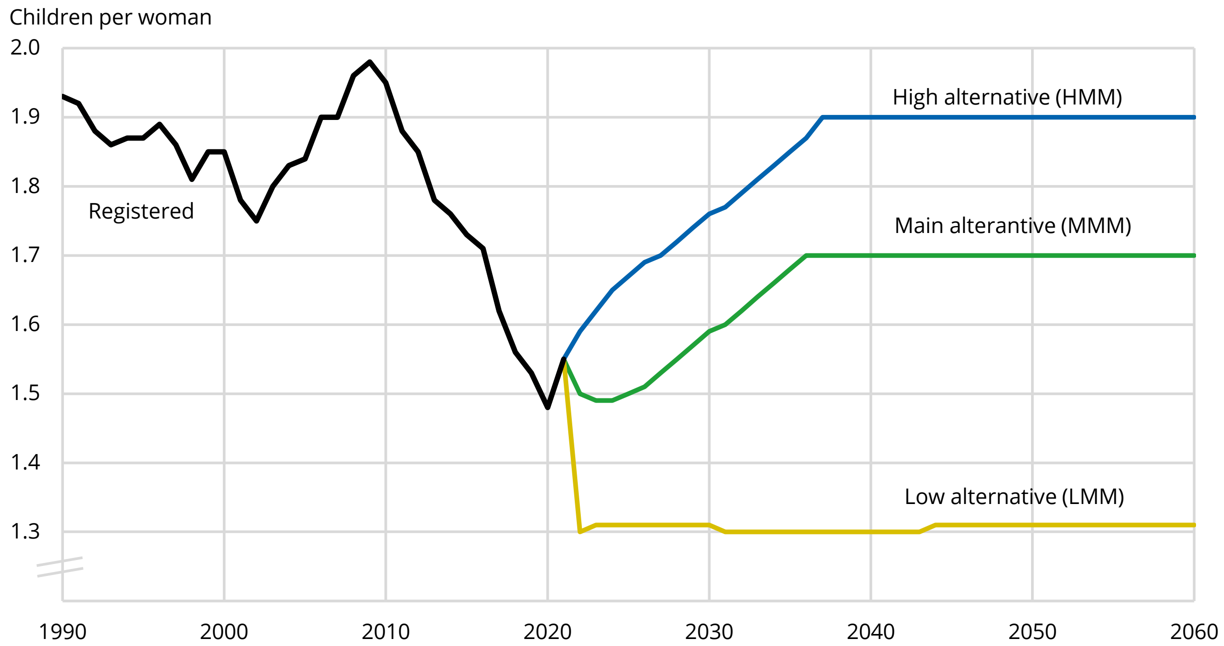
[5] For the 2022 population projections, the reference group consisted of the following members (listed alphabetically with associated organization in parentheses): Lars Dommermuth (Statistics Norway), Øystein Kravdal (University of Oslo/Norwegian Institute of Public Health), Trude Lappegård (University of Oslo), Lena Lundkvist (Statistics Sweden, demographics), Sturla Løkken (Statistics Norway) and Astri Syse (Norwegian Institute of Public Health).

Figure 4.1 Total fertility rate in Norway by country group, 2007-2021



Source: Statistics Norway

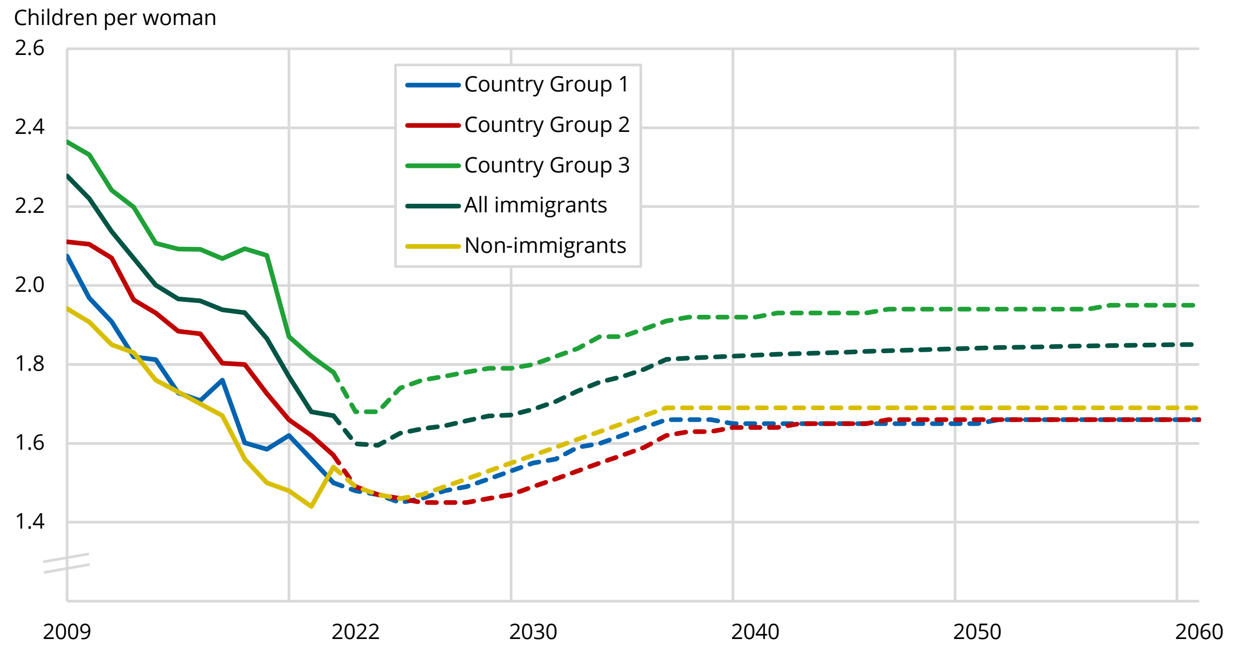
Figure 4.2 Total fertility rate in Norway, registered 1990-2021 and projected 2022-2060 in three alternatives[1]



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

Figure 4.3 shows registered and projected TFR (MMM) for immigrant women from each of the three country groups as well as non-immigrant women and all immigrant women combined. In the short run, the fertility levels will decline for all three groups of immigrant women, with women from Country Group 2 having the steepest decline. By 2028, fertility levels among immigrant women from Country Groups 1 and 3 return to levels higher than those observed in 2021, while for Country Group 2 the recovery in fertility is not observed until 2034. From 2040, TFRs in the main alternative broadly stabilise at levels between 1.64 and 1.67 for Country Groups 1 and 2 and 1.92 and 1.95 for Country Group 3. This is in accordance with the assumptions for the gradual phasing-in of long-term levels of TFR discussed earlier. Long-term fertility for women with immigrant backgrounds will stabilize at a level of approximately 1.85 children per woman.

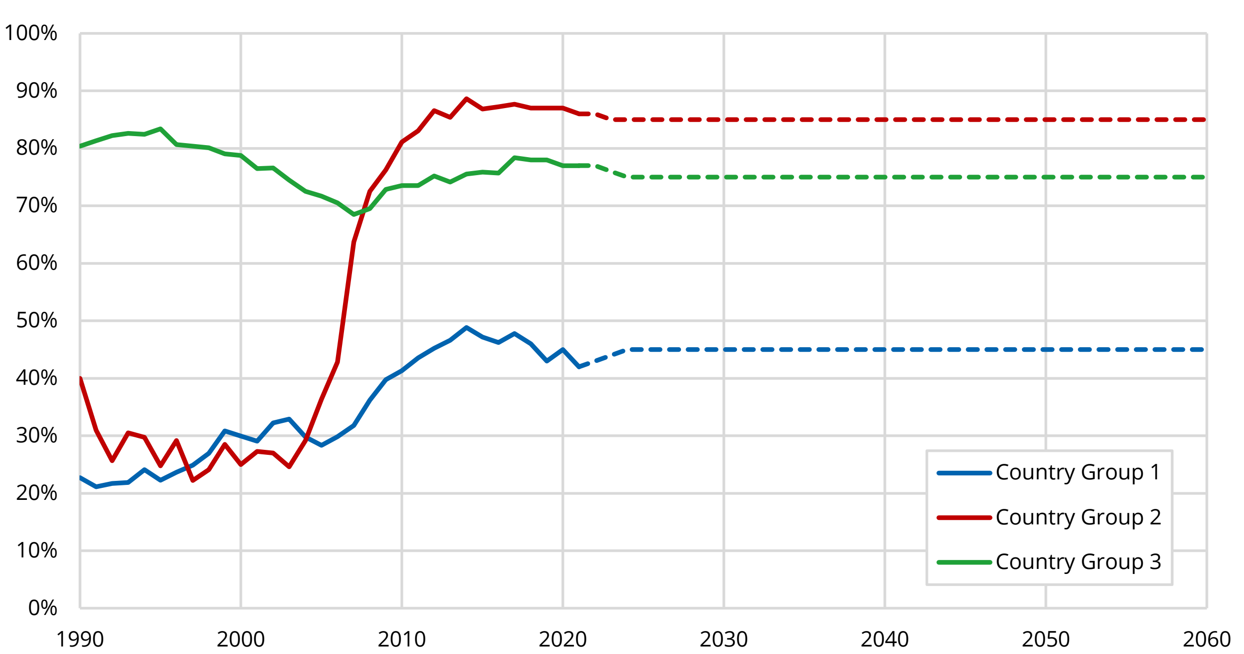
Figure 4.3 Total fertility rate in Norway by country group, registered 2009-2021 and projected 2022-2060, main alternative (MMM)



Source: Statistics Norway

To calculate the number of Norwegian-born children to two immigrant parents, we make assumptions about the proportion of immigrant women who will have children with immigrant men. This is discussed in more detail in the chapter on international migration (Chapter 7). Figure 4.4 visualises the assumptions for the shares used in this year's projections.

Figure 4.4 Share of immigrant women who have children with immigrant men, by country group, registered 1990-2021 and projected 2022-2060



Source: Statistics Norway

4.2. Life expectancy and mortality

Statistics Norway uses the product-ratio variant of a Lee-Carter model (Hyndman et al. 2013), wherein the trend in mortality for a selected time period, represented by two estimated time series, is extended using an autoregressive integrated moving average (ARIMA) model. The period of registered data used as input is determined prior to each projection round.

This method produces mortality rates by age and sex up to and including the year 2100. The mortality rates are converted into probabilities before being 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 projections, we use input data for 2000-2021. We calculate age-specific mortality rates for men, women and both sexes combined for all ages 0-110 and allow for the fact that deaths do not occur linearly throughout the year. Once we have calculated the mortality rates in the input period and adjusted for extreme values (See Box 4.2), the actual modelling of projected rates can begin.

Box 4.2 Mortality rates

We calculate age-specific mortality rates for men, women and both sexes combined 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. 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 past instances where deaths have not occurred in a certain age, sex and year group.

There are large fluctuations from year to year for older ages (101-110 years). Therefore, to estimate projected mortality 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 2000-2021. This reduces the noise in the estimates at high ages and provides stable projected death rates for the entire age range. For ages 111-119 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) and women (m_W) 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. So long as $p(x,t)$ and $r(x,t)$ are not completely uncorrelated, the correlation is significantly reduced when applying this method.

A model based on the Lee-Carter method (Lee and Carter 1992, Lee 2000, Li and Lee 2005) is then applied to the observed mortality data in our sample. The method estimates parameters of 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 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, from 2000 to 2021. To make assumptions about how mortality will develop in the future, we use an ARIMA model (Wei 2006). In this model we use what is termed 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 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 (described below) can be used in the BEFINN model, the mortality rates are converted into probabilities using the following formula:

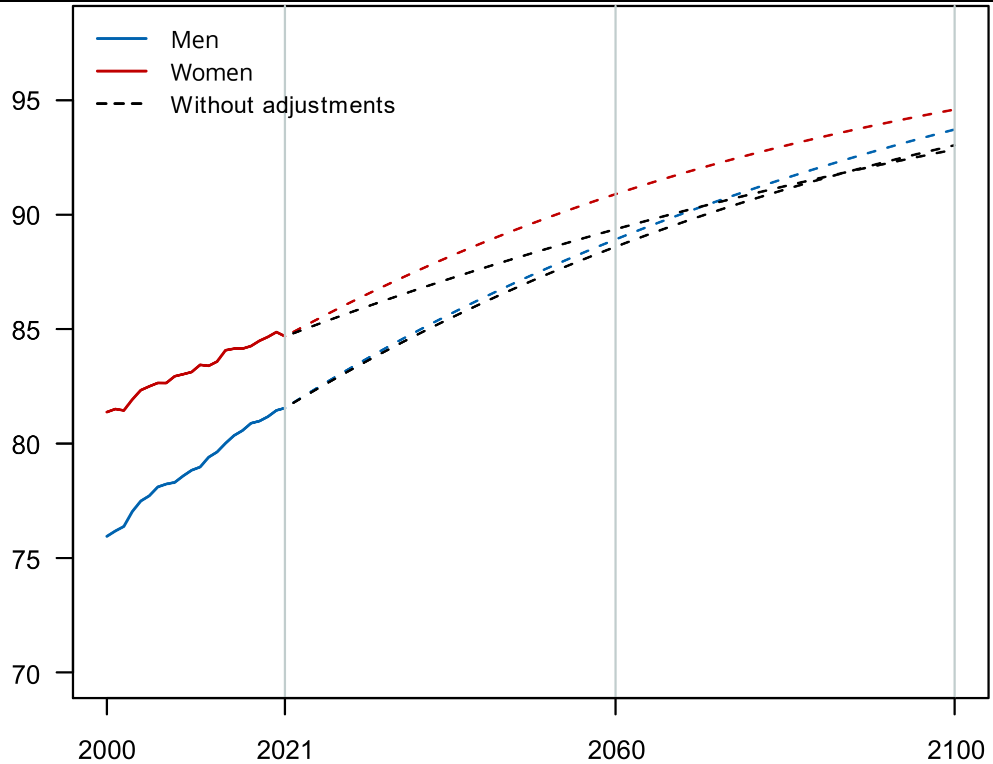
$$q(x,t) = 1-(exp(-m(x,t)))$$

Discretionary adjustments

The period used as input is determined prior to each projection round. After assessing the plausibility of the projected mortality rates resulting from the model, we also make other discretionary assessments.

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 from the perspective of a population projection. However, since male mortality has declined very rapidly in recent decades, simple extrapolation leads to higher life expectancies for men than women for several ages in the range 50-80 years. We have therefore made a discretionary adjustment that, throughout the projection period, reduces the mortality rates and increase life expectancy somewhat more than the initial model estimates indicate for women (see Section 6.2). The effect of this adjustment on life expectancy at birth is shown in Figure 4.5.

Figure 4.5 Projected life expectancy at birth for men and women, with and without discretionary adjustment, registered 2000-2021 and projected 2022-2100[1]



[1] Dashed lines represent the medium alternative in each instance.
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.

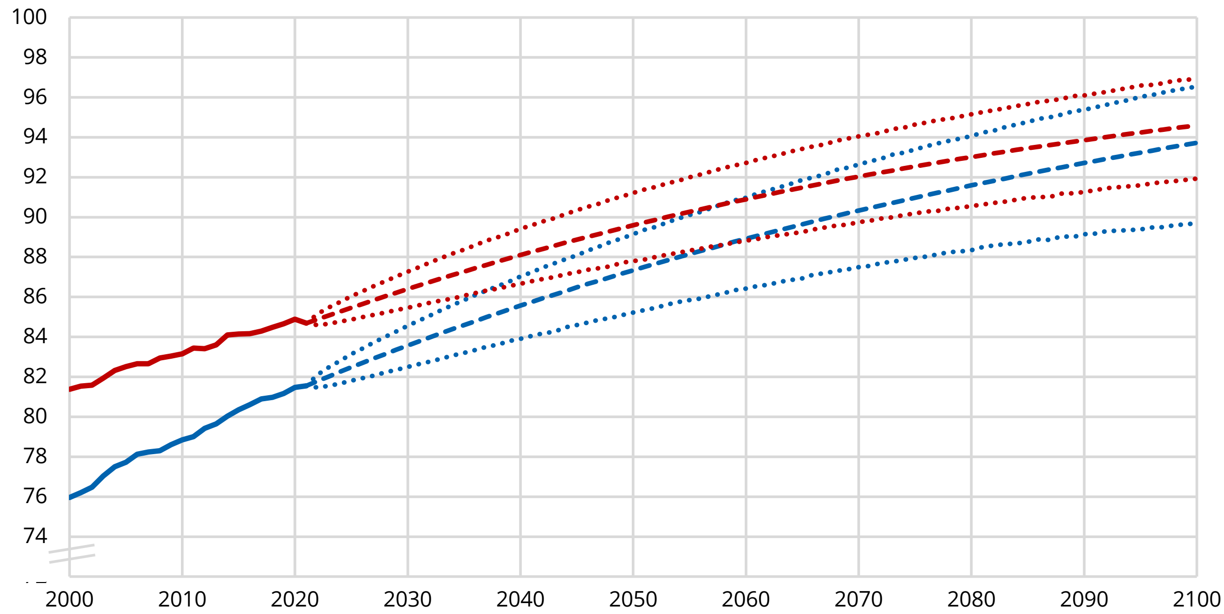
The same mortality level is assumed for immigrants as for the general population, since the disparities on average are below ten percent and decline further for immigrants with a long duration of stay in Norway (Syse et al. 2016, Syse et al. 2018b).

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.

In our medium alternative, life expectancy at birth for men increases from 81.6 years in 2021 to almost 89 years in 2060, i.e. an increase of more than seven years (Figure 4.6). For women, we have assumed a slightly less pronounced increase from 84.7 years in 2021 to almost 91 years in 2060, i.e.

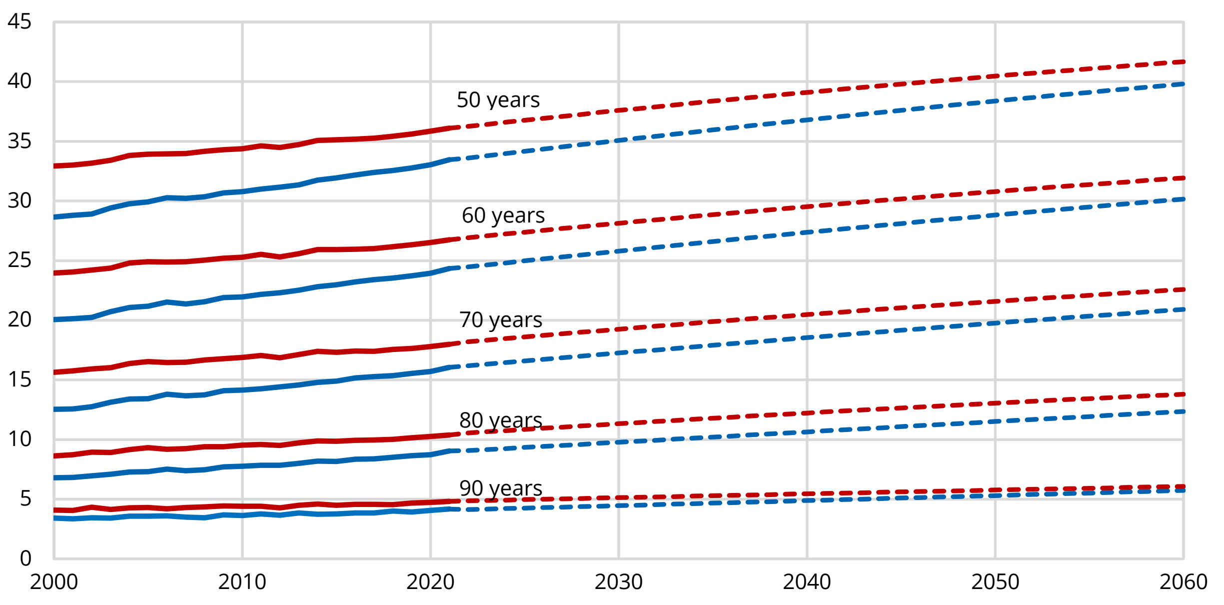
an increase of around 6 years. In the low alternative, the increase will be weaker – just under five years for men and just over four years for women – over the same period. Life expectancy in the high alternative increases by more than nine years for men and eight years for women.

Figure 4.6 Life expectancy at birth for men (blue) and women (red), registered 2000-2021 and projected 2022-2100 in three alternatives[1]



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

Figure 4.7 Remaining life expectancy at ages 50, 60, 70, 80 and 90 for men (blue) and women (red), registered 2000-2021 and projected 2022-2060, medium alternative (M)



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 4.7. According to the medium alternative, remaining life expectancy for 70-year-olds will be around 4-5 years longer in 2060 than today. The increase is also pronounced for 80-year-olds, who can expect to live 3 years longer on average in 2060. This is also reflected in the average age of death, which, according to the main alternative, is expected to increase from around 80 years today to around 87 years by 2060.

To summarise, we assume an approximate continuation of the strong increase in life expectancy witnessed over in recent decades. Consequently, people in the oldest age groups will constitute an increasing share of the population in the years to come. 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 patterns during the period 2012-2019.[6]

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 are grouped according to their own country group of origin while Norwegian-born children to two immigrant parents are grouped according to their mothers' country of origin, see Box 4.4.

Data

Data on Norwegian immigration and emigration 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 in the general statistics. This applies particularly 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 projections, data are needed from other sources, and more details are available in Chapter 7. 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 from these groups. 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. 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 unemploy--ment rate in Country Group 1, we use unemployment figures from the OECD. For the unemploy-ment rate in Country Group 2, 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 included. Lastly, we have calculated a

[6] We did not use registered data for 2020 and 2021 in the calculation of future emigration probabilities due to the strict global travel restrictions that severely restricted opportunities for cross-border travel and relocation in these years.
[7] The United Nations global demographic estimates and projections are updated every other year, see http://esa.un.org/unpd/wpp/index.htm. At the time of writing (early May 2022), the World Population Prospects 2019 are the most recent.

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. Preliminary analyses suggest that the network effect only bears relevance to immigrants from Country Group 3 and therefore network effects are only included for this group.

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.

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, individuals from these countries display relatively similar demographic behaviour with regards to fertility and emigration. Moreover, few or no restrictions apply in terms of opportunities for 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 (e.g. with especially low fertility and projected population decline). 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 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 typically includes 7 000-10 000 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.

Econometric models for three country groups and three age groups

Our modelling approach follows Cappelen and Skjerpen (2014) and the references therein. In Section 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 line with the 2020 population projection round, we use a disaggregated approach when it comes to the age composition of immigrants. That is, we 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 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 (2020). It should be noted that 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 (see Eq. (6) in Section 7.3). One motivation behind the disaggregation relates to 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 (United Nations 2019), 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 propensities of the youngest age group are linked to the propensities of the other two age groups because most child migrants arrive with their parents. Given the dependence on the migration propensities of the other two age groups, we encounter a simultaneity issue when estimating the immigration rate of the youngest age group. This is handled in the modelling approach.

Excluding dummies, the most common variables 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 Section 7.3 we provide the explicit numerical models used for forecasting immigration from the three country groups. Altogether there are 9 equations, one for each age group within each country 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. A detailed discussion of the results obtained for each of the country groups is provided in Section 7.3.

Forecasts of the variables

Once the parameters have been estimated (or 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).

The figures for the future development of the population in the three country groups are taken from the most recent United Nations population projections (United Nations 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 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.

For Country Group 1, the registered and projected age distribution undergoes considerable change. While the number of children has been approximately 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 approximately constant and is expected to remain around 250 million people in Country Group 1. Depending on the UN variant, there is clear uncertainty in terms of whether the total population in Country Group 1 will remain stable, decrease or increase. The age distribution of Country Group 2 is also expected to change. The number of people in the most mobile age groups started to decline at the time most of these countries became EU-members. 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. If the aggregate emigration rate to Norway from Country Group 2 were to remain constant, the decline in the population alone would lead to a strong reduction in annual immigration to Norway. Country Group 3 has by far the largest population among the three country groups. According to the United Nations main variant, the population in this country group will reach 10 billion by 2100. In the low-fertility variant, it will reach a maximum of around 8 billion sometime during the 2050s, while in the high-fertility variant the rapid trend in population growth over recent decades will simply continue. Country Group 3 is no different in expecting significant population ageing in the coming decades.

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 projections made in 2020. Once the number of immigrations has been predicted, the population projection model (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 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.

Forecasts of the unemployment rate in Norway have been levelled off to a historically 'normal' level, around the average of the last three decades (3.7 percent). In recent years the unemployment rate in Country Group 2 has significantly reduced. We assume that it will stay at a low level (4 percent) in the long run. For Country Group 1, the unemployment rate has also recently declined. In the long term, the unemployment rate is expected to stay at a relatively low level (5.5 percent) when compared to previous decades. The changing demographic structure in both Country Groups 1 and 2 is one reason why we think this is a reasonable long-run assumption. The unemployment rates are assumed to be the same in all three scenarios.

Three alternative paths have been made for future income development (low, medium and high alternatives). They reflect 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 this case, the relative income levels have simply been extended from an estimated level in 2022. 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 absolute convergence in relative incomes between Norway and the three country groups, also in the very long run. The effects on the world economy of the COVID-19 pandemic and the war in Ukraine make it difficult to forecast relative incomes in the short run. If all countries are negatively affected in a roughly similar fashion, this moderates the effect on relative incomes. However, the Norwegian economy is highly affected by changes in the prices of crude oil and natural gas and currently enjoys dramatic terms of trade improvements, which affects relative incomes this year. We have assumed that energy prices fall from next year, onwards, to more normal levels so that the relative increase in Norwegian incomes is short lived. A more thorough discussion of historical and projected relative income per capita ratios for each country group in the three alternatives is provided in Section 7.3.

Immigration forecasts for the three country groups
The estimated equations (7)-(9) in Chapter 7 are utilised for dynamic projections. First, the unknown parameters are replaced by their estimates and the errors are set to zero. Second, the log of the immigration rate of the age groups is forecasted and the rates are then multiplied with corresponding population forecasts from the United Nations. For Country Group 3, the forecasts are based on a more elaborated procedure. 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 2022-2100. Values for the lagged right-hand side variables are obtained recursively ('dynamic forecasts'). In Chapter 7, we present the immigration forecasts for the three country groups in the medium, high and low alternatives based on the various assumptions for unemployment rates, relative incomes and United Nations population projections.

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. The estimated standard error of the forecasts is used to allow for model uncertainty in the calculations.[8] 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 war in Ukraine, and the subsequent refugee crisis, we have made *ad hoc* adjustments to the low, medium and high immigration alternatives for Country Group 3. More specifically, the adjustment in the medium alternative involves the inclusion of an additional 20 000 gross immigrations in 2022, followed by an additional 10 000 in 2023 (30 000 in total). The low alternative comprises an additional 15 000 gross immigrations in 2022, a figure which is based on the approximate number of arrivals and planned transfers thus far, while the high alternative includes an additional 40 000 gross immigrations in 2022, followed by 20 000 in 2023 and 10 000 in 2024 (70 000 in total). We assume a return to relative normality in 2023 in the low alternative, 2024 in the medium alternative, and 2025 in the high alternative. We discuss the formation of these *ad hoc*

[8] 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.

adjustments in more detail in Section 7.1. It should also be noted that this year's projections do not expect significant global travel restrictions relating to the COVID-19 pandemic.

Every year, a number of people with a Norwegian background return to live in 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 assumed marginal 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 our medium assumption, we expect the immigration of 'non-immigrants' to increase somewhat, from around 6 500 today to 7 300 in 2060. In the high assumption, the increase is stronger, to 9 300 in 2060, and in the low assumption the number is reduced to around 5 300 in 2060.

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

Emigration

Emigration is calculated using emigration probabilities derived from observed data for the period 2012-2019, i.e. excluding the peak COVID-19 years. The propensity to emigrate is significantly higher for immigrants than for their children born in Norway, with emigration rates tending to decline as duration of stay in Norway increases. Persons who belong to the remaining general population have the lowest tendency to emigrate. For immigrants from the three country groups, emigration propensities are highest for those from Country Group 1 and lowest for those from Country Group 3.

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 to produce reliable 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.

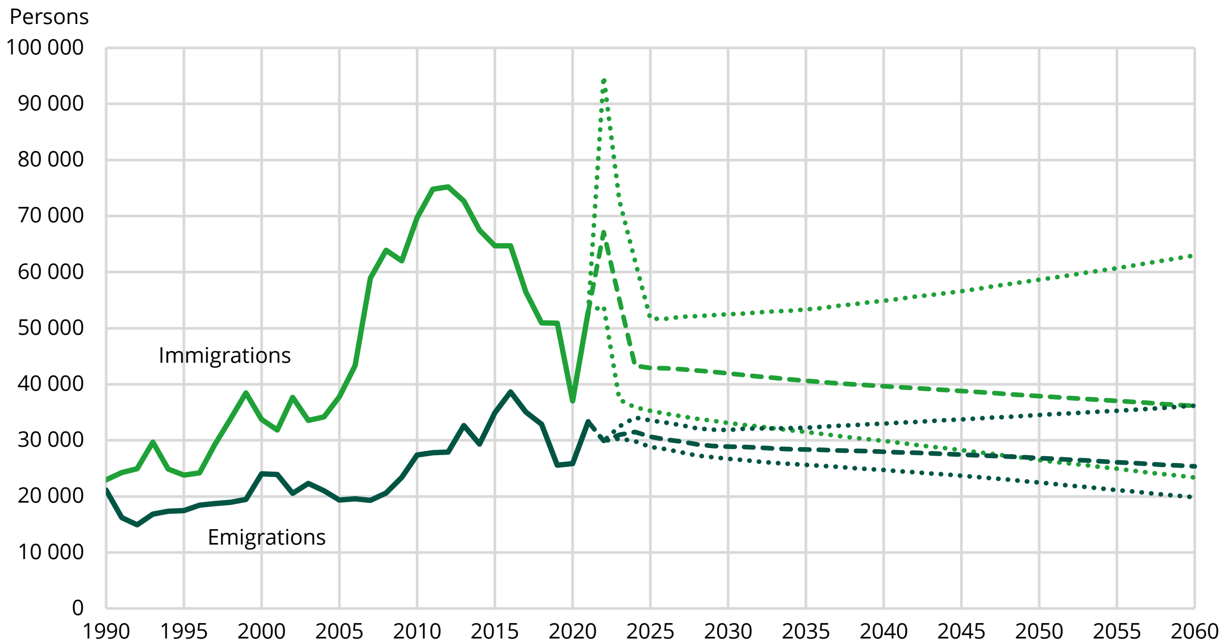
Since high immigration one year will entail higher emigration in the ensuing years, the estimates of the number of emigrations are largely dependent on the figures for immigration. Separate high and low assumption alternatives for emigration are thus not currently produced. We therefore produce only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

International migration assumptions

A more detailed account of this year's immigration and emigration assumptions is provided in Chapter 7. Figure 4.8 presents the projected total immigration and emigration in thee alternatives. We assume an initial increase in the main alternative from 53 000 in 2021 to 67 000 in 2022 (low 54 000, high 95 000), which is driven by the *ad hoc* adjustments to Country Group 3 in response to the war in Ukraine. From this peak, we assume a sharp decline in all alternatives, before the projections settle on more stable trajectories. In the main alternative, immigration to Norway will decline somewhat, from around 43 000 in 2024 to around 36 000 in 2060. The low immigration alternative assumes an even stronger decline, to around 23 000 in 2060, while our high immigration alternative assumes an increase, up to around 63 000 over the same period.

For emigration, we project relatively stable emigration levels, though there is a small decrease from around 30 000 to around 25 000 per year by 2060 in the main alternative. In the low immigration alternative, we project a more pronounced decline in emigration, falling to around 20 000 in 2060. In contrast, around 36 000 are projected to emigrate in 2060 in the high immigration alternative.

Figure 4.8 Immigrations and emigrations, registered 1990–2021 and projected 2022–2060 in three alternatives[1]

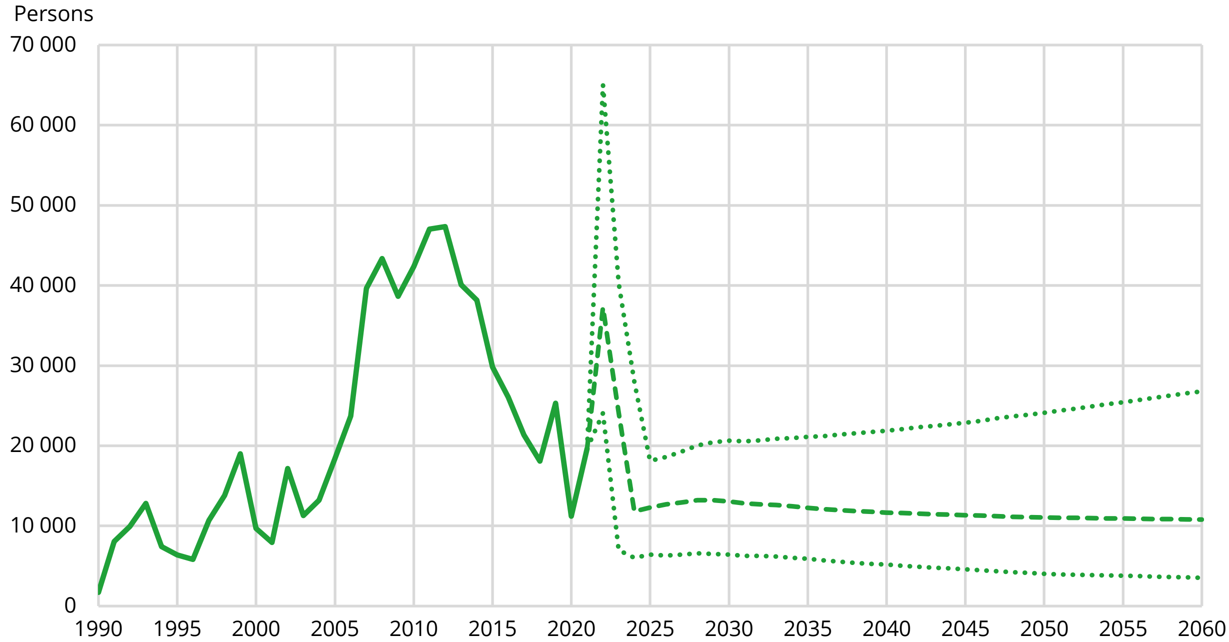


[1] Excludes persons who have both immigrated and emigrated during the same year. The three alternatives are MMM (main), MMH (high immigration) and MML (low immigration).
Source: Statistics Norway

Net migration

Figure 4.9 shows the projected net migration in the main alternative, as well as in the low and high immigration alternatives. Net migration remains positive to 2060 in all three alternatives, although the magnitudes vary considerably. In the main alternative, we project net migration to rise from around 20 000 in 2021 to around 37 000 in 2022 (low 24 000, high 65 000). From this peak, we expect a sharp fall, corresponding to the assumed decline in arrivals from Ukraine, followed by a more gradual decline in the main alternative and low immigration alternative. In the main alternative, we see a decline from around 12 000 in 2024 to just under 11 000 in 2060. In the low immigration alternative, we see a decline from 6 000 to less than 4 000 over the same period, while the high immigration alternative projects a gradual increase, to around 27 000 by 2060.

Figure 4.9 Net migration, registered 1990–2021 and projected 2022–2060 in three alternatives[1]



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

Distributions by age, sex, duration of stay and immigrant background

The projections of immigration and emigration are also used to estimate the future number of immigrants and Norwegian-born children with two immigrant parents. This is done in the national population projection model, BEFINN. For this we need an additional assumption describing the proportion of women who have children to immigrant men. 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 empirical trends of immigration over the last ten years. 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 immigrant 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

Ane M. Tømmerås[9]

Fertility levels in Norway increased in 2021, after 12 years of decline. Still, fertility levels are historically low and birth statistics of the first quarter of 2022 indicate no further increase (Statistics Norway 2022a), which suggests that the upswing in 2021 was temporary and related to the COVID-19 pandemic (Lappegård et al. 2022). The main fertility assumption in this year's population projections shows a continuation in the decline in fertility over the next couple of years, before a period of increase and then stabilisation occurs. From 2035, the main fertility assumption is set at around 1.7 children per woman. The low fertility assumption is set to 1.3 children per woman from 2022 forward, while the high fertility assumption is set to 1.9 children per woman from the mid-2030s onwards.

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, completed cohort fertility reflects the average number of births by all women born in the same calendar year. Cohort fertility is usually calculated when women born in the same year have finished their fertile period, often defined at age 45 years. Thus, by 2022, we can calculate cohort fertility at age 45 for women born prior to 1977. Although some women have children after age 45, the small numbers have only a minor impact on cohort fertility. Cohort fertility is less variable over time than TFR (period fertility) as births can be postponed or recovered without having major consequences for the final number of children.

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. Since 2009, TFR has declined, reaching a record low of 1.48 in 2020. Despite the short-lived increase in 2021 (to 1.55), fertility levels remain at a historically low level. As such, Norway has witnessed a decrease of almost half a child per women (0.45) over approximately the last decade. 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 (Hellstrand et al. 2021). While there remains uncertainty over to the extent to which the postponed first births may be 'recovered', we are more confident that the downward trend in third and higher order births will continue.

[9] We thank the advisory reference group for fertility, which consisted of the following members: Lars Dommermuth (Statistics Norway), Øystein Kravdal (University of Oslo/Norwegian Institute of Public Health), Trude Lappegård (University of Oslo) Lena Lundqvist (Statistics Sweden, demographics), Sturla Løkken (Statistics Norway) and Astri Syse (Norwegian Institute of Public Health). 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.

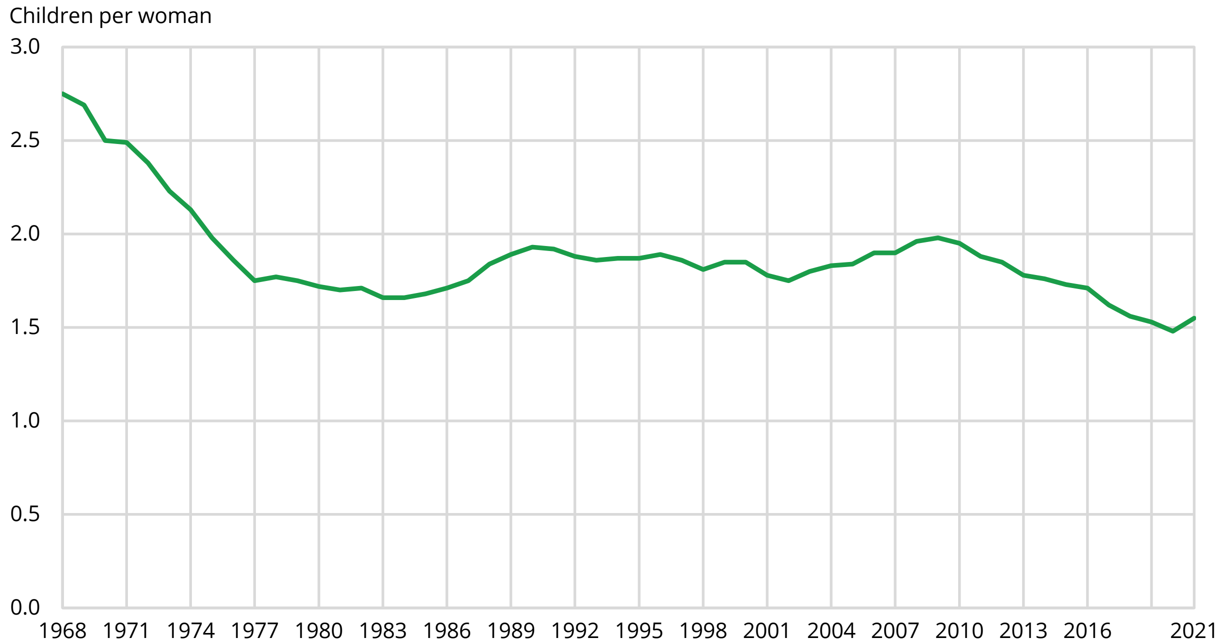
A primary aim of this chapter is to provide a detailed overview of how the fertility assumptions for this year's projections were formed. Currently, Statistics Norway does not use a formal statistical model for fertility (Gleditsch et al. 2021). Instead, we consider observed trends in the TFR over recent years, changes in age at first and higher order births, shifts in cohort fertility (see Box 5.1), as well as differences between immigrant and non-immigrant women in their fertility outcomes. We examine these trends for Norway as well as 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 emphasis placed on the development up to 2060.

5.1. Fertility development in Norway

Since the beginning of the 1970s, TFR (period fertility) in Norway has ranged between approximately 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 in 2009. At that point in time, the fertility level in Norway was the highest the country had witnessed since the 1970s, and among the highest in Europe. However, since 2009, a persistent decline in the TFR has been observed, equivalent to a decline of almost half a child per woman. In 2021, the first increase in TFR in 12 years was registered, from 1.48 in 2020 to 1.55 in 2021. Even so, the birth numbers in the first quarter of 2022 are lower than the years before. This indicates that the increase in TFR in 2021 might have been temporary, and that the TFR for 2022 might be back to record low levels.

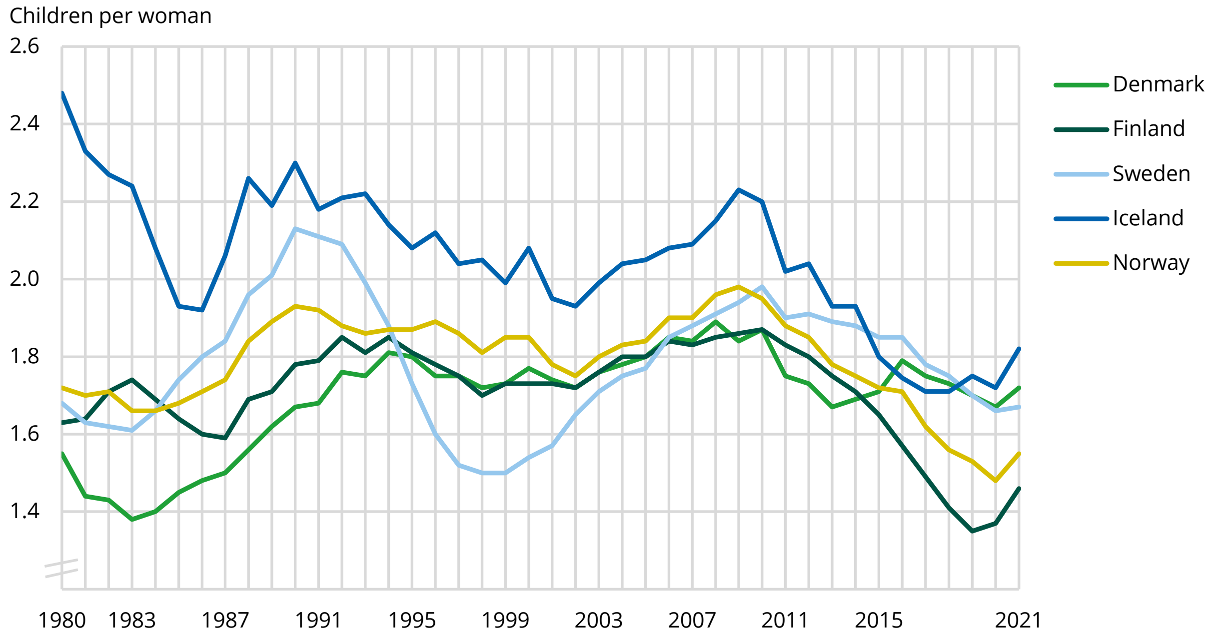
Declining fertility in recent years is not only a Norwegian phenomenon. As Figure 5.2 illustrates, most Nordic countries have seen a fall in fertility in the period 2009-2020. The decline has been greatest in Finland and Iceland, although increases in fertility levels were observed for both countries in 2021. The decline in Finland was large enough to reach a record-low TFR of 1.35 in 2019, with a small increase in 2020 and a larger increase in 2021 to 1.46. The TFR in Denmark and Sweden is somewhat higher, at approximately 1.72 for Denmark and 1.67 for Sweden in 2021. 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 2020 it had risen to 1.5 (Population Reference Bureau 2022). 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 1.5 in 2020 (Eurostat 2022a).

Figure 5.1 Total fertility rate, 1968-2021



Source: Statistics Norway

Figure 5.2 Total fertility rate in the Nordic countries, 1980-2021



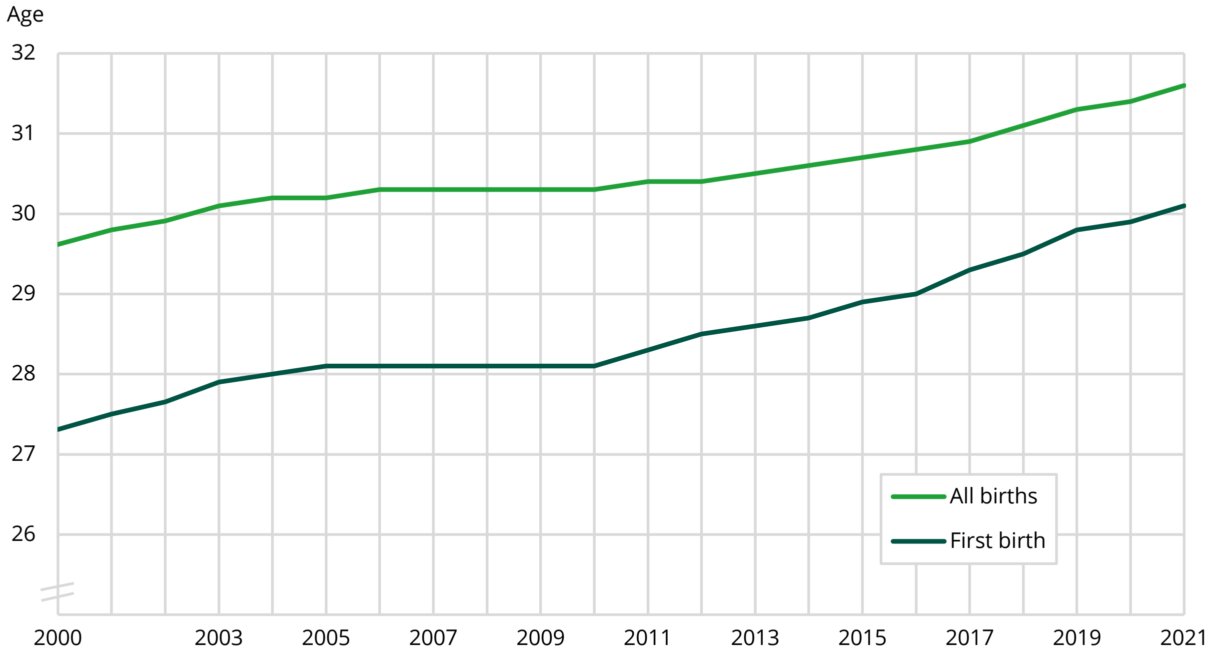
Source: Statistics Norway and the national statistical agency for each Nordic country

The impact of maternal age on fertility

As outlined in Box 5.1, TFR is a summary measure of age-specific period fertility. Thus, TFR is influenced by the ratio of the number of children born to women in the different fertile age groups (between 15-49 years) and the number of women in these age groups. Because TFR summarizes age-specific period fertility rates, it is 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. Moreover, 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

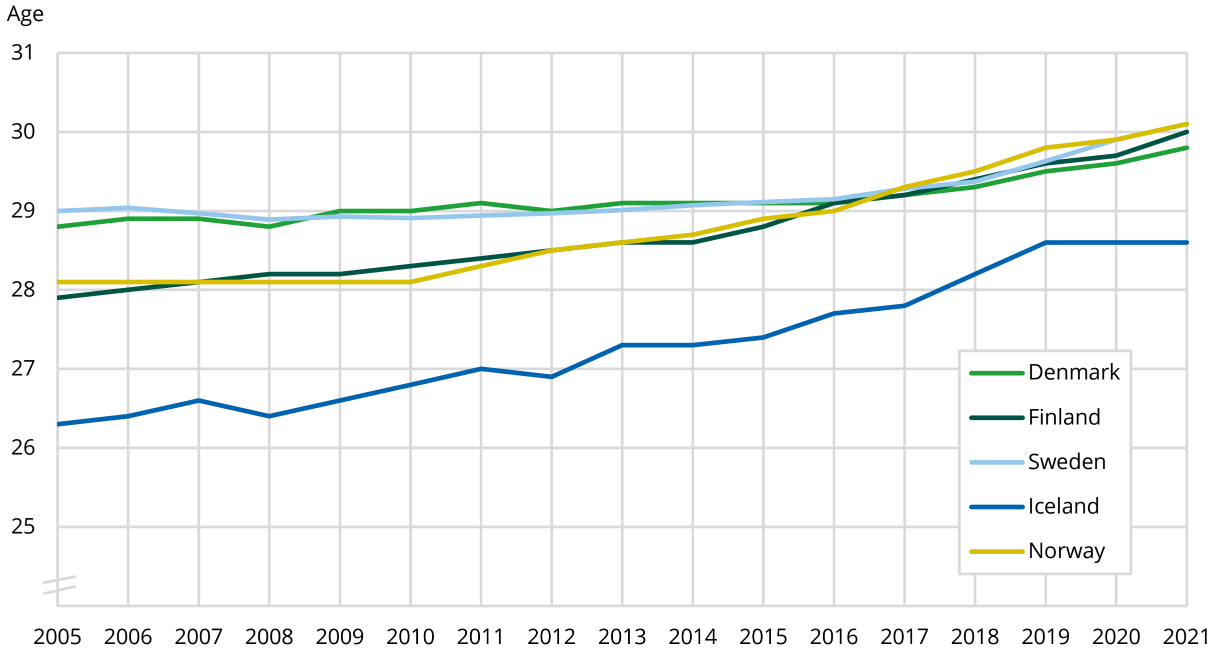
age at birth increased to 31.6 in 2021, from 30.3 in the period 2006-2010 (see Figure 5.3). This is the highest mean age at birth ever registered in Norway. As shown in Figure 5.3, the most pronounced increase is observed for first births, where it has increased from 28.1 years in 2010 to more than 30 years in 2021. Just three decades ago, the average age of women at first birth was approximately 25.

Figure 5.3 Mean age of women at first birth and all births, 2000-2021



Source: Statistics Norway

Figure 5.4 Mean age of women at first birth in the Nordic countries, 2005-2021



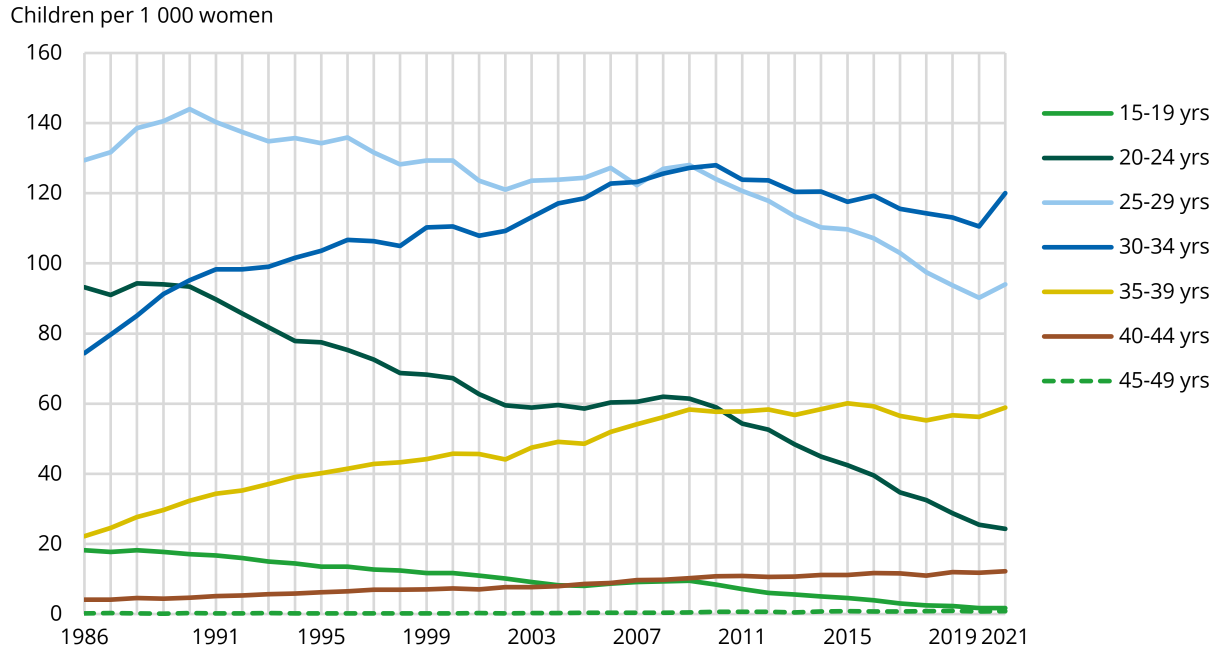
Source: Statistics Norway and the national statistical agency for each Nordic country

The trend towards a higher mean age at first birth for women is also present in the other Nordic countries (Figure 5.4). While Sweden and Denmark had the highest mean ages at first birth in the years 2005-2015, increases in Norway and Finland mean that all four countries had relatively similar mean ages, at around 30 years, in 2021. While Iceland had the lowest mean age of women at first birth among the Nordic countries in 2021, at 28.6 years, it has seen the largest absolute increase over the period since 2005.

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, fertility in Norway has generally declined among women aged 15-29 while having generally increased among women in older age groups. These changing trends show that there has been a shift in the age groups that contribute most to fertility in Norway. Until 2009, women aged 25-29 had the highest ASFRs. Since 2009, women aged 30-34 have contributed most. Accompanying this has been a steady decrease in the contribution of women aged 20-24 years, with women aged 35-39 years having had higher birth rates for the last decade.

Despite an increase in TFR and the total number of births, the average age at first birth still increased in 2021. Age at first birth, the spacing between children, and the number of children in different parities all affect the TFR. The increase in TFR in 2021 will be a temporary trend if postponement continues and the final number of children each woman has continues to decline. Birth numbers for the first quarter of 2022 are indeed lower than the years before and so it seems likely that lower fertility levels will again be observed in the very near future.

Figure 5.5 Children per 1 000 women, by age group, 1986-2021

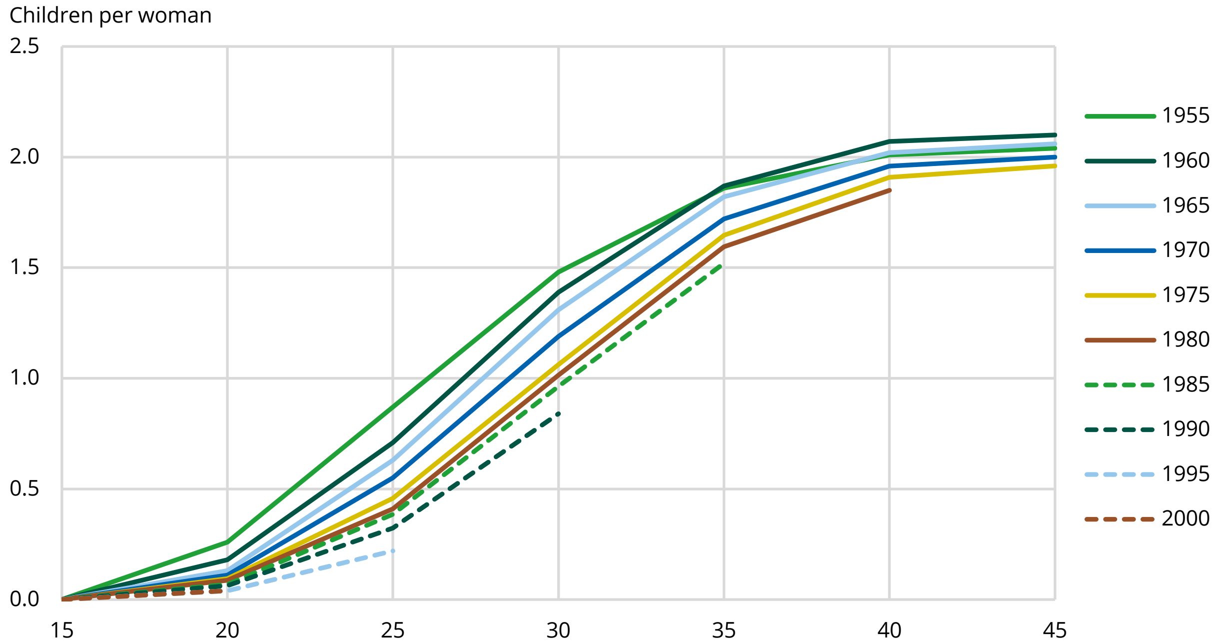


Source: Statistics Norway

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. Cohort fertility at younger ages may also be useful in providing some idea of the degree to which women are choosing to delay fertility. Figure 5.6 illustrates the average number of children born to selected cohorts of women (1955-1995) over their life course. Although four of these selected cohorts (stippled lines) have not yet finished their childbearing careers, the figure illustrates differences between younger and older cohorts. 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 the trends suggest that completed cohort fertility will be lower in the future.

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



Source: Statistics Norway

Table 5.1 provides more detailed information on cohort fertility at different ages. The general trend is a decline in 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 younger birth cohorts.[10] A pattern of postponement is also visible in Table 5.1. If we compare cohort fertility at age 20 for the 1940 and 1975 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 1975 birth cohort (0.09). 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 1975 birth cohort has a completed cohort fertility of 1.96. Despite this clear evidence of postponement, completed cohort fertility has steadily declined: Women born in 1975, who turned 45 in 2020, had on average 1.96 children, while those born in 1965, for instance, had on average 2.06 children.

Table 5.2 displays the parity percentages for female birth cohorts. It is apparent that the fall in completed cohort fertility is, to a large extent, due to a decrease in women having three or more children and an increase in childlessness. Indeed, childlessness has increased from 9 percent among the 1945 birth cohort to over 14 percent for the 1976 birth cohort. The two-child norm has remained consistent since the 1945 birth cohort, with around 4 out of 10 women having two children.

[10] 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.

Table 5.1 Cohort fertility of women at exact ages, selected cohorts, 1935-2000

Year of birth	20	25	30	35	40	45	Completed
1935	0.20	1.04	1.86	2.29	2.41	2.42	2.42
1940	0.24	1.14	1.92	2.26	2.34	2.35	2.35
1945	0.26	1.16	1.82	2.09	2.18	2.19	2.19
1950	0.28	1.06	1.65	1.95	2.06	2.08	2.08
1955	0.26	0.87	1.48	1.86	2.01	2.04	2.04
1960	0.18	0.71	1.39	1.87	2.07	2.10	2.10
1965	0.13	0.63	1.31	1.82	2.02	2.06	2.06
1970	0.11	0.55	1.19	1.72	1.96	2.00	2.00
1975	0.09	0.46	1.06	1.65	1.91	1.96	1.96
1980	0.09	0.40	1.02	1.60	1.85		
1985	0.07	0.39	0.96	1.52			
1990	0.06	0.32	0.84				
1995	0.04	0.22					
2000	0.04						

Source: Statistics Norway

Table 5.2 Parity percentages for female birth cohorts and completed cohort fertility, selected cohorts, 1935-1976

Year of birth	0 children	1 child	2 children	3 children	4+ children	Average 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	13.3	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	39.4	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
1975	14.2	15.3	41.7	21.8	7.0	1.96
1976	14.4	15.3	41.8	21.2	7.3	1.95

Source: Statistics Norway

Childlessness

The gradual trend towards increasing childlessness among women has been evident for many years. 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 the highest childlessness with 19.5 percent in the 1976 cohort, while in recent years the trends in Sweden have started to decline again (Andersson 2009, Jalovaara et al. 2019, Hellstrand et al. 2021).

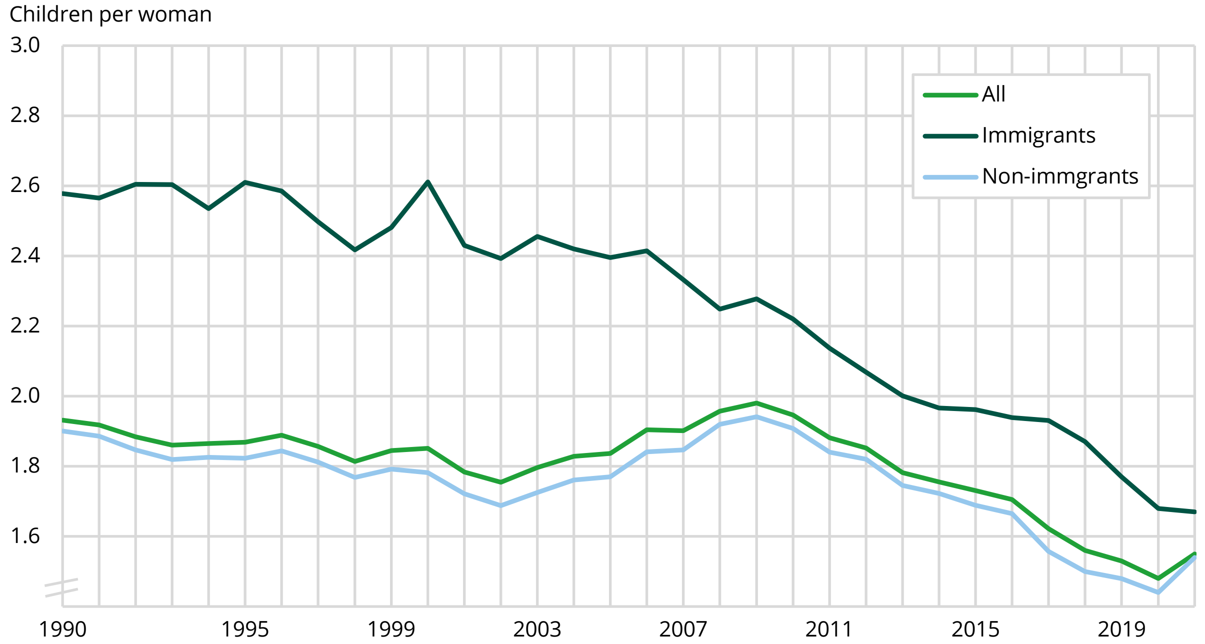
To get an idea about future childlessness, it can be useful to examine changes in patterns among women who have not yet completed their fertile years. The share of childless women by age 35 in Norway has seen a gradual increase from less than 20 percent among women born in 1970, to 25 percent among women born in 1986. Although a share of women aged 35 may want and will have children in the future, it is still likely that the proportion of childless women will continue to increase. As fecundity (i.e. the ability to conceive and carry a child to term) decreases from a certain age, not all fertility intentions will be realised.

The impact of immigration on fertility

Figure 5.7 displays the TFR of immigrant women, non-immigrant women and all residents in Norway for the period 1990-2021. Despite a stronger decrease in fertility levels among immigrant women compared to non-immigrant women over the past years, levels of fertility among immigrants remain higher than those of the rest of the population. While an increase in the total TFR and among non-immigrant women was observed in 2021, the TFR of immigrant women continued to decline. Overall, the impact of immigrants childbearing behaviour on TFR in Norway is minor and has been stable for many years. The TFR for non-immigrant women in 2021 was 1.54, while the TFR for the entire resident population was 1.55. Thus, the childbearing behaviour of immigrant women only increased the TFR in Norway by 0.01. In the period 1990-2020, the impact of immigrants on fertility has ranged between 0.03 and 0.07.

Even though the impact of immigrant women on the overall level of the TFR is rather small, immigrants in Norway have a larger relative share of women in their prime childbearing ages. Thus, immigrant women do contribute significantly to the total number of births. In 2021, around 26 percent of all new-borns had an immigrant mother.

Figure 5.7 Total fertility rate by immigrant background, 1990-2021



Source: Statistics Norway

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):

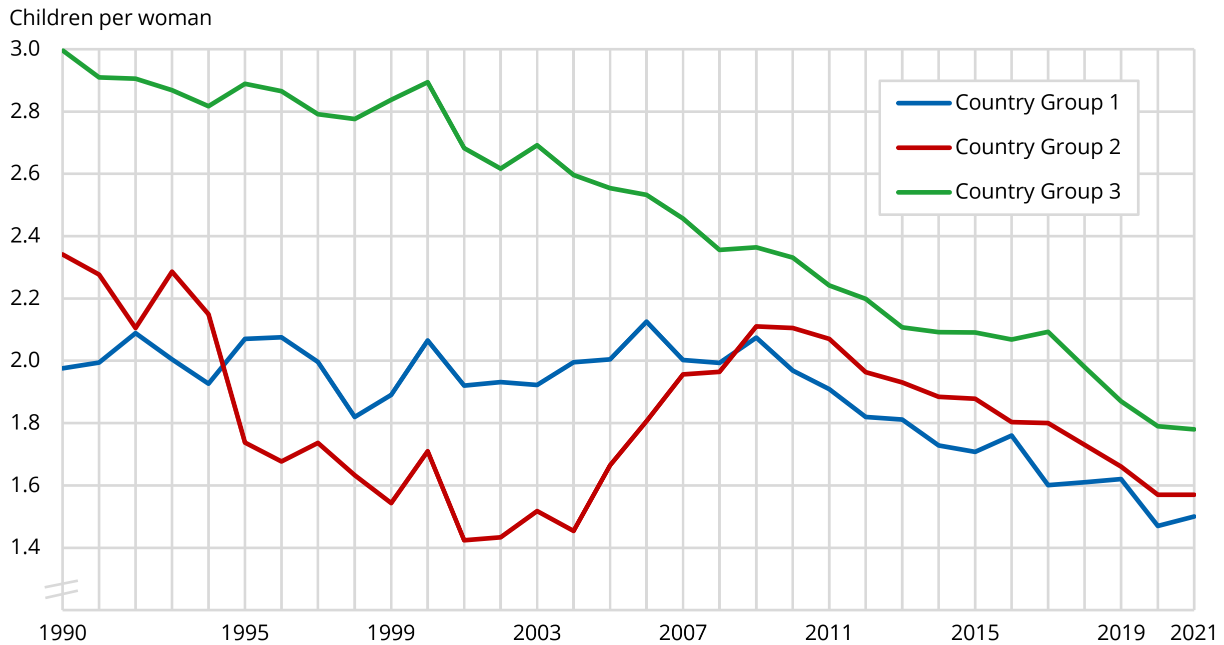
Country Group 1: Western Europe, the US, Canada, Australia and New Zealand.

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).

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 for the period from 1990-2021. Immigrant women from Country Group 1 had a relatively stable fertility level of approximately two children until 2009 and, in line with the TFR for Norwegian-born, their TFR declined thereafter, before increasing slightly in 2021. Immigrant women from Country Group 2 had an average TFR of 1.8 over the period, although large fluctuations (between 1.4 and 2.4) are visible. The fertility trends of this group appear to be closely linked to the immigration patterns associated with EU accession. The rates were in relatively sharp decline prior to EU accession, which began in 2004, before they then sharply increased, peaking at around 2.1 children per woman in 2009. Since 2009, the TFR of Country Group 2 has declined again. While immigrant women from Country Group 3 have the highest TFR, we have witnessed a strong and persistent decline for this group throughout the period, from a TFR of 3.0 in 1990 to a TFR of 1.78 in 2021.

Figure 5.8 Total fertility rate of immigrant women by country group, 1990-2021



Source: Statistics Norway

5.2. Assumptions of future fertility patterns in Norway

The following section will provide a more detailed discussion on the reasoning behind the assumptions when determining future fertility development in the 2022 national population projections. With 2021 the exception, we have seen a consistent decline in period fertility since 2009. Fertility has declined among both immigrant and non-immigrant women, and among almost all but the oldest ages. To form assumptions for fertility, we must consider whether this downward trend will continue, stabilise and/or reverse in the coming years. To assess these possibilities, we utilise the widely used framework of Easterlin and Crimmins (1985) who distinguish 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 to have child(ren). The demand for children can be influenced by purchasing power, expected costs of having children (both direct costs such as food and clothing, and indirect costs such as a loss of income if one parent stays home to care for children), preferences of having children compared to investing resources on other things, as well as norms related to the ideal number of children. Below is a brief discussion of changes in supply, regulation costs and demand that may have occurred in previous years. A more detailed and nuanced overview of the Norwegian fertility development, from a theoretical perspective, is provided by Kravdal (2016).

Supply

As the biological ability to have children decreases with age, so too does supply. Thus, the postponement of childbirth can result in an increasing proportion of women being unable to conceive or bring to term the children they want at the time in their life when they wish to have them.[11] With that said, modern medical treatment makes it possible to assist women who struggle to reach their fertility goals. Recent figures suggest 3-4 percent of Norwegian children have been born with the help of assisted reproductive technology (Norwegian Biotechnology Advisory Board 2019). Although this assistance is very important for the families who utilize it, the contribution to the overall number of children born in Norway is still small. 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 rate at below 10 abortions per 1 000 women (NIPH 2022a).[12] The numbers are declining for all age groups. In summary, regulation costs have been stable, possibly declining, and therefore we consider it unlikely that future changes in regulation costs will be of a magnitude great enough to impact markedly on future fertility.

Demand

The demand for children can be influenced by purchasing power, direct and indirect costs of raising children, preferences and norms. Higher 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.

According to Kravdal (2002), fertility levels in Norway have historically been little affected by the purchasing power of individuals. However, on the individual level both income (Hart 2015, Hart et al. 2015) and employment (Dommermuth & Lappegård 2017) are associated with childbearing. Paid parental leave is directly linked to previous labour market participation. Previous research indicates that the transition to first birth is particularly sensitive to individual economic insecurity and more general economic uncertainty.

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 subsidised public day-care and paid parental leave. A recently published systematic review concludes that childcare expansions may increase completed fertility, while cash transfers mainly have a temporary effect (Bergsvik et al. 2021). In line with this, the relatively high fertility rate observed in Norway last decade has been linked to the availability of subsidised day care (Rindfuss et al. 2010). In addition, the paid parental leave scheme in Norway facilitates the combination of work and family life. The existence of these comparatively generous family policies does not fit with the considerable decline in the TFR in recent years. However, the positive impact of such welfare measures on fertility is mainly related to their introduction, not their maintenance. They still have an overall positive, or at least stabilizing impact, on fertility rates in Norway but may not hinder a decline in fertility due experienced or perceived economic insecurity (Comolli et al. 2021, Vignoli et al. 2022). In Norway, children already have a right to day-care at a subsidised 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). As such, it can be assumed that welfare schemes that facilitate the combination of work and

[11] 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.
[12] We use figures from 2019 as figures from 2020 and 2021 may be affected by restrictions and lockdowns pertaining to the COVID-19 pandemic. In 2021, the rate fell to nine abortions per 1 000 women.

family will remain at least at current levels in the future, and there may be room for expansions of the policies if fertility continues to decline.

The presence and location of wider family networks (i.e. parents and siblings) has also been noted as an important factor in facilitating access to cost-free and reliable childcare, with recent research demonstrating a positive effect of proximity to non-resident family on transitions to motherhood in Norway (Thomas and Dommermuth 2021).

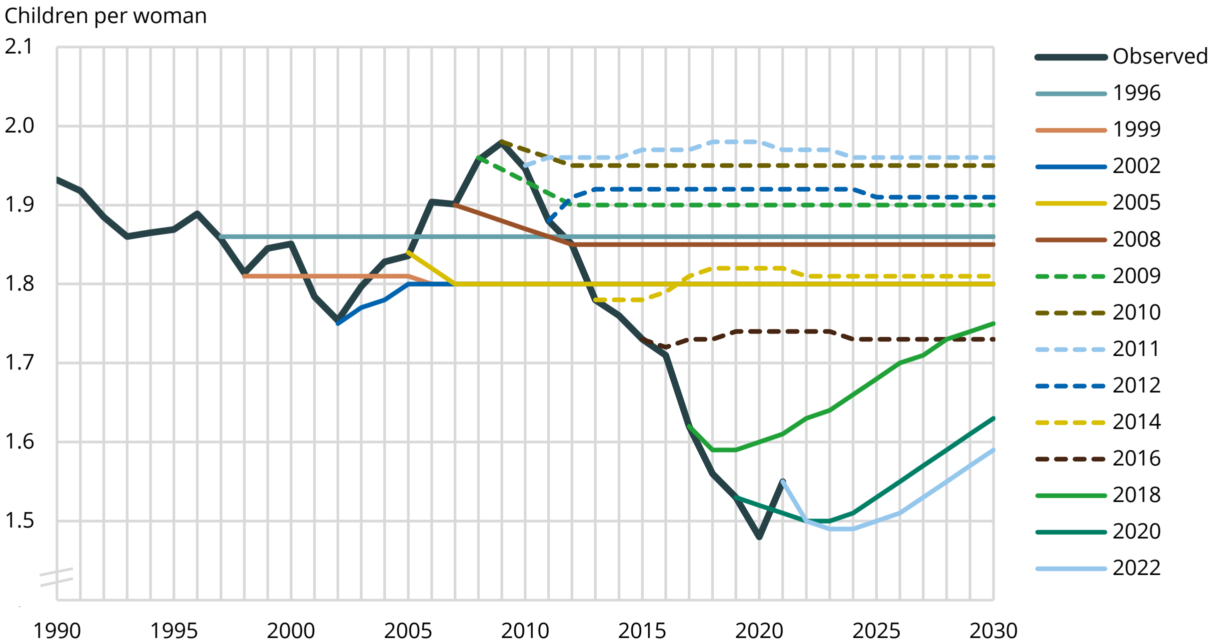
COVID-19 and fertility development in Norway

When the COVID-19 pandemic emerged, there were speculations as to whether the associated lockdowns might lead to a 'baby boom' or 'baby bust'. Research indicates that a health crisis such as COVID-19, especially when coupled with increased mortality rates, tends to reduce fertility levels, at least in the short-term (Mamelund 2004). A comparative analysis of different health crises and other disruptive shocks shows a decline in birth rates nine months after such events (Richmond and Roehner 2018). The financial and employment uncertainty that the first period of the pandemic heralded has also been noted as a potential contributing factor to a possible decline in fertility on a short-term basis (Sobotka et al. 2011). Yet, in Norway, TFR increased from 1.48 in 2020 to 1.55 in 2021, the first increase in 12 years. As such, the data suggest a potential positive effect of the pandemic on fertility in Norway. As noted above, data for the first quarter of 2022 suggest the number of births has since fallen again, to a level even lower than before the pandemic. As such, any pandemic-related effects seem to have been short lived.

The accuracy of past fertility projections

Figure 5.9 evaluates the degree to which past population projections have accurately portrayed realised fertility. Generally, it appears that there has been a strong tendency to project fertility at levels similar to those observed the year prior to the production of the projections. 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. Although the 2020 projections assumed a lower TFR in 2020 than observed in 2019, the actual TFR for 2020 was even lower than projected. The subsequent upswing in the registered TFR meant the 2020 projections then underestimated TFR to an equivalent degree. Still, in the short term, the 2020 projections appear to have performed reasonably well in terms of avoiding consecutive under- or overestimation. Birth numbers for the first quarter of 2022 (the most recent at the time of writing, early May 2022) suggest that fertility levels are again lower than pre-2021 levels, while age at first birth continued to increase in 2021, which indicates that one of the main drivers of the decline since 2009, namely postponement, remained. Taken together, the upswing in TFR in 2021 appears to be a short-lived pattern, mainly related to the specific situation experienced during the COVID-19 pandemic. As such, the pattern for 2022 is likely to move back towards the direction of the 2020 projected estimate for that year.

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



Source: Statistics Norway

Box 5.3 Changes from the last projection

In the main alternative of the 2020 projections, the long-term fertility level was set at approximately 1.74 children per woman. The long-term level was based on the assumption that the preference to have more than two children has declined (as suggested by the patterns observed in Table 5.2). For the short term, the assumption was that fertility would continue to decline before then increasing (from 2023) towards its long-term level (1.74). The number of births was 1 600 lower than projected in 2020 and 1 600 higher than projected in 2021. The 2020 projections assumed a TFR of 1.52 in 2020 and 1.51 in 2021, whereas the registered TFR fell to 1.48 in 2020 before recovering to 1.55 in 2021.

As fertility is the only component for which we do not employ a model in our assumption work, we undertook a survey to identify the different approaches used to project fertility among statistical agencies in Europe and to provide an assessment of the different approaches according to the producers themselves (Gleditsch et al. 2021). This survey revealed that most agencies combine formal models with expert opinion. We are currently examining the potential of a model-based approach for future projection rounds at Statistics Norway.

For this year's projections, our medium assumption projects a continued decline in fertility to 2025, before a gradual increase occurs followed by a stabilisation from 2035 onwards. We assume that fertility will be lower than in the last projection round, ending up at approximately 1.71 children per woman. This long run TFR is around 0.03 children per women lower than the long run TFR from the 2020 projections. Compared to the main alternative in the last projections, the 2022 main alternative projects approximately 1 200 fewer births in 2060. Figure 5.14 compares the overall projected TFRs from the 2020 and 2022 projections in the main, high and low fertility alternatives.

Fertility assumptions

The potential changes in preferences, such as fewer women opting to have three or more children and a slight increase in childlessness, coupled with a tendency to postpone childbirths among the younger cohorts, seems to indicate a continued decline in fertility in the short term, and as such this is what we have assumed for this year's fertility projections.

In the longer run, Norway is likely to continue to have generous work-family policies, while the two-child norm is strong and is expected to remain so (see Cools and Strøm 2020). This indicates that future TFR in Norway will gradually increase from the historically low levels observed in recent years, as reflected in our long-run TFR of 1.71.

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.

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 decline in TFR seen in the years after 2009 has coincided with an increase in maternal age, especially at first birth. When examining patterns of fertility decline, there has been a sharper decline in fertility among younger women, often in education. The combination of participating in higher education and lower fertility among female students is likely to contribute to the postponement of fertility. At the same time, there is a positive association between education and fertility in Norway, meaning that completed fertility is likely to remain relatively high given that most women go on to obtain a higher education in Norway. The increase in maternal age at first birth is also unlikely to continue at the same pace in the future, at least if the two-child norm is to persist. As a consequence, TFR will begin to increase again.

Fertility in the long run

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 1.95 children per woman for the cohort born in 1976. The changes seen in cohort fertility over the past decades are, to a large extent, due to the decrease in the number of women having three or more children and an increase in the number of women having no children.

At the same time, the norm of having two children continues to be strong in Norway (Table 5.2) and research indicates that this is one of the reasons for why cohort 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 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 an increase in fertility levels in the long run. Even though trends in cohort fertility indicate that it is unlikely that women in Norway will reach levels of more than two children per woman, we assume that the fertility will increase at a slow rate before stabilizing at a higher level than we see today. The reasoning behind this is that 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 alternative, we project a future TFR of 1.71. This figure is clearly higher than today's period fertility of 1.55, but at the same time clearly lower than the most recent completed cohort fertility of 1.95. This assumption is due to the changes seen in fertility over the past decade, resulting from the increase in maternal age, as well as the expectation that women will, to some extent, 'recover' the births they have postponed until now.

Box 5.4 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 are calculated according to observed data for the last registered year (2021 in this projection round).

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 wherein the last year of available data counts the most. We also make assumptions about the proportion of immigrant women who will have children with men who are also 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.

Since the same factor is used for all women, one might assume that the differences in fertility between the immigrant women from each of the three country groups and the remaining women would be constant throughout the projection period. They are not. 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 also for how fertility will develop among immigrant women overall. As such, the projected total fertility rate will not be constant as the composition of the different groups of women will change over time.

5.3. Consequences of the assumptions for future fertility

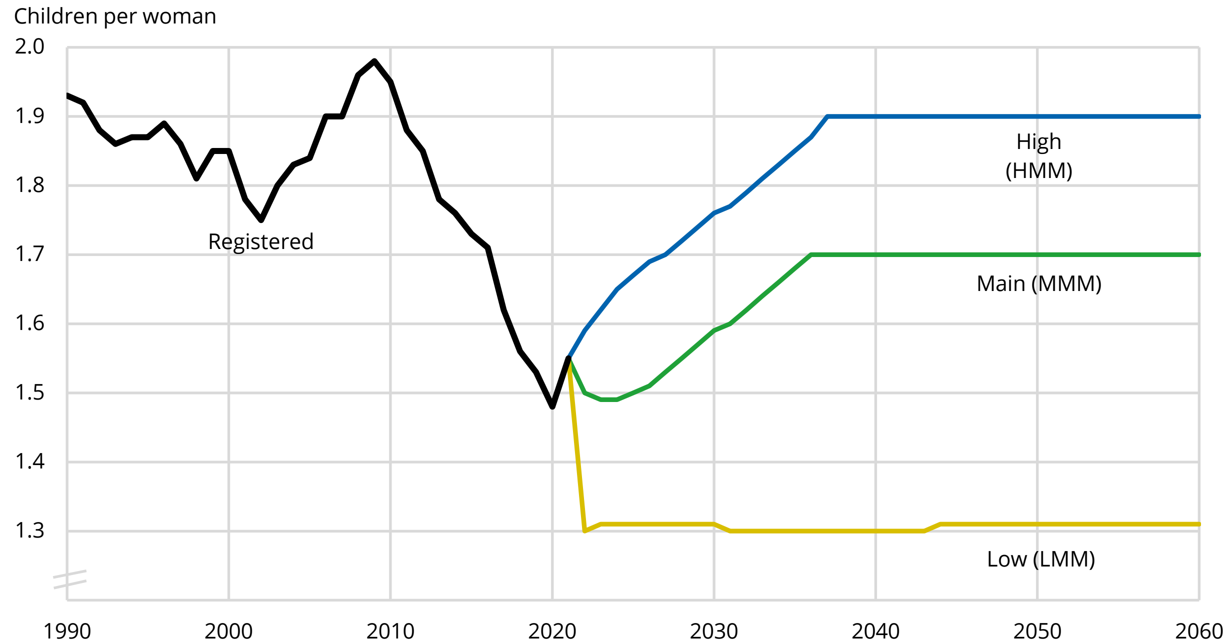
In this section we will summarize the consequences of this year's assumptions for the future level of fertility, total number of births and the population development. Figure 5.10 gives an overview of registered TFR for all resident women for the years 1990-2021 and projected TFR up to 2060, according to the main (MMM), low (LMM) and high (HMM) fertility alternatives. As mentioned in Box 5.4, the same percentage of change in fertility is used for all 16 groups of 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 the immigration assumptions).

For the main alterative, we assume that the TFR for non-immigrant women will decrease over the next couple of years to approximately 1.47 children per woman in 2025. For all women, this results in a TFR of approximately 1.50. After the initial decline, the TFR in the main alternative increases to 1.70 by 2036, after which it remains constant at approximately 1.70-1.71 up to 2100. For non-immigrant women, this corresponds to a level of approximately 1.69 children per woman from 2036 onwards. This is significantly lower compared to the cohorts of women who have recently completed their childbearing years, but we assume that postponed childbirths and changing preferences will contribute to this development.

In the low fertility alternative, we set the TFR constant at 1.30 for non-immigrant women, which corresponds to a TFR of 1.31 for all women. This approach is the same as was used in the 2020 projection round. A TFR of 1.3 is 0.05 lower than the lowest TFR observed for Finland (1.35 in 2019). Finland has the lowest fertility among the Nordic countries (with a relatively similar population structure and welfare system) and has also had a lower TFR than Norway almost every year since the 1960s.

In the high fertility alternative, we project an increase from the current TFR for non-immigrant women (1.53) up to a TFR of 1.89 in 2037, after which it remains constant. This corresponds to a TFR of approximately 1.90 for all women in the long run. The combination of 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 over how these complex trends may develop, and thus the high alternative is set at this relatively high long-term level.

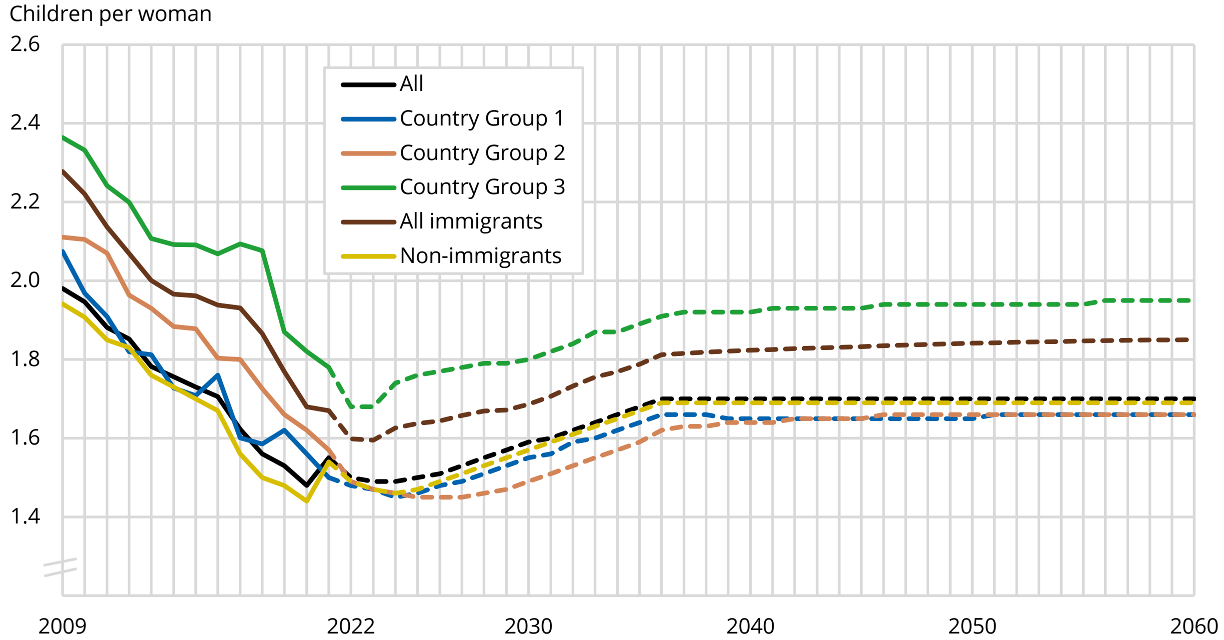
Figure 5.10 Total fertility rate, registered 1990-2021 and projected 2022-2060, in three alternatives



Source: Statistics Norway

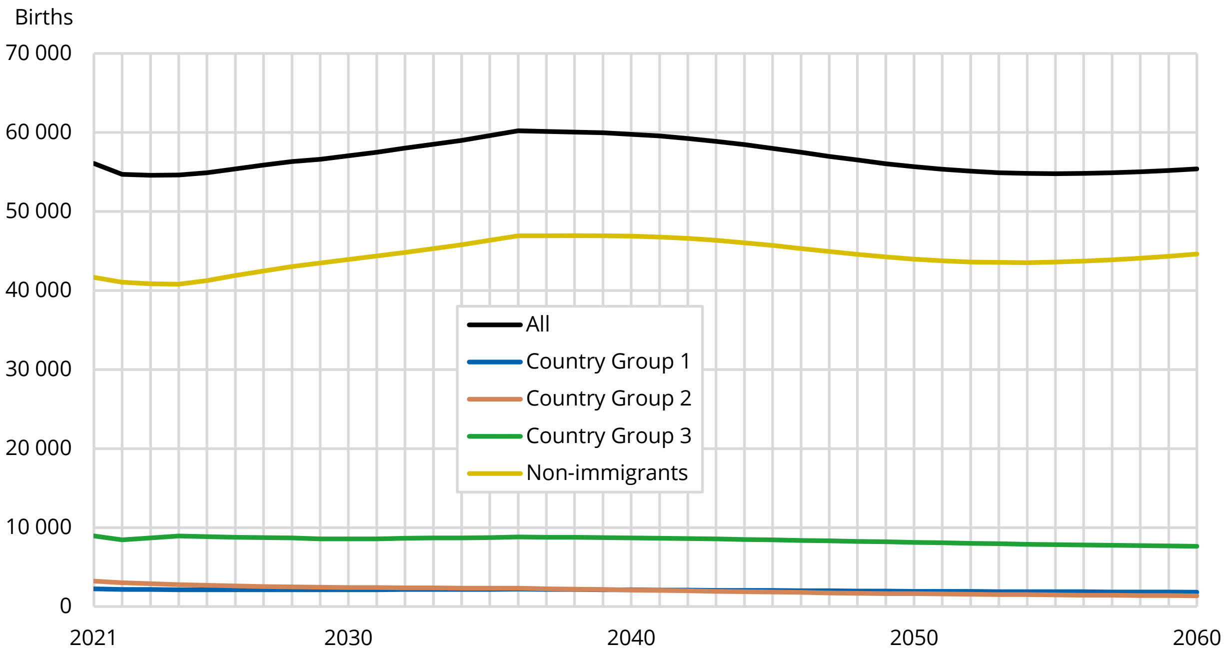
Figure 5.11 illustrates the registered and projected (MMM) TFR for all women, all non-immigrant women, all immigrant women, as well as for separate immigrant country groups for the years 2009-2060. For the first couple of years of the projection period, the fertility level will decrease for all three country groups. The TFRs for Country Groups 2 and 3 decrease by 0.1 in the short-term, before all country groups recover. By 2060, Country Groups 1 and 2 are projected to have a TFR of 1.66, while for Country Group 3 the TFR is projected to reach 1.95. In the long run, the fertility rate for all-immigrant women is approximately 1.85, while for Norwegian-born women the long-term rate is approximately 1.70.

Figure 5.11 Total fertility rate for different groups of women, registered 2009-2021 and projected 2022-2060, main alternative (MMM)[1]



[1] Dashed lines represent the main alternative (MMM) projection.
Source: Statistics Norway

Figure 5.12 Number of births to different groups of women, registered 2021 and projected 2022-2060, main alternative (MMM)



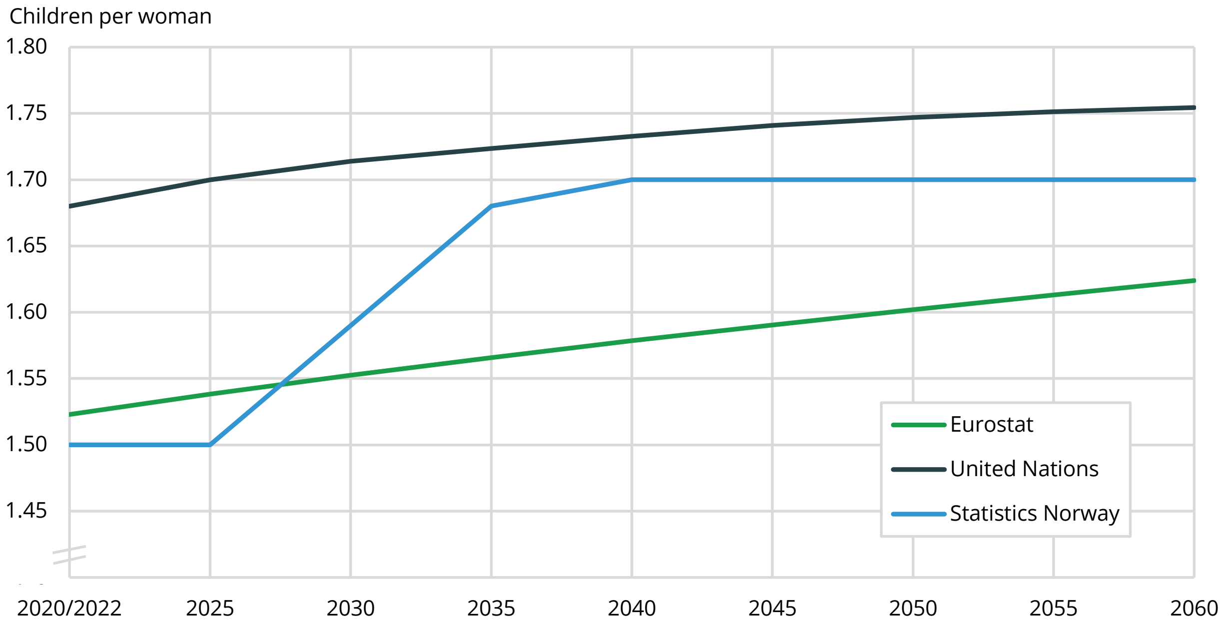
Source: Statistics Norway

Figure 5.12 illustrates the development in the main alternative (MMM) in the number of births. 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 ages (15-49 years). According to our main alternative, the number of births to all women in Norway will increase from around 56 000 in 2021 to approximately 60 000 in 2040, before a decrease is observed to around 55 000 in 2060. Non-immigrant women will clearly contribute most births (between 40 000 and 50 000 annually), with immigrant women from Country Group 3 contributing the next highest amount, though always below 10 000 annually up to 2060.

5.4. Projected fertility from an international perspective

Both Eurostat (2020) and the United Nations (2019) publish fertility projections for Norway. The most recent United Nations projections (as of early May 2022) published estimates for five-year periods, while Eurostat and Statistics Norway publish estimates for one-year periods. Whereas 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 main/medium alternatives for Norway produced by Statistics Norway, Eurostat and 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 in the long run, 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 1.71. 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 1.71, respectively.

Figure 5.13 A comparison of medium fertility assumptions for Norway made by the United Nations, Eurostat and Statistics Norway, 2020-2060[1]

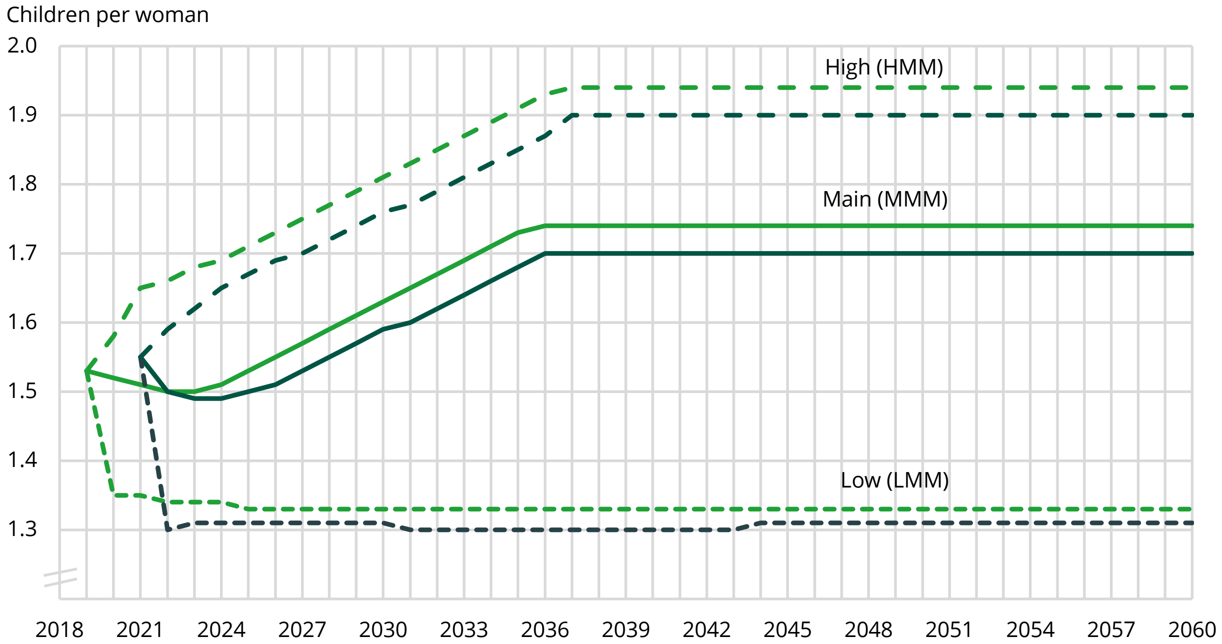


[1] United Nations and Eurostat projections are shown for the period 2020-2060. Statistics Norway projections are shown for the period 2022-2060.
Source: United Nations, Eurostat and Statistics Norway

5.5. Changes in the fertility assumptions from the last projection

As shown in Figure 5.14, the main, low and high alternatives are slightly lower in the 2022 projections than they were in the 2020 projections. This is partly due to lower assumed fertility for Norwegian-born women, but also due to a smaller contribution of immigrant women to the overall TFR. The smaller contribution of immigrant women to the overall TFR results from the fact that updated figures were used in the estimation of ASFRs and because the 2022 projections have slightly lower long-run immigration than was projected in the 2020 projection round. The general trajectories of the TFR for the respective alternatives remain very similar.

Figure 5.14 A comparison of fertility assumptions in the 2020 (green) and 2022 (black) projections in three alternatives, 2020-2060



Source: Statistics Norway

5.6. Summary

Period fertility (measured by the TFR) in Norway has ranged from 1.6 to 2.0 for almost 40 years. From a recent peak level of 1.98 in 2009, TFR declined to a historic low of 1.48 in 2020. An increase to 1.55 was recorded in 2021. The decline in fertility is mainly due to two factors: First, women have been postponing births and, second, 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 years at approximately two children per woman. However, younger cohorts get their first child later and thus will have to recover these births more quickly than has been the case previously if they are to end up with similarly high levels of competed fertility 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. TFR declined among immigrant women even in 2021, when the rest of the population witnessed a brief increase. 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 to have longer durations of stay. As such, the contribution of immigrant women's fertility to the overall TFR 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. The current fertility projections are based on the historical development of fertility and in our long run main alternative we have projected a TFR of approximately 1.7 children per woman. In our low fertility alternative, we project that the TFR will decline from its current level to approximately 1.3 children per woman, while our high fertility alternative assumes a long-run TFR of approximately 1.9 children per woman.

6. Life expectancy and mortality – Assumptions and results

Michael J. Thomas and Dinh Q. Pham

Since 1990, life expectancy at birth has risen by 8.1 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 7.3 years – from 81.6 years in 2021 to 88.9 years in 2060. For women, an increase of around 6.2 years is assumed, from 84.7 in 2021 to 90.9 in 2060. In the high alternative for life expectancy, the increase is clearly stronger – 9.4 years for men and 8.0 years for women – while the low alternative assumes a weaker growth of 4.8 years for men and around 4.1 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 number and share of older persons is expected to increase considerably, with strong growth even among the very oldest old (i.e. 90+). 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 period. Those aged 70 and over represent 13 percent of the population today, whereas by 2060 we project this share to have risen 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 about future mortality. Following the description of observed trends, we detail our mortality assumptions before describing and discussing the results of the mortality projections.

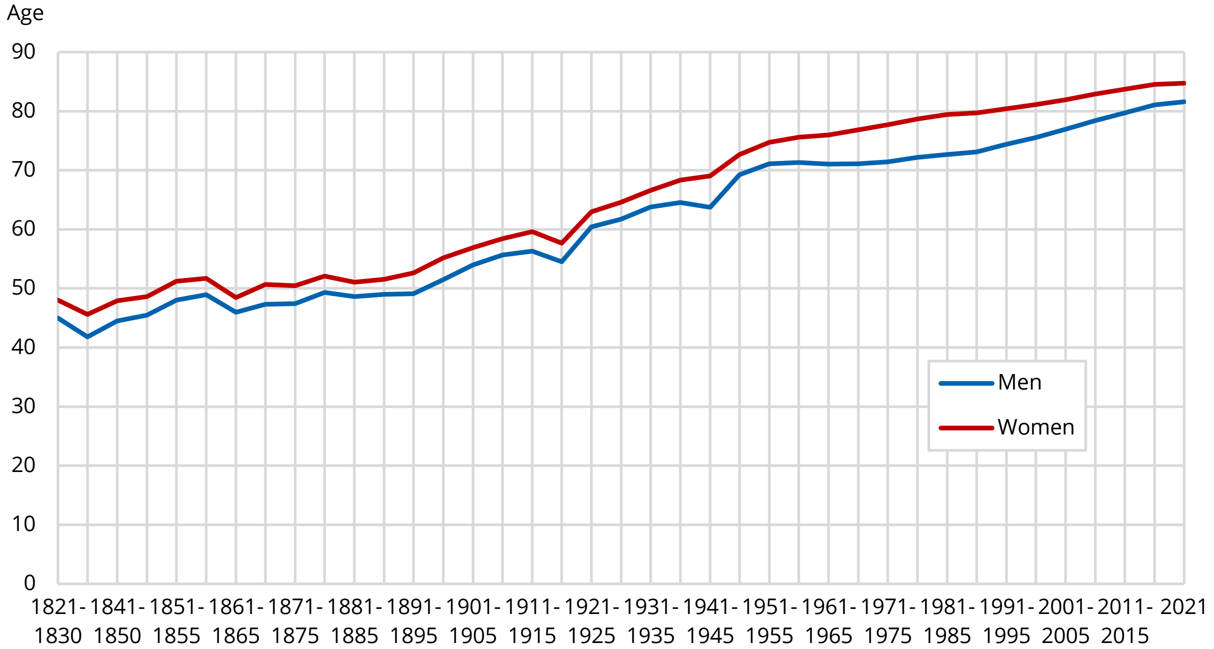
6.1. Trends in mortality and life expectancy

Period life expectancy and sex differences

Period life expectancy at birth (see Box 6.1) is now the highest it has ever been for men in Norway, with data for 2021 revealing life expectancy at birth to be 81.6. This represents an increase of 0.55 years compared to the average for the period 2016-2020 (see Figure 6.1). For women, life expectancy at birth was 84.7 in 2021. This represents an increase of 0.23 years compared to the average for the period 2016-2020, although life expectancy at birth for women was 0.16 years higher in 2020 than in 2021.

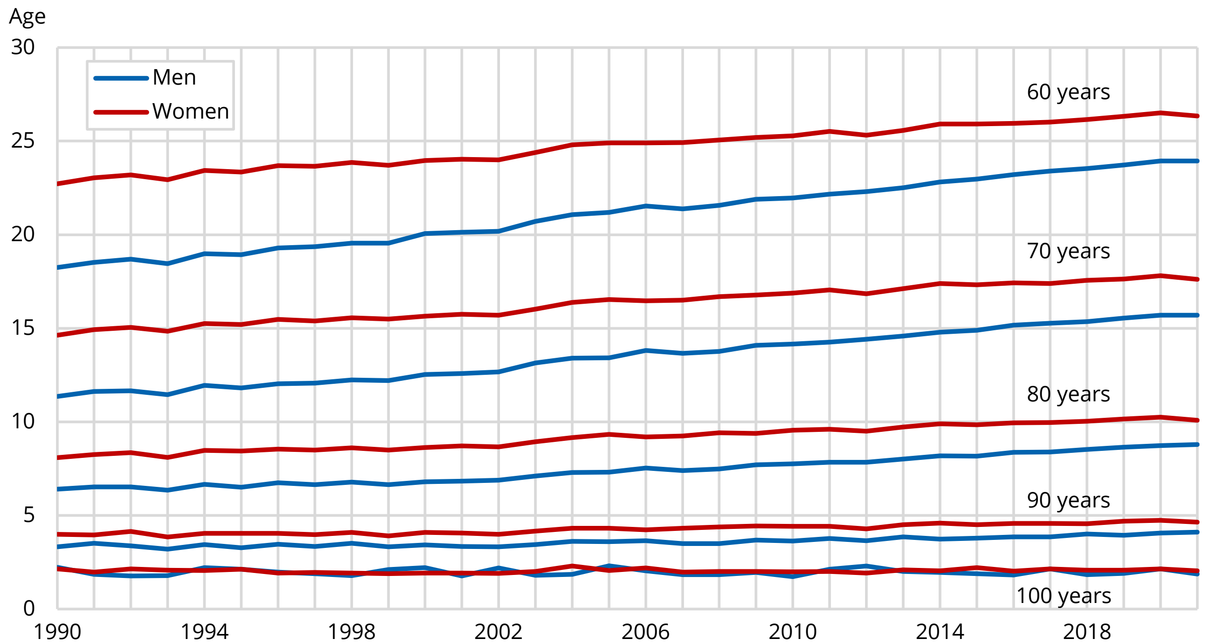
The life expectancy differences between men and women have been decreasing in recent decades. In 2021, the difference in period life expectancy at birth was 3.1 years. As Figure 6.1 shows, this difference is the smallest we have observed since the early 1930s. In 1990, the difference between men and women stood at 6.4 years. Nevertheless, there still exists a relatively large gap between the sexes in terms of life expectancy. In 2021, new-born boys had an average life expectancy at birth equivalent to that of new-born girls in 2002, that is, almost two decades earlier.

Figure 6.1 Life expectancy at birth for men and women, 1821-2021[1]



[1] Life expectancy at birth is presented in 10-year groupings for 1821-1850, five-year groupings for 1851-2020.
Source: Statistics Norway

Figure 6.2 Life expectancy at selected ages for men (blue) and women (red), 1990-2021

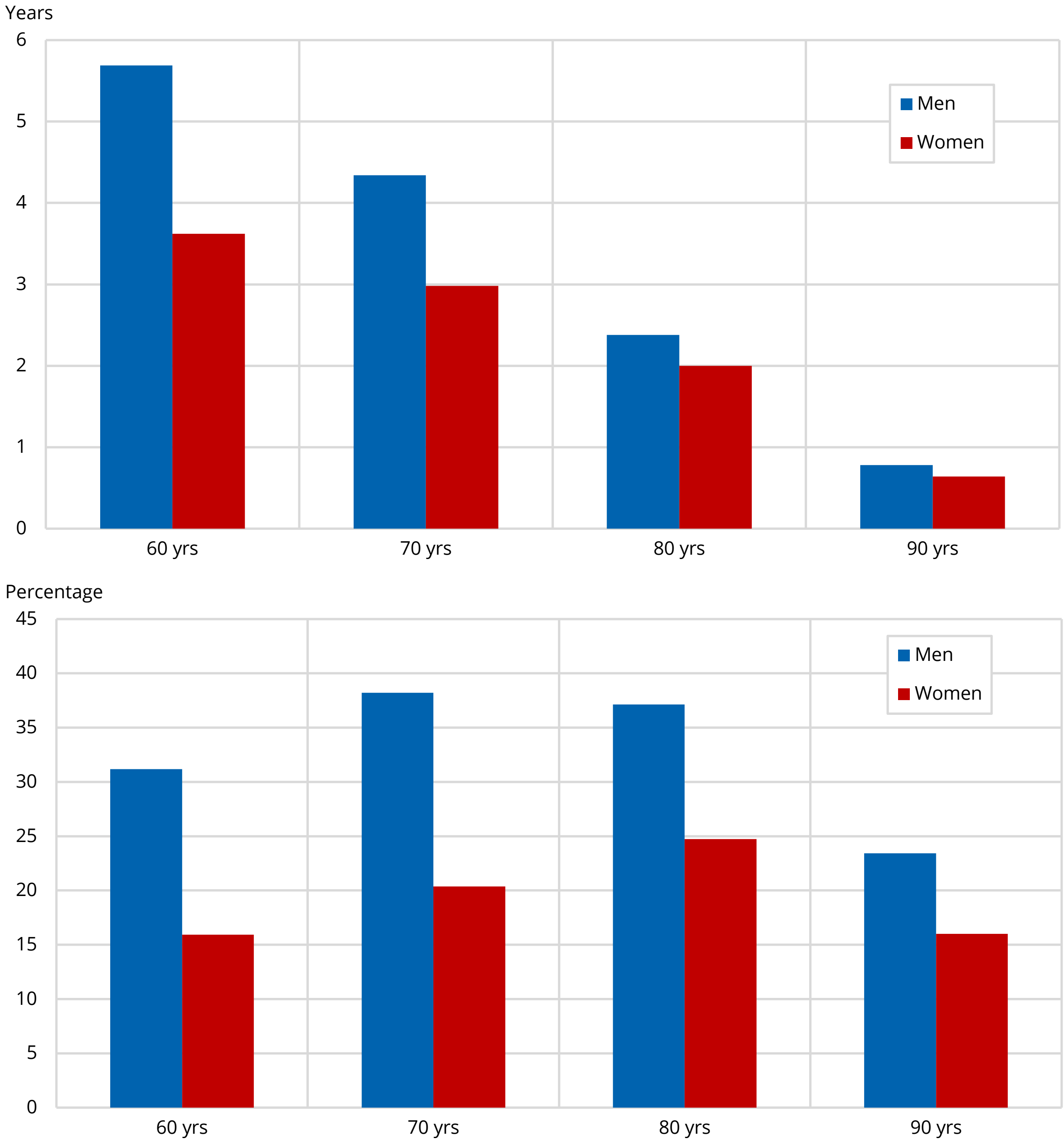


Source: Statistics Norway

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 less 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 – although the limited number of people aged 100 or older means these estimates are particularly uncertain.

For age groups under 30, the difference in remaining life expectancy between men and women remains around three years, and above two years for those up to their late sixties. 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 1990-2021 has witnessed a stronger rise in life expectancy among men than women (Figure 6.3).

Figure 6.3 Changes in remaining life expectancy by sex from 1990 to 2021 for selected age groups, years (top) and percentage (bottom)



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.

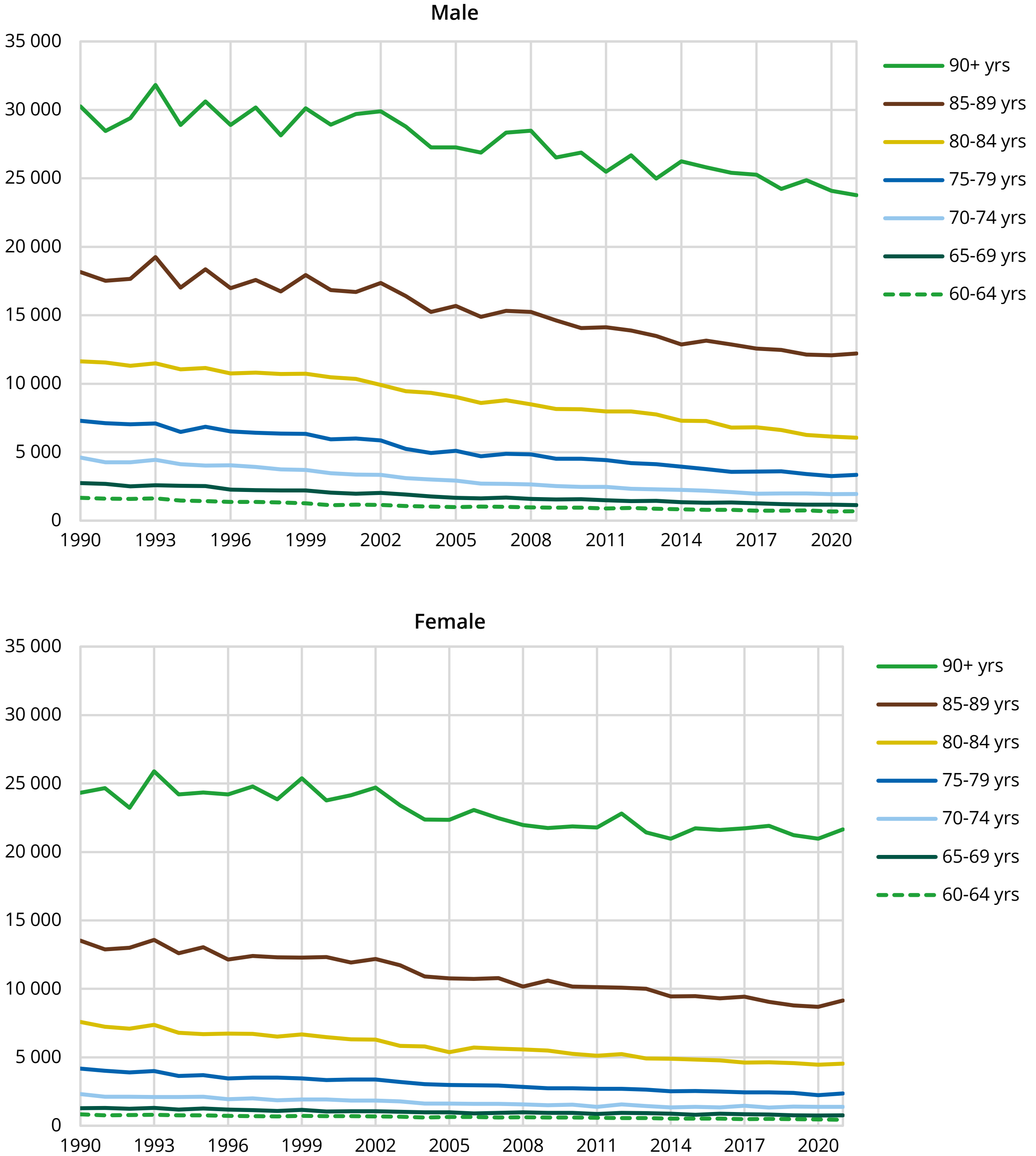
Trends in deaths and causes of death

Up to 1997, more men than women died in Norway. However, with far more older women than men, the pattern has since reversed. In 2021, 42 002 people died in Norway, comprising 20 578 men and 21 424 women. This was 535 more men and 856 more women than in the previous year, and 3 288 fewer men and 731 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.

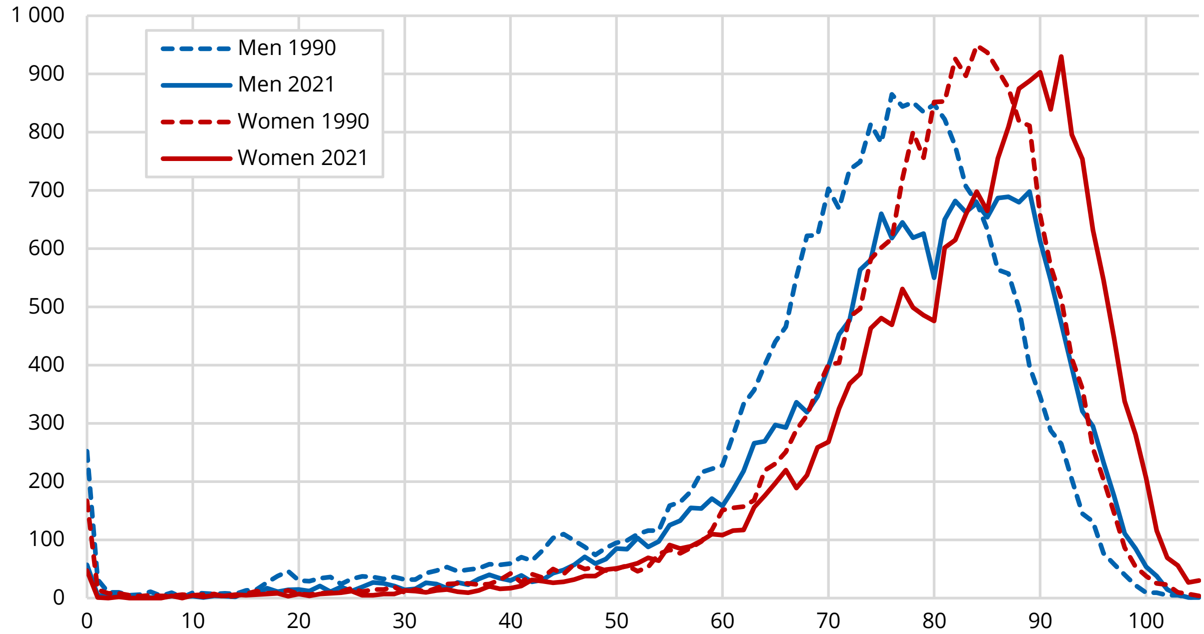
As with life expectancy, the average age at death also differs between the sexes. In 2021, the average age at death was 82.3 years for women, while for men it was just 77.0 years. This compares to 1990 where the average age at death was 72.0 and 78.2 years for men and women, respectively. The change 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 89 in 2021 for men and from 84 to 92 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 13 years – while for women this development is weaker, at around eight 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 2021.

Figure 6.4 The number of male (top) and female (bottom) deaths per 100 000 of the mid-year population by age, 1990-2021



Source: Statistics Norway

Figure 6.5 Distribution of deaths by age and sex in 1990 and 2021

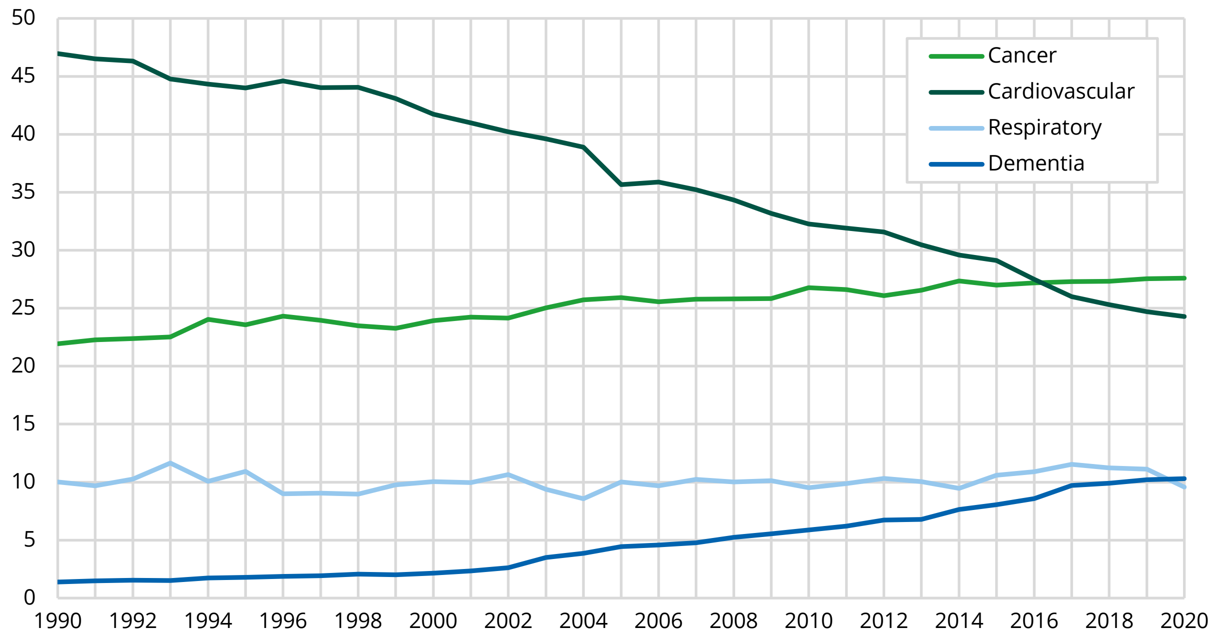


Source: Statistics Norway

Figure 6.6 shows the development over time in the number of deaths by selected causes of death.[13] Cardiovascular disease constitutes an ever-smaller proportion of all deaths, with the decline being particularly noticeable from the late 1990s. Figures from the Cause of Death Registry reveal that less than 25 percent of all deaths in 2020 were due to cardiovascular disease, this compares to almost half (47 percent) of all deaths in 1990 (NIPH 2021). 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 27.6 percent in 2020 (NIPH 2021). 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 population being older, with the age-standardised death rates for cancer declining over the past decade (Cancer Registry of Norway 2021). 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, the mortality rate associated with dementia has been increasing since 2000 (NIPH 2019). In 2020, more than ten percent of deaths were linked to dementia, which is almost five times higher than the relative share observed in 2000. While this increase can be linked to an ageing population, there have also been improvements in identifying dementia as the underlying cause of death. The proportion of violent deaths (not shown in Figure 6.6), such as accidents, suicide and homicide, has remained stable over the past decade, accounting for approximately six to seven percent of all deaths (NIPH 2021).

[13] 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 (NIPH 2021).

Figure 6.6 Four major causes of death in Norway as a percentage of all deaths, 1990-2020



Source: Norwegian Institute of Public Health (NIPH 2021)

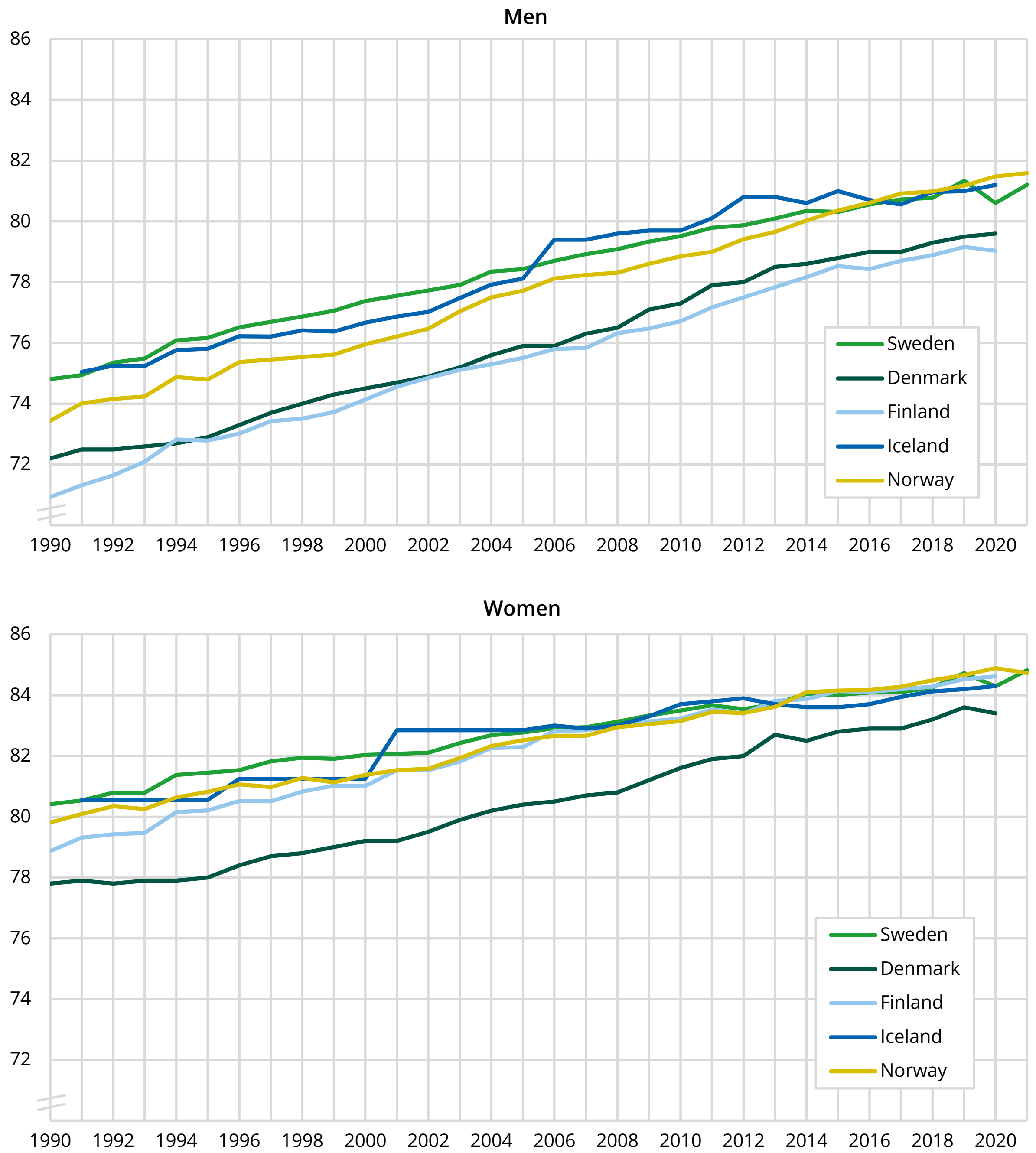
Norwegian trends in an international context

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 2022b). 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 have the highest life expectancy for men, while Japan and Hong Kong top the list for women.[14] Norway finds itself at 16th on the list for male life expectancy at birth and 20th on the list for female life expectancy (United Nations 2019). 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). According to Eurostat (2022b), which restricts its focus to European nations, Iceland and Norway are the top countries for male life expectancy at birth, while France and Spain are in the top positions for female life expectancy at birth. Norway is in fourth place for female life expectancy at birth (Eurostat 2022b).

Figure 6.7 shows the development in life expectancy as calculated by the national statistical agency of each Nordic country. 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, a catch-up has been observed in recent years, with Norway having the highest male and female life expectancy at birth in 2020 (the last year for which all the national statistical agencies have published). At the time of writing (early May 2022), only Norway and Sweden have published data for 2021. Based on these figures, Norway retains its position as having the highest male life expectancy at birth, while female life expectancy is slightly higher in Sweden.

[14] At the time of writing (early May 2022), the 2019 version is the most recent (United Nations 2019). An updated United Nations World Population Prospects is expected to be delivered in Summer 2022.

Figure 6.7 Life expectancy at birth for men (top) and women (bottom) in the Nordic countries, 1990-2021



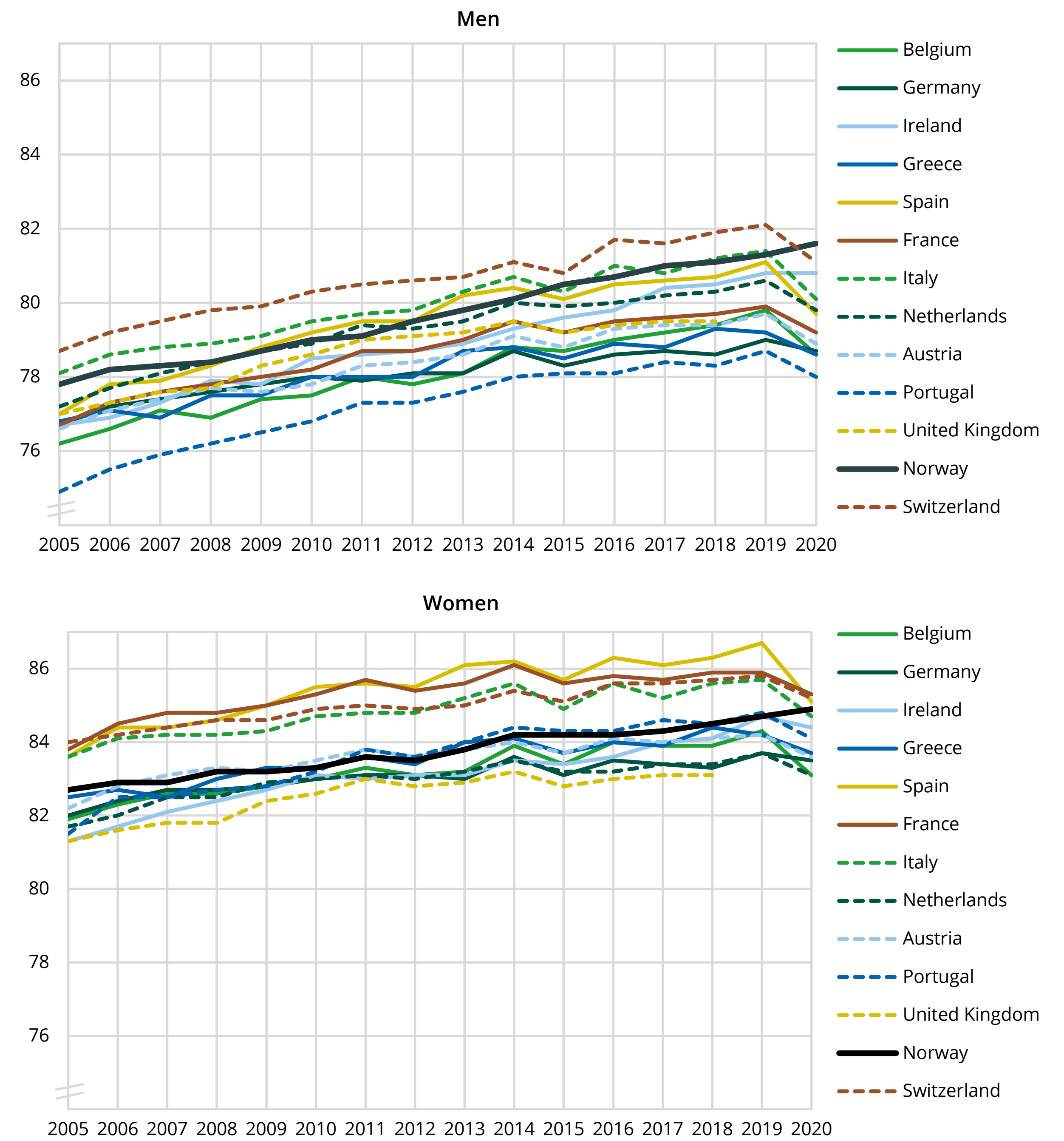
Source: National statistical agency for each country

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). 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).[15] This was the first decline observed since 2002, the first year for which data for most countries are 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. The negative effects of

[15] 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.

the COVID-19 pandemic on life expectancy were also felt widely across the EU, with 23 of the 27 Member States observing a decline in life expectancy. Indeed, life expectancy at birth in the EU in 2020 was 0.8 years lower for women and 1.0 years lower for men than in 2019 (Eurostat 2022c). Life expectancy also decreased in all EFTA countries, except Norway (Eurostat 2022c). While Norway already had one of the highest male life expectancies in Europe before the COVID-19 pandemic, Figure 6.8 reveals Norwegian male life expectancy to have increased in 2020, in contrast to all of the other selected European countries. Female life expectancy is somewhat lower in the European context, with a rate of increase broadly in line with the EU average up to the COVID-19 pandemic. However, as with male life expectancy, female life expectancy in Norway in 2020 was rather unique in being higher than the estimated value for 2019. The sharp decline in female life expectancy in many other European countries meant Norway had the 4th highest life expectancy among the selected countries shown in Figure 6.8.

Figure 6.8 Life expectancy at birth for men (top) and women (bottom) in selected European countries, 2005-2020



Source: Eurostat 2022b

What affects mortality?

Along with any differences in genetic vulnerabilities or predispositions for adverse health, social characteristics and conditions 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). 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 attainment are closely associated with 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 associated with lower mortality, as is support from other non-resident family, friends and neighbours in good health
- 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.
- 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

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 (NIPH 2018, Arntzen et al. 2019). 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), as well as 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 improved ability to understand complicated modern medical treatments (Berkman et al. 2011). Indeed, a larger part of the investigation and treatment of disease and illness takes place in outpatient clinics, where patients are expected to follow-up on their own appointments and stay informed about which examinations might be most relevant.

In Norway, the relationship between education and health is stronger than the relationship between income (measured in a broad sense) and health. 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 parents (vs non-parents) and those in relationships (vs singles) (Berntsen 2011, Kravdal 2013). For both parenting and partnerships, processes of social control and selection are thought relevant. Close family members are also important sources of informal care and support, while outcomes are also known to be influenced by wider networks of non-resident family, friends, colleagues and neighbours (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. 2016, Syse et al. 2018b). With that said, the immigrant health advantage appears to lessen as duration of stay increases (Elstad 2016, Syse et al. 2016, 2018b). Meanwhile, within the group of immigrants, those who move for educational or occupational reasons tend to have better health, while refugees and migrants moving for family reasons (or as family members of labour migrants) tend to have somewhat worse health (Syse et al. 2018b).

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 2020), indicate that the proportion of daily smokers has declined, but that the decline has been somewhat slower among the old than young. The most recent data on tobacco use shows that 8 percent of persons aged 16-74 are daily smokers, while those who had the highest educational attainment were found to smoke the least (Statistics Norway 2022b). Alcohol use, on the other hand, remains relatively high among older age groups (Statistics Norway 2022b). In 2021, more than 35 percent of people aged 16-79 drank alcohol weekly – 42 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), 8 percent (men) and 2 percent (women) (Statistics Norway 2022b). 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, three in four people report exercising or training at least once a week (Statistics Norway 2020). Norwegians have, however, become more overweight. In the late 1960s, around 5 percent of middle-aged men were obese (NIPH 2017). Estimates now suggest 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 2017). 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 from 58 percent in 1998 to between 70 and 80 percent over the period 2005-2019 (Statistics Norway 2020).

The mortality rate associated with cardiovascular disease has decreased in recent years (see Figure 6.6). The trend in incidence rates is more variable. While the number of first-time cases has decreased among older age groups, 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 share of deaths associated with 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 older ages where cancer incidence is highest. While a decrease in mortality from other illnesses has been a factor behind this increased incidence, cancer survival rates have consistently improved over the last five decades (Cancer Registry of Norway 2021). As a result, there will be more older people living with a cancer diagnosis. Indeed, even if age-standardised incidence rates remained stable over the next 15 years, the number of new cases would increase as a result of population growth and ageing (Cancer Registry of Norway 2021).

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 and 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 had traditionally been linked to relatively few deaths in Norway, but in 2019 and 2020 more than 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 number of persons in older age groups – and especially those over 85 years of age – is likely to lead to an increased incidence of dementia in the future. Recent estimates suggest the number of persons with dementia in Norway is set to increase from around 100 000 in 2020 to approximately 240 000 by 2050 and 380 000 by 2100 (Gjøra et al. 2021).

Depression, anxiety, type 2 diabetes and fall-related accidents are also important causes of health loss among older persons (NIPH 2018). While these factors rarely lead to death, they do require treatment and often have major impacts on daily life. Unhealthy diets, high blood pressure, smoking, being overweight or obese, physical inactivity, high cholesterol, high blood sugar and high alcohol consumption have been associated with one or more of these conditions and, as such, are all risk factors that can be addressed. With that said, survey results suggest older persons are less active today than in the past, and physical inactivity is known to be associated with other unhealthy lifestyle behaviours (Morseth et al. 2016).

In summary, cancer, cardiovascular and respiratory diseases have taken the most lives in Norway in recent decades (NIPH 2021), while dementia has become increasingly important as a major cause of death since the early 2000s. 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. minimising 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 autoregressive integrated moving average (ARIMA) model. This is described in more detail in Section 4.2. The historical period used as a basis for the projections is determined prior to each projection round. 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 past projections have shown that, aside from the 2020 projections, Statistics Norway has continuously underestimated the increase in life expectancy (Keilman 1997, Thomas et al. 2022). 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, the 2020 projections utilised time series of registered data for the years 2000-2019. The use of time series starting in 2000, as compared to 1990, had the desired effect of increasing life expectancy without greatly increasing the prediction intervals around the estimates (Syse et al. 2020). This year's projections utilise time series covering the years 2000-2021 (see Box 6.2).

Box 6.2 Data

The figures for the number of deaths and the size of the population are taken from Statistics Norway's population statistics and the period 2000-2021 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.

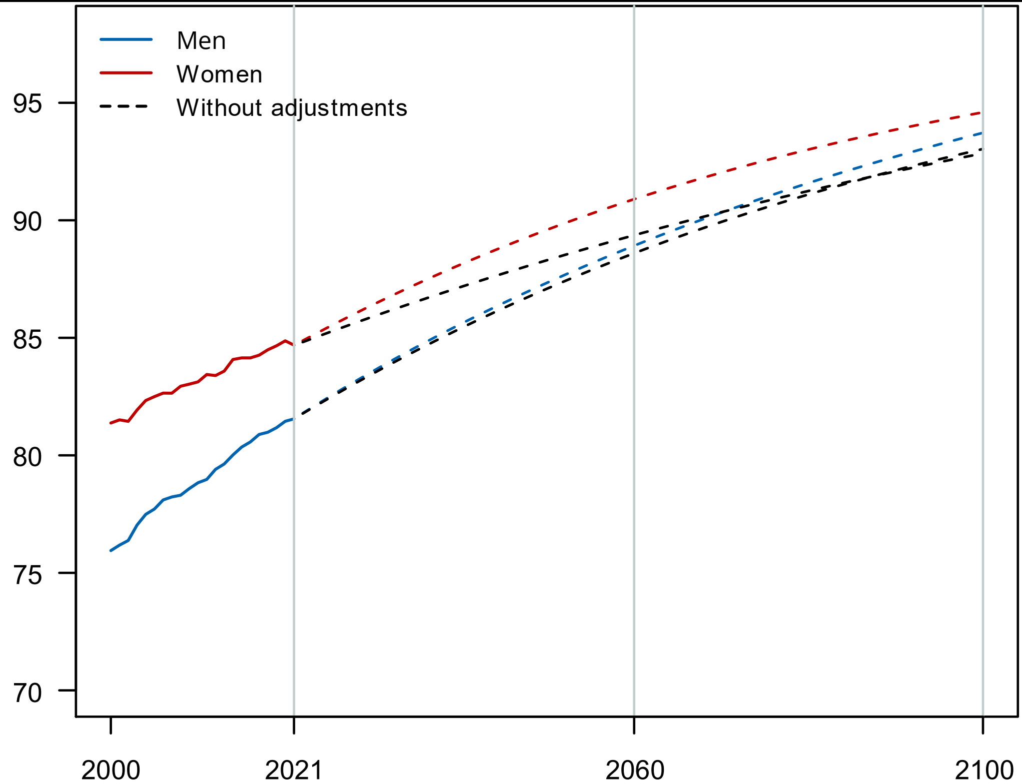
There are large fluctuations from year to year for ages 101-110. Therefore, to estimate projected death rates for these age groups, a logistic model has been used to extrapolate and smooth the estimated death rates for ages 101-110 years. Input in this model is death rates for the age groups 70-100 years in the period 2000-2021. 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.

Discretionary adjustments

The medium alternative in the 2022 mortality projections is based on an extension of the mortality patterns for the period 2000-2021. 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 than women in the coming decades. 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. A discussion and explicit incorporation of lifestyle-related effects (e.g. smoking, alcohol and obesity) in life expectancy projections in the European context was provided by Janssen et al. (2021). Janssen et al.'s (2021) projections lend support, at least qualitatively, to the assumed reduction in the effect of smoking.

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 6.9 shows how this adjustment raises female life expectancy at birth by approximately 1.5 years in 2060. The increase proves effective in removing cross-overs in male and female death rates up to 2060 for all but the very oldest ages. 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 us to systematically underestimate the development of male life expectancy (Thomas et al. 2022), we feel justified in our approach.

Figure 6.9 Life expectancy at birth for men and women, with and without discretionary adjustment, registered 2000-2021 and projected 2022-2100[1]



[1] Dashed lines show 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 consider 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 15 percent today to around 19 percent in 2060. 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. 2016, Syse et al 2018b). 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 and 3 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 Kingdom have experienced periods of high excess mortality during the COVID-19 pandemic (EuroMOMO 2022), all-cause mortality in 2020 actually decreased in Norway (Juul et al. 2022). Based on the most recent data from the Cause of Death Registry (NIPH 2021), deaths from COVID-19 were most common among those aged 90-94, with 85 deaths in this age group by the end of 2020. At time of writing (early May 2022), the winter wave has decreased, but it is likely that a new infection wave will return in the autumn or winter and new variants of the COVID-19 virus are also probable. With that said, the population's basic immunity should help to protect against the effects of serious illness, regardless of the variant (NIPH 2022b). Subsequently, we do not expect to observe appreciable increases in mortality relating to COVID-19 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.

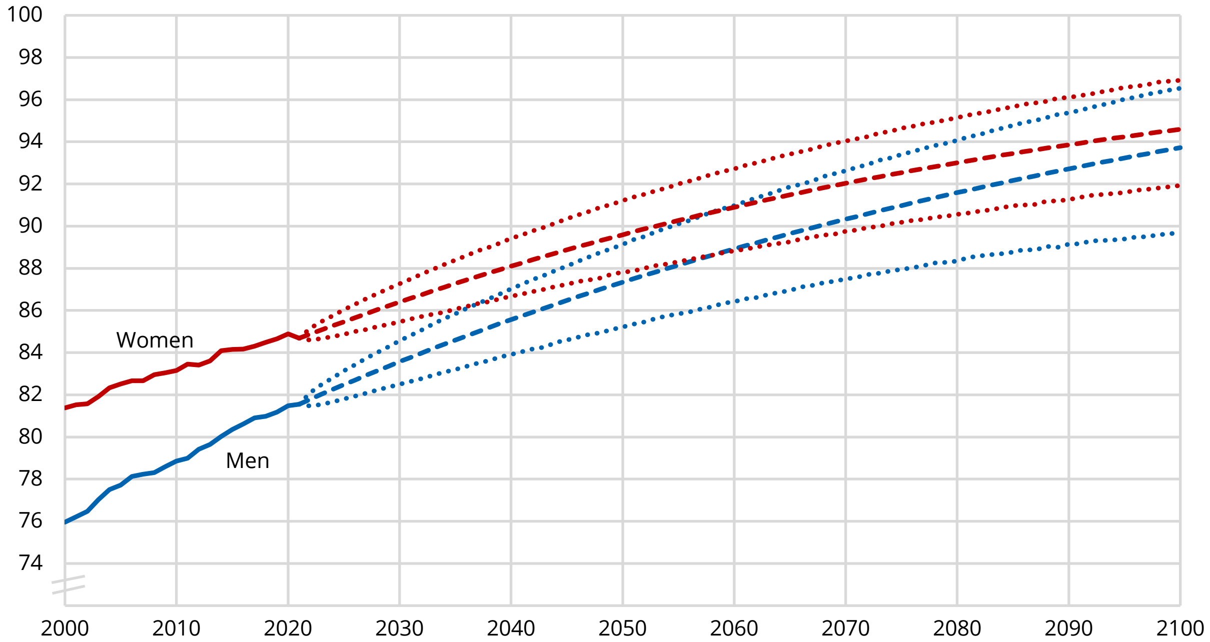
Uncertainty and alternative trajectories

We do not know for sure how mortality will develop in the future and the uneven effects of the COVID-19 pandemic across Europe clearly demonstrate how, even in countries with similar levels of economic and welfare development, there is always a degree of uncertainty, even in the short term. To illustrate this uncertainty, we calculate four alternatives 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 narrower (67 percent) prediction intervals (see Figure 6.11).

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

Since 1990, life expectancy at birth has risen by 8.1 years for men (approximately three months per year) and 4.9 years for women (approximately two months per year). In this year's projections, we assume that mortality will continue to decline and life expectancy will subsequently increase. In the projected medium alternative, we have assumed that male life expectancy at birth will rise by 7.4 years, from 81.6 years in 2021 to 88.9 years in 2060. For women, we expect a somewhat smaller increase, at 6.2 years, from 84.7 years in 2021 to 90.9 by 2060. By 2040, the corresponding increase for men and women is expected to be around 4.0 years and 3.4 years, respectively, which translates to a life expectancy at birth of 85.6 and 88.1 years, respectively.

Figure 6.10 Life expectancy at birth for men (blue) and women (red), registered 2000-2021 and projected 2022-2100 in three alternatives[1]

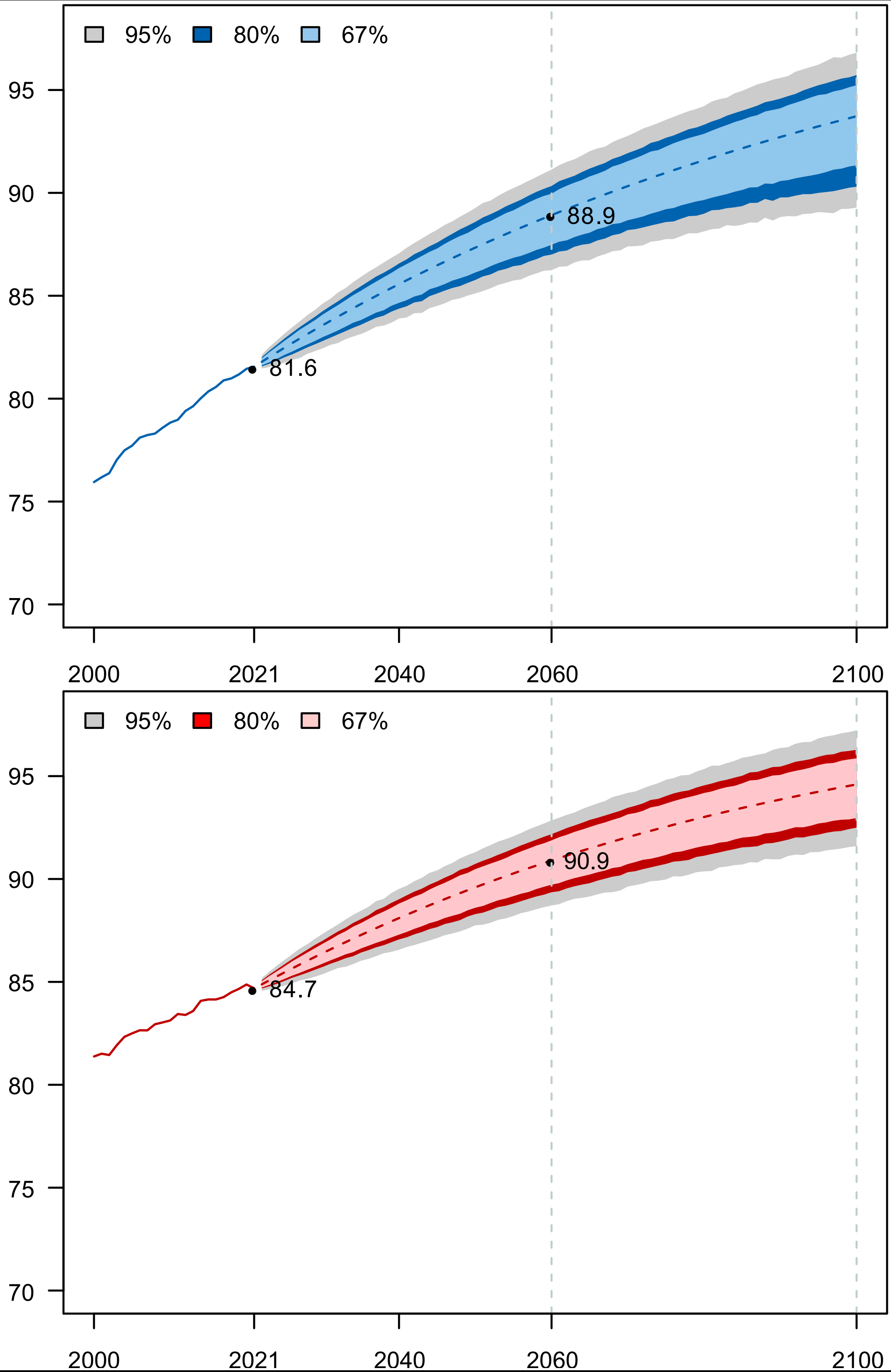


[1] Dashed lines show the medium alternative, dotted lines show the high and low alternatives.
Source: Statistics Norway

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 9.4 years for men (to 91.0 years) and 8.0 years for women (to 92.7), whereas in the low alternative a weaker growth of around 4.9 years for men (to around 86.4 years in 2060) and 4.1 years for women (to 88.8) is assumed. The projected alternatives for life expectancy at birth for men and women are shown in Figure 6.10. From Figure 6.11, we can see that the uncertainty in the projection increases as we move further from the projection baseline.

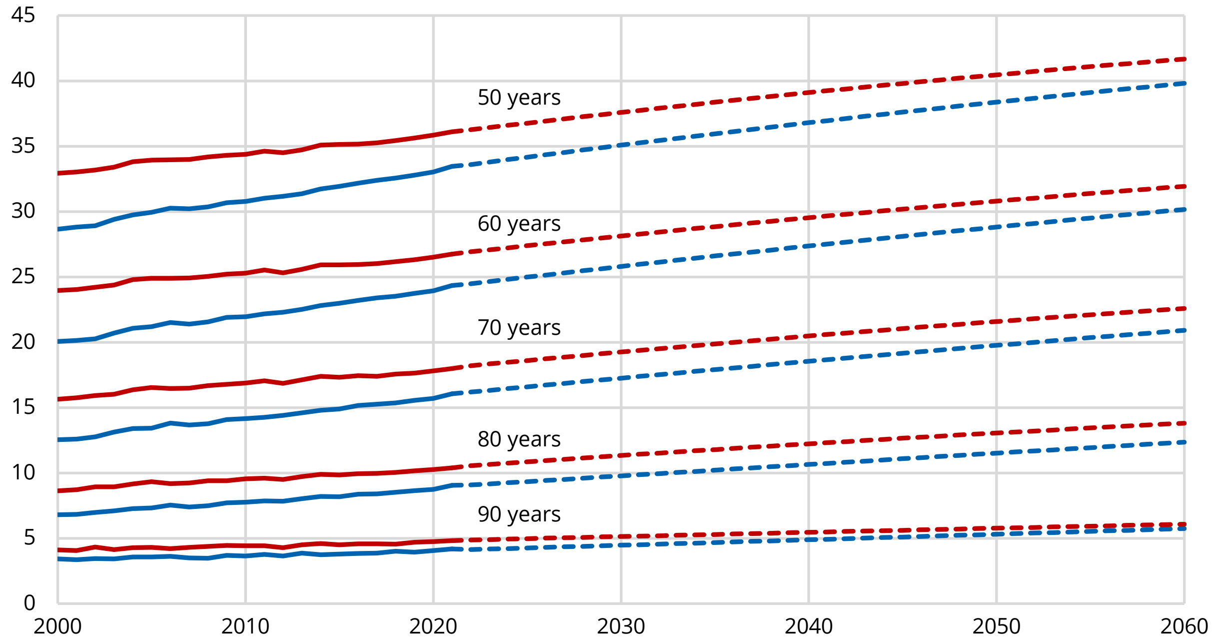
As shown in Figure 6.12, we assume remaining life expectancy to increase, even among the very oldest in society. For 60-year-olds, remaining life expectancy in 2021 was just over 24 years for men and almost 27 years for women. In the medium alternative, 60-year-olds in 2040 are assumed to have a remaining life expectancy of almost 28 years for men and almost 30 years women. By 2060, men aged 60 are assumed to have an average remaining life expectancy of just over 30 years, while women are assumed to have a remaining life expectancy of nearly 32 years. As we move up the age distribution the relative increase in life expectancy is lower. For 90-year-olds in 2021, remaining male life expectancy was 4.2 years, while for women it was 4.8 years. By 2040, we expect this to increase to 4.9 years and 5.5 years, respectively. By 2060, it is expected to increase slightly more, to 5.7 years for men and 6.1 years for women.

Figure 6.11 Life expectancy at birth for men (blue) and women (red), registered 2000-2021 and projected 2022-2100, medium alternative with prediction intervals[1]



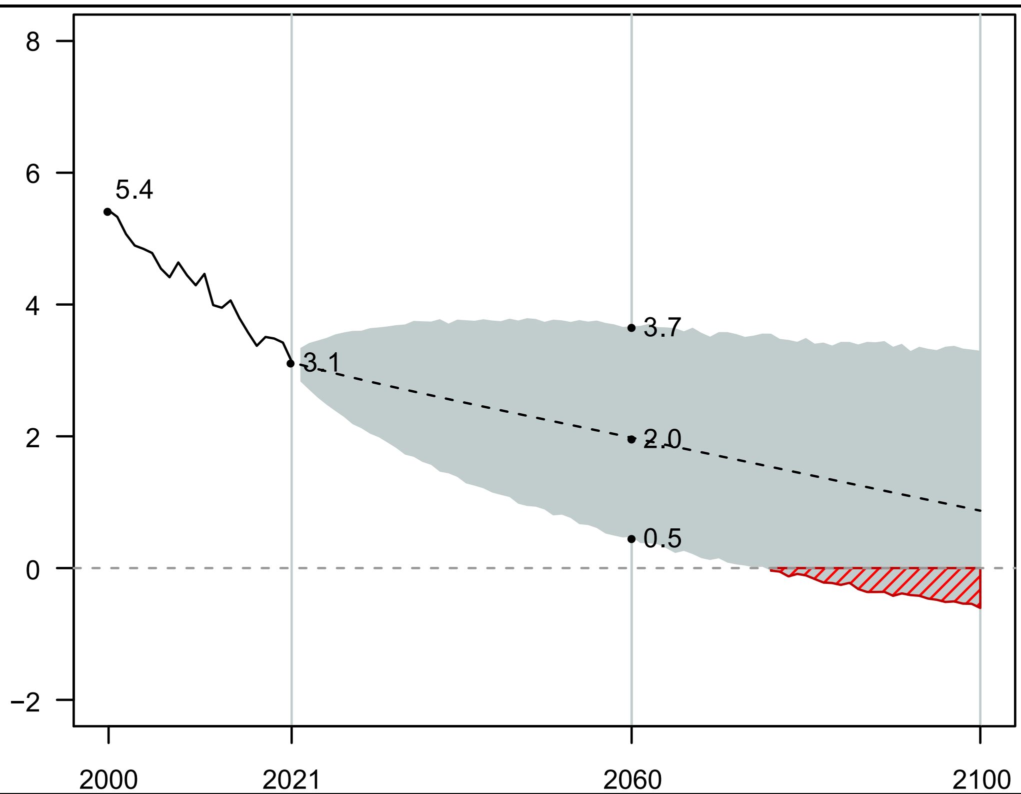
[1] Dashed lines show the medium alternative, while the shaded areas show the 67, 80 and 95 percent prediction intervals (5,000 simulations), respectively.
Source: Statistics Norway

Figure 6.12 Life expectancy at ages 50, 60, 70, 80 and 90, for men (blue) and women (red), registered 2000-2021 and projected 2022-2060, medium alternative



Source: Statistics Norway

Figure 6.13 The difference between male and female life expectancy at birth, registered 2000-2021 and projected 2022-2100[1]



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

Based on the medium alternative, Figure 6.13 shows the registered and projected difference between male and female life expectancy at birth, with 80 percent prediction intervals indicated by the shaded area. The sex difference in life expectancy at birth is assumed to fall from 3.1 years to

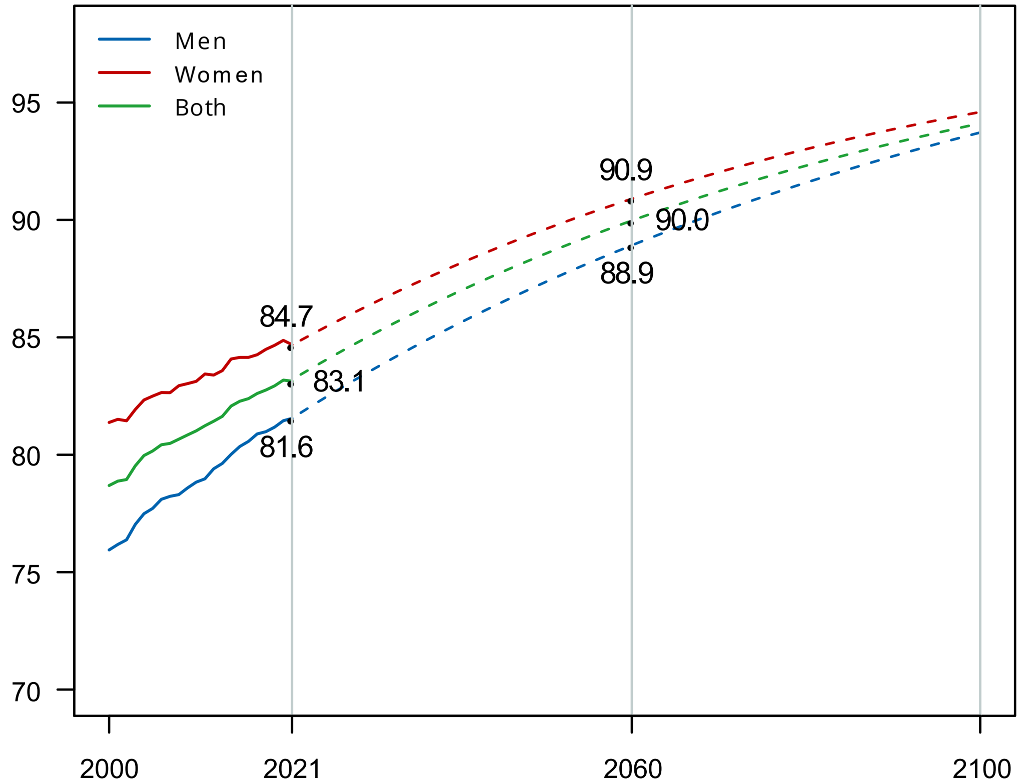
2.0 years by 2060 – a result of our discretional adjustment. The area in red indicates that there is a small chance that men will have a slightly higher life expectancy at birth than women by the 2080s.

6.4. Results from this year's projection

Life expectancy for both sexes combined

Life expectancy at birth for men was 81.6 years in 2021, 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 2021 and is expected to rise to 90.9 years by 2060. For both sexes combined, life expectancy at birth in Norway was 83.1 years in 2021 and by 2060 it is assumed to increase to 90.0 (Figure 6.14). 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 2021-2100, life expectancy at birth and remaining life expectancy for both sexes combined are published in the StatBank (https://www.ssb.no/en/statbank/table/13604).

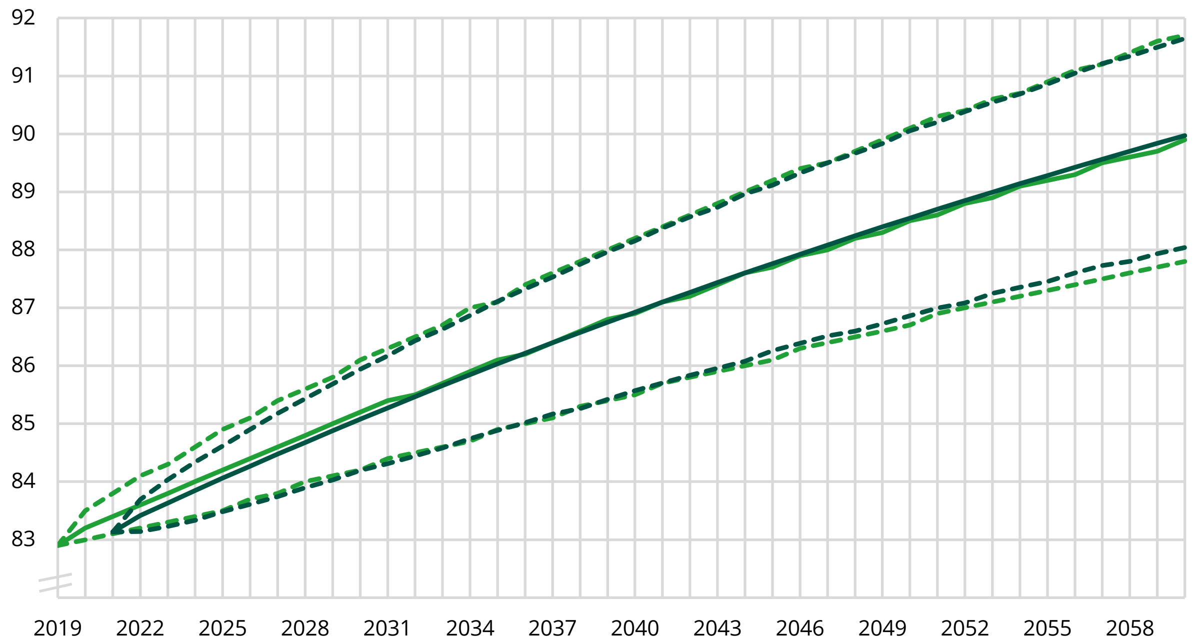
Figure 6.14 Life expectancy at birth for men (blue), women (red) and both sexes combined (green), registered 2000-2021 and projected 2022-2100, medium alternative



Source: Statistics Norway

If we compare life expectancy at birth for both sexes combined in this year's projection round to that from the previous projection round in 2020, the estimates are very similar. By 2060, the medium life expectancy alternative in the 2022 projections is less than 0.1 years higher than the equivalent estimate from the 2020 projections (Figure 6.15). More details on the comparison with the 2020 projections can be found in Box 6.3.

Figure 6.15 A comparison of life expectancy at birth for both sexes combined in the 2020 (green) and 2022 (black) projections in three alternatives, 2019-2060[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

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 42 000 in 2021, 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 57 000 deaths expected in 2040 and 65 000 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 50 000 expected in 2040 and around 59 000 expected in 2060.

The number of deaths will increase in the future because there will be more older 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. 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 around 87 years by 2060. As discussed in Chapter 1, we can expect older persons to constitute an increasingly significant share of the population, while the age of the very oldest should also increase steadily.

Box 6.3 Changes from the last projection

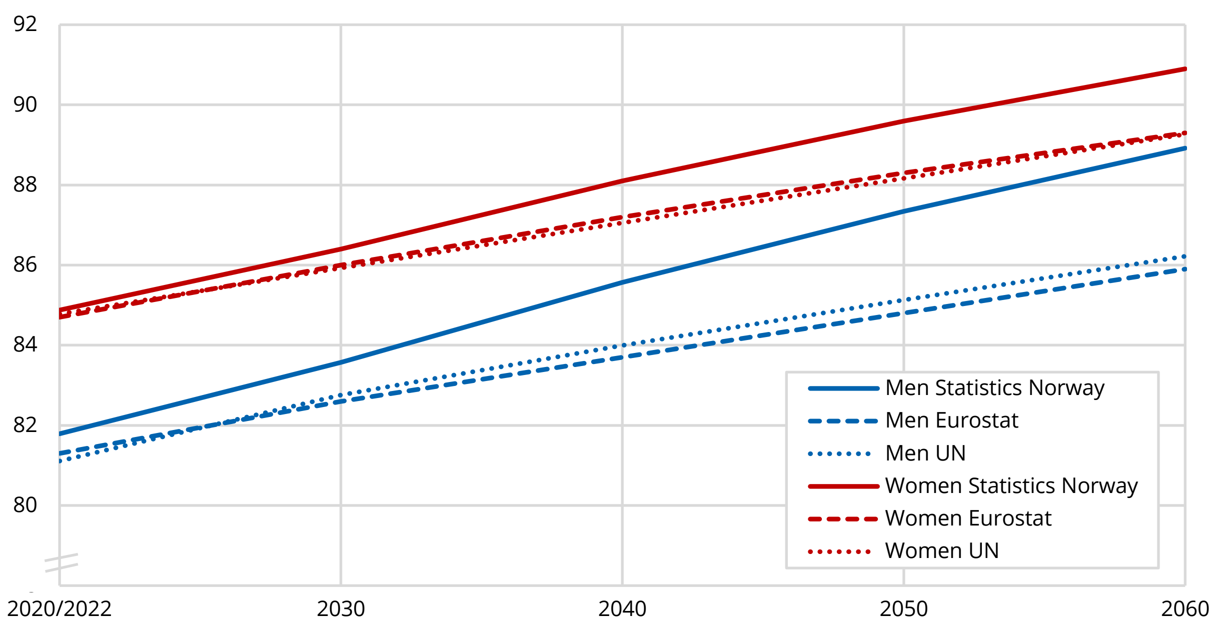
In the medium alternative for the 2020 projections, it was assumed that male (period) life expectancy at birth would rise to around 85.4 years in 2040 and 88.4 years in 2060. The corresponding figures for women were 87.8 and 90.3 years. An evaluation of the accuracy of these estimates in the very short term shows that the 2020 projections hit exactly for men, while for women it underestimated by just 0.1 years. For 2020, this resulted in 224 more projected deaths than registered. For 2021, however, projected life expectancy was overestimated by 0.2 years for men and nearly 0.3 years for women. As such, we underestimated deaths by 1 064 in 2021. This contrasts to the systematic underestimation of life expectancy that has been a characteristic of the national projections up to the 2020 projection round (Thomas et al. 2022).

In this year's projections, we have assumed a somewhat lower short-term life expectancy for both sexes (around 0.1 years in 2025), though in the long term the estimates remain very close to those from the previous projection round. This year's medium alternative (MMM) gives a total of about 700 more deaths in 2025, around 100 fewer deaths in 2040 and around 100 more deaths in 2060 than the medium alternative in the previous projection round.

6.5. Projected life expectancy from an international perspective

Both Eurostat (2020) and the United Nations (2019) publish their own life expectancy projections for Norway. At the time of writing (early May 2022), the most recent United Nations projections provide 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 (United Nations 2019). The corresponding figures from the most recent Eurostat projections are 85.9 years and 89.3 years, respectively (Eurostat 2020). Figure 6.16 compares the development of the three projected middle alternative estimates. Statistic Norway's own projections are clearly the highest, with the difference for men between Statistics Norway and Eurostat being the most pronounced at three years in 2060. For women, the difference between Statistics Norway and the other two projections is around 1.6 years. Updated United Nations projections will be delivered in 2022, with new Eurostat projections expected in 2023.

Figure 6.16 A comparison of life expectancy at birth medium alternatives for Norway made by the United Nations, Eurostat and Statistics Norway, 2020-2060[1]



[1] United Nations probabilistic projections (2020-2060) based on 5-year grouped estimates (e.g. 2020-2025, 2030-2035, etc.). Eurostat (2020-2060) and Statistics Norway (2022-2060) 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 2021 population projections produced by Statistics Finland provide the closest estimates for life expectancy at birth in 2060, at 87.4 years for men and 90.5 years for women.[16] Statistics Sweden's 2022 population projections assume a life expectancy at birth of 86.7 years for men and 88.9 years for women in 2060. The same estimates for the 2021 projections for Iceland are 83.9 for men and 88.1 for women. Meanwhile, the 2021 projections for Denmark, which only project to 2059, estimated male life expectancy to be 86.9 and female life expectancy to be 89.3 by the final projected year. Thus, by 2060, this year's projections for Norway assume between a 1.6-year to 2.3-year male life expectancy advantage over Finland, Denmark and Sweden, while for Iceland we assume a five-year advantage. For women, we assume a life expectancy advantage of between 0.4 years (Finland) and 2.8 years (Iceland) by 2060.

6.6. 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) and causes of death (such as increased cancer incidence and reduced cardiovascular disease), are thus only implicitly accounted – to the extent that changes that have already occurred are reflected in the trends in the historical time series. In this year's projections, we use time series of registered death rates (for men, women and both sexes combined) covering the period 2000-2021.

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 ongoing 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.

We assume an approximate continuation of the strong increase in life expectancy witnessed over recent decades. In our medium alternative, male life expectancy at birth increases from around 81.6 years today to just under 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 difference in life expectancy at birth between men and women will be reduced from 3.1 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 almost 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 the 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 13 percent of the population today, and by 2060 we expect this share to increase to just

[16] Life expectancy by age and sex: Denmark (https://www.statbank.dk/20022); Finland (https://statfin.stat.fi/PxWeb/pxweb/en/StatFin/StatFin__vaenn/statfin_vaenn_pxt_139l.px/); Iceland (http://px.hagstofa.is/pxen/pxweb/en/Ibuar/Ibuar__mannfjoldaspa/MAN09012.px/?rxid=d28ca977-507d-4fbc-87d2-35ba13bb9cd5); and Sweden (https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0401__BE0401A/BefProgLivslangdNb/).

over 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. Regardless of the projection alternative used, the ageing of the population is inevitable because it is already written into the age structure of today's population. 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.

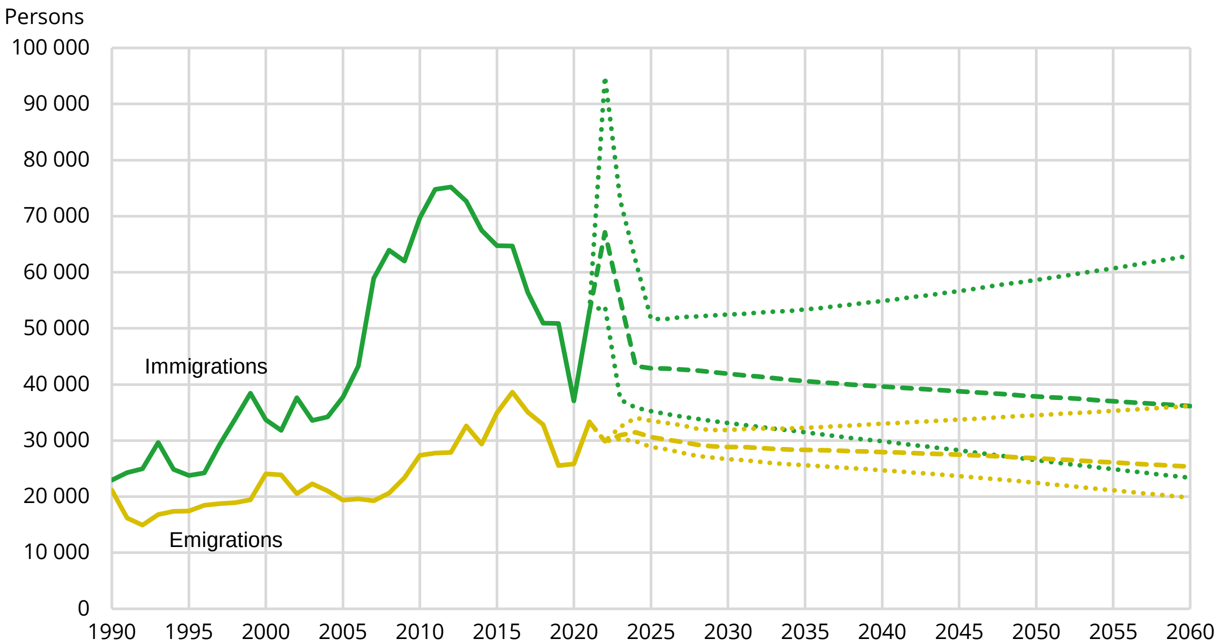
7. International migration – Assumptions and results

Ådne Cappelen, Terje Skjerpen and Michael J. Thomas[17]

In the medium alternative of the national population projections we assume that immigration to Norway will increase from 53 000 in 2021 to 67 000 in 2022 (low 54 000, high 95 000). This initial increase is driven by *ad hoc* adjustments formulated in response to the war in Ukraine (see Section 7.1). From this peak, we assume a sharp decline across all alternatives, before the projections settle on more stable trajectories. In the medium alternative, we assume that immigration to Norway will decline somewhat, from around 43 000 in 2024 to around 36 000 in 2060. In the long run, we assume that immigration from all country groups will decline, except for a slight increase in the number of re-immigrations of persons with a Norwegian background.

In line with the 2020 projections, this year's projections account for the age distribution of the sending country groups. Countries in Africa, Asia and other parts of the Global South are expected to experience pronounced population ageing and, because people tend to migrate at younger ages, we assume a much lower level of immigration from these countries than was assumed in projections produced prior to 2020. 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 works to lower immigration further in the longer term. We also 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. In addition to the medium alternative, we produce low and high immigration alternatives. As shown in Figure 7.1, our low immigration alternative assumes an even stronger decline, to around 23 000 in 2060, while our high immigration alternative assumes a gradual increase, to around 63 000 over the same period.

Figure 7.1 Immigrations and emigrations, registered 1990–2021 and projected 2022–2060 in three alternatives[1]



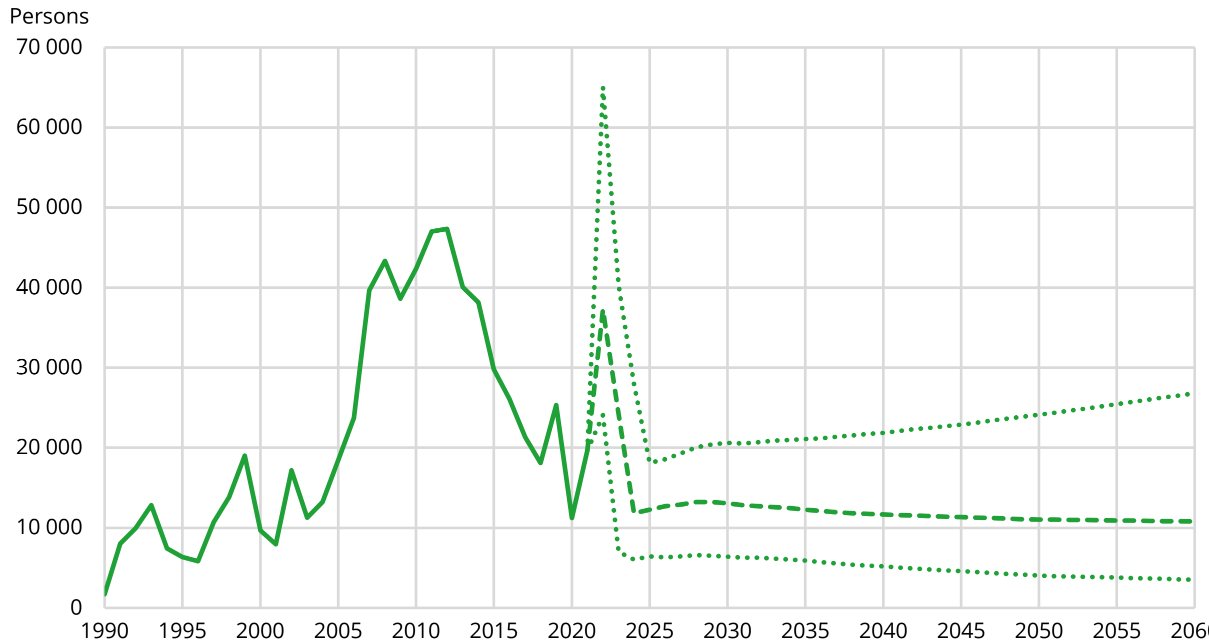
[1] Excludes persons who both immigrate and emigrate during the same year. Alternatives are MMM (main), MMH (high immigration) and MML (low immigration).
Source: Statistics Norway

[17] We thank the advisory reference group for migration: Marta Bivand Erdal (Peace Research Institute Oslo), Marie Hesselberg (The Norwegian Directorate of Immigration), Vitor Miranda (Statistics Sweden), Astri Syse (Norwegian Institute of Public Health), Marianne Tønnessen (NIBR, OsloMet). Members are listed in alphabetical order.

Future emigration from Norway depends on the number of people in the country and their potential emigration propensities. For instance, immigrants are more likely to emigrate than persons who are born in Norway. In the main alternative, we project relatively stable emigration levels, though there is a small decrease from around 30 000 to around 25 000 per year by 2060 (see Figure 7.1). In the low immigration alternative, we project a more pronounced decline in emigration, falling to around 20 000 in 2060. In contrast, around 36 000 are projected to emigrate in 2060 in the high immigration alternative.

Net migration is calculated by subtracting annual emigrations from annual immigrations. Prior to 2011, explicit assumptions were made for net migration in the official population projections. In all projections since then, net migration has been derived by taking the difference between assumptions for gross immigration and emigration. Figure 7.2 shows projected net migration in the main alternative, as well as in the low and high immigration alternatives. Net migration remains positive throughout the projection period, although the magnitudes vary considerably. In the main alternative, we project a yearly net migration of around 12 000 in 2024, up to around 13 000 by 2030. After this, we project a gradual decline to around 11 000 in 2060. In the low immigration alternative, we project a more pronounced relative decline, from around 6 000 to around 4 000 over the same period. In the high immigration alternative, net migration is projected to be around 27 000 by 2060. In our main alternative, the number of immigrants in Norway increases from 819 000 in 2022 to almost 1.2 million by 2060, while the number of people born in Norway to two immigrant parents increases from 206 000 to 570 000 over the same period.

Figure 7.2 Net migration, registered 1990–2021 and projected 2022–2060 in three alternatives[1]



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

Projecting future immigration and emigration is notoriously difficult due to the many 'moving parts' that work to influence international migration flows. Demographic and economic developments in Norway, as well as the relative changes in such factors across the world, are themselves inherently uncertain. Added to this is the unpredictability of wars, conflicts, pandemics and natural disasters, and the subsequent uncertainty that emerges when such things do occur. 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 and future economic differences between Norway and the rest of the world. While the COVID-19 pandemic added an additional layer of uncertainty to the 2020 projections, we do not expect the imposition of global travel restrictions in this year's projections. With that said, the ongoing war in Ukraine means that uncertainty, at least in the short-term, is again more pronounced than usual.

We discuss the potential implications of the war in Ukraine on migration in the following section. We then discuss historical patterns in Norwegian immigration and emigration, before presenting the methods used to produce our assumptions for future immigration.[18] Finally, we turn to a discussion of the results of the projections, with a particular focus being placed on gross immigration to Norway and resulting implications for changes in the stock of immigrants and Norwegian-born to two immigrant parents.

7.1. The war in Ukraine and potential implications for migration to Norway

The 2022 national population projections were produced in the context of war in Ukraine. At the time of writing (early May 2022), approximately six million refugees have fled Ukraine, with the majority fleeing to neighbouring countries such as Poland, which alone hosts more than three million Ukrainian refugees (UNHCR 2022a). The estimated number of refugees fleeing to Poland has, however, reduced from its peak, at around 140 000 daily movements on 6 March 2022, to approximately 20 000 daily movements by 1 May 2022 (UNHCR 2022b). The data on arrivals in bordering Schengen countries (e.g. Poland, Hungary and Slovakia) only represent border crossings in that country and the United Nations Refugee Agency (UNHCR) estimates that many people have moved onwards to other countries (UNHCR 2022a). The right to move freely within the Schengen Area means that there are very few border controls from which to assess this onward movement. UNHCR also provides estimates on movements back to Ukraine, although they reflect cross-border movements and are not necessarily indicative of sustainable returns to the country (UNHCR 2022a). As of May 2022, it is estimated that approximately 1.5 million movements back to Ukraine have occurred since the start of the war (UNHCR 2022c).

With regards to the potential flow of refugees to Norway, the Norwegian Directorate of Immigration (UDI) has provided a range of potential scenarios for 2022 (UDI 2022a). These scenarios are formed by a working group which comprises representatives from UDI in collaboration with the National Police Immigration Service (PU), the National Criminal Investigation Service (Kripos), Landinfo, the Norwegian Directorate for Civil Protection (DSB) and the Directorate of Integration and Diversity (IMDi). The scenarios are updated weekly and are the working groups' best assessment of publicly available information about the war, the situation in Ukraine and the situation in other European countries at the time. The 2022 national population projections utilise the UDI scenarios to guide our short-term immigration assumptions for Country Group 3, of which Ukraine is a member. More specifically, we utilise UDI's assessment based on the situation as of 9 May 2022 (UDI 2022b). This assessment was the most recent version at the time of production of this year's immigration assumptions.

The UDI's medium scenario from this assessment suggests that approximately 40 000-50 000 Ukrainian refugees will arrive by the end of 2022. This figure assumes that hostilities continue throughout the autumn and the number of refugees fleeing to other European countries will reach 8.3 million. Given the protracted nature of the war, many refugees are assumed to give up hope of being able to return to their homes in 2022, while the pressure on countries bordering Ukraine is also expected to increase, with more people subsequently applying to move to other European countries. Norway is considered a country with generous welfare schemes and a favourable labour market and so it is expected that Norway receives a somewhat larger proportion of those who flee

[18] Details on the formation of the assumption for emigration are given in Section 4.3.

(at 0.5 percent) than has been observed so far. It should be noted that this scenario is lower than it has been in previous weeks due to Norway having received a relatively low proportion of those who have already left Ukraine. Moreover, the number of people applying for collective protection in Norway has decreased significantly in recent weeks, while the war has been largely limited to areas in the east and south of Ukraine (UDI 2022b). It should also be noted that the stock of Ukrainians living in Norway prior to the war was just 3 500. As such, the network effect for this group will be very small.

The UDI's low scenario assumes between 25 000-35 000 will arrive (UDI 2022b). Here, the situation in Ukraine is expected to stabilise and a large proportion of refugees are assumed to prefer to remain in neighbouring countries pending their return. The low scenario assumes that the number of new refugees to Norway will rapidly reduce, such that there will be between 3 500 and 13 500 new refugees in addition to those who have already arrived, or are planned transfers, as of 8 May 2022. The UDI's high scenario assumes between 90 000 and 120 000 will arrive (UDI 2022b). In this scenario, it is assumed that the war continues and living conditions deteriorate during 2022, with more than 10 million people fleeing Ukraine. The scale of this movement will lead to capacity problems in the countries bordering Ukraine and mechanisms will be needed to distribute the refugees to other countries. Here, Norway is assumed to receive a proportion of refugees that corresponds to the country's population relative to that of the EU + population, i.e. 1.17 percent (UDI 2022b).[19]

Thus far, the UDI scenarios do not consider Ukrainian returns or onward movements. As with immigration, emigration in these situations is highly uncertain, with the duration of the conflict and legal rights to residence being among a plethora of potential factors worth considering. People fleeing Ukraine to Norway can be granted temporary collective protection for one year at a time, and this can be extended for a period of up to three years, after which authorities would need to decide on whether to offer permanent residence or not. The scheme of collective protection may be discontinued if Ukraine is deemed to have become a safe country again. Similar schemes were employed in the context of two previous European wars, namely the Bosnian War (1992-95) and the Kosovo War (1998-99). Approximately 13 000 Bosnian refugees fled to Norway in 1993, while 7 000 Kosovo refugees fled to Norway in 1999. These past examples provide stark contrasts in the return rates of refugees. In the case of the Bosnian War, conflict and unrest persisted, which resulted in the Norwegian authorities granting amnesty to all refugees who wanted to stay in Norway. In the context of the Kosovo War, hostilities quickly ceased and displaced persons were able to return relatively quickly, with most who had arrived in the summer of 1999 having already returned by the autumn of that year (see Brekke 2001; Brekke 2002). At the time of writing, we have very little information from which to form strong assumptions on return rates for Ukrainian refugees, though conflict at least in the south and east of Ukraine appears likely to continue for some time yet.

In the very short term, we have attempted to account for the immediate effects of the war in Ukraine by increasing gross immigration from Country Group 3. More specifically, our *ad hoc* assumption in the medium alternative is that an additional 20 000 will arrive in 2022, followed by an additional 10 000 in 2023 (30 000 in total). The low alternative comprises an additional 15 000 gross immigrants in 2022, a figure which is based on the approximate number of arrivals and planned transfers thus far, while the high alternative includes an additional 40 000 gross immigrants in 2022, followed by 20 000 in 2023 and 10 000 in 2024 (70 000 in total). Our numbers are lower than those presented in the UDI scenarios for several reasons. Key among them is that people cannot immigrate and emigrate in a single calendar year in the projection model (see Chapter 3). We must

[19] The EU + constitutes the 27 countries in the European Union, plus Iceland, Liechtenstein, Norway, Switzerland and the United Kingdom.

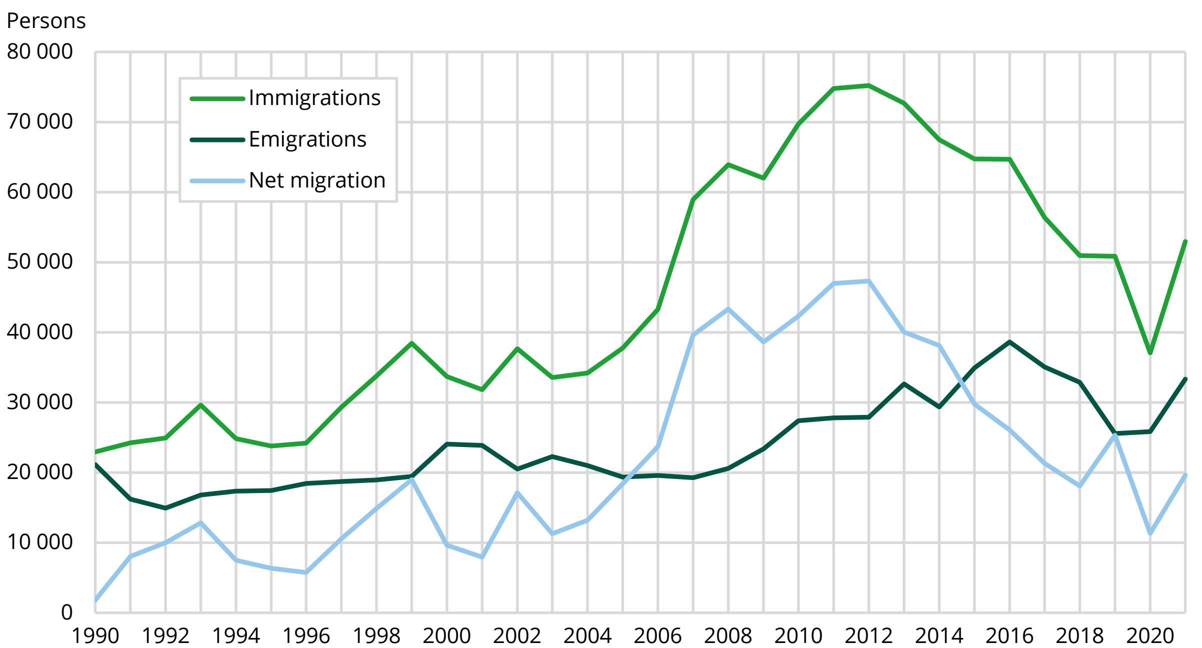
therefore provide a net approximation (i.e. subtracting potential return and onward migration) for each year in which we make adjustments. Our figures must also reflect the registered population, which means we must consider the time-lag between arrival and inclusion in the population registers. Given that the duration of the conflict remains unknown, we have not included any *ad hoc* adjustments to the data-driven emigration probabilities underlying the emigration assumption.

How long the war will last and how severe the refugee crisis and related economic impacts will be are unclear. As such, our assumptions regarding immigration and emigration, in both the short and longer term, are particularly uncertain in this projection round. While we assume a return to relative normality in 2023 in the low alternative, 2024 in the medium alternative, and 2025 in the high alternative, these decisions too are open to much debate.

7.2. Past trends in immigration and emigration

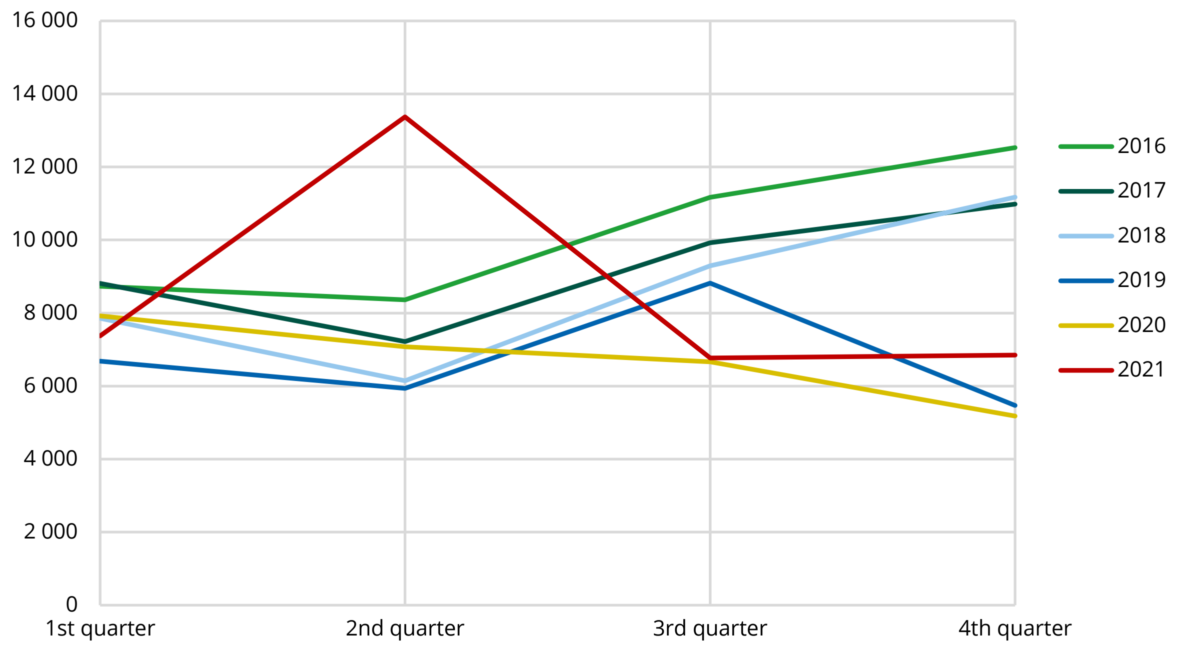
As is shown in Figure 7.3, immigration to Norway has fluctuated between 37 000 and 75 000 over the past decade. Immigration numbers peaked in the years 2011 and 2012, before a gradual decline developed. The negative effect of the COVID-19 pandemic on international migration is clearly observed in 2020, with annual immigration falling by almost 14 000 when compared to the figure in 2019. Emigration remained relatively stable in 2020, as compared to 2019, although 2019 was unusual in having fewer than usual administrative deregistrations (see Box 7.1). Still, the registered number of emigrations in 2019 and 2020 (approx. 26 000) was well below levels seen in the peak year 2016 (approx. 39 000). As travel restrictions and strict global measures affecting economies and societies were relaxed, the number of immigrations and emigrations increased in 2021, to 53 000 and 33 000, respectively.

Figure 7.3 Immigration, emigration and net migration, 1990-2021



Source: Statistics Norway

Figure 7.4 Emigrations from Norway, 2016Q1-2021Q4



Source: Statistics Norway

Box 7.1 Emigration and administrative deregistrations

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 (2016-2018), there would have been just over 5 000 more emigrations and correspondingly fewer residents at the end of the year. This figure pertained primarily to non-Nordic EEA citizens, of whom 1 700 were 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 were largely within what we 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 returned to a level similar to that in 2018 (to 7 922). The effects of COVID-19 restrictions in the remainder of 2020 are visible, with emigration declining with each quarter. For 2021, it is not yet possible to know if the peak in the second quarter was associated with administrative deregistrations or not.

Fewer immigrations from the typical sending countries

Beyond the temporary impact of the COVID-19 restrictions in 2020, the past decade has seen a reduction in immigration from the most common sending countries of Europe, namely, Poland, Sweden and Lithuania. Annual immigration of Polish individuals declined from approximately 13 000 in 2011, to 5 000 in 2018 and 4 000 in 2020. By the end of 2021, Polish immigrations had increased again to 8 000, which likely includes a temporary catch-up effect associated with delayed migration from the previous year. Immigration from Sweden and Lithuania declined up to 2016, before stabilizing somewhat at around 2 000 and 3 000 annual immigrations, respectively. Other important sources of immigration from Europe include Germany, Romania, Denmark and the United Kingdom, with each country typically contributing between 1 000 and 2 000 immigrations per year.

With regards to countries outside of Europe, the largest source of immigration since 2014 has been Syria. Immigration among Syrians was especially large in 2016 (at 11 000), with most arriving in Norway as asylum seekers in 2015, before entering the population statistics in 2016. Since 2016, fewer Syrians have arrived, although they still represented the largest share of non-European immigrations in 2021, at approximately 2 000. India and the United States are now the second and third most important sources of non-European immigration, with over 1 000 registered immigrations from each country in 2021. While Eritrea, Somalia and the Philippines were important sources of immigration to Norway between 2011 and 2018, their numbers declined to below 1 000 immigrations per country by 2020.

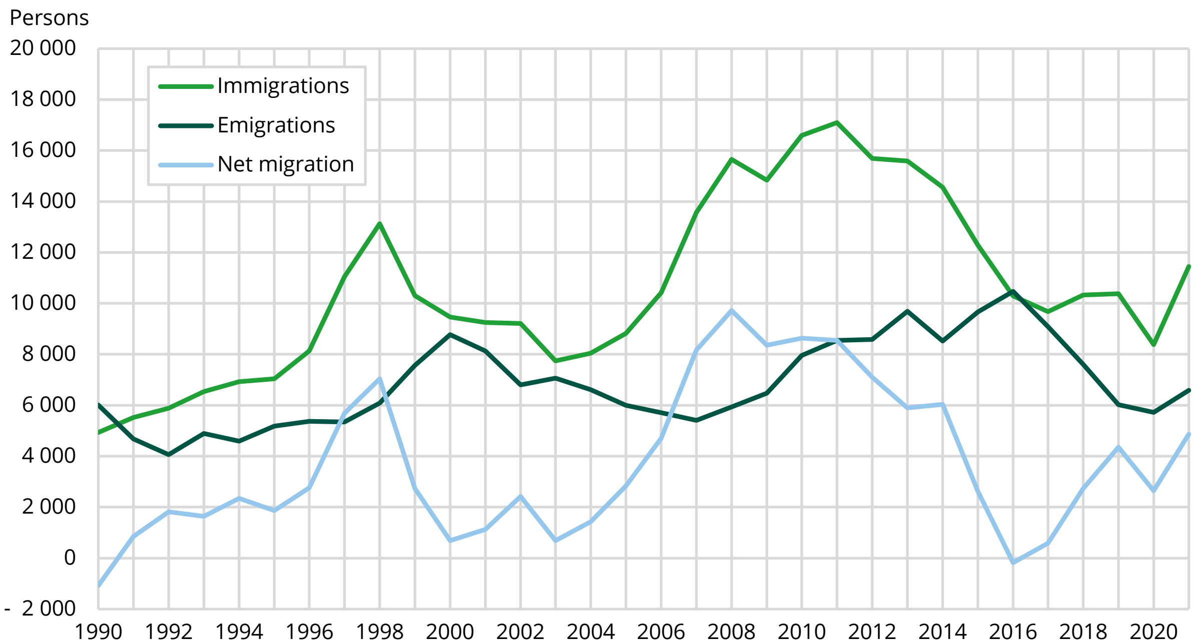
Migration by country group

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 4.3). We therefore focus our attention on developments in migration for each country group.

Figure 7.5 shows the total number of annual immigrations and emigrations for persons from Country Group 1 in Norway. According to Figure 7.5, immigrations from Country Group 1 are less common today than in the peak immigration years of 2007-2015. Since 2016, however, immigration has been fairly stable, aside from the obvious COVID-19 related reduction in 2020 and the apparent catch-up effects in 2021. Emigration, on the other hand, declined markedly after 2016, with net migration having increased as a result. The overall contribution from Country Group 1 has amounted to less than 5 000 net migrations per year since 2014. In 2016, net migration was negative for the first time since the early 1990s.

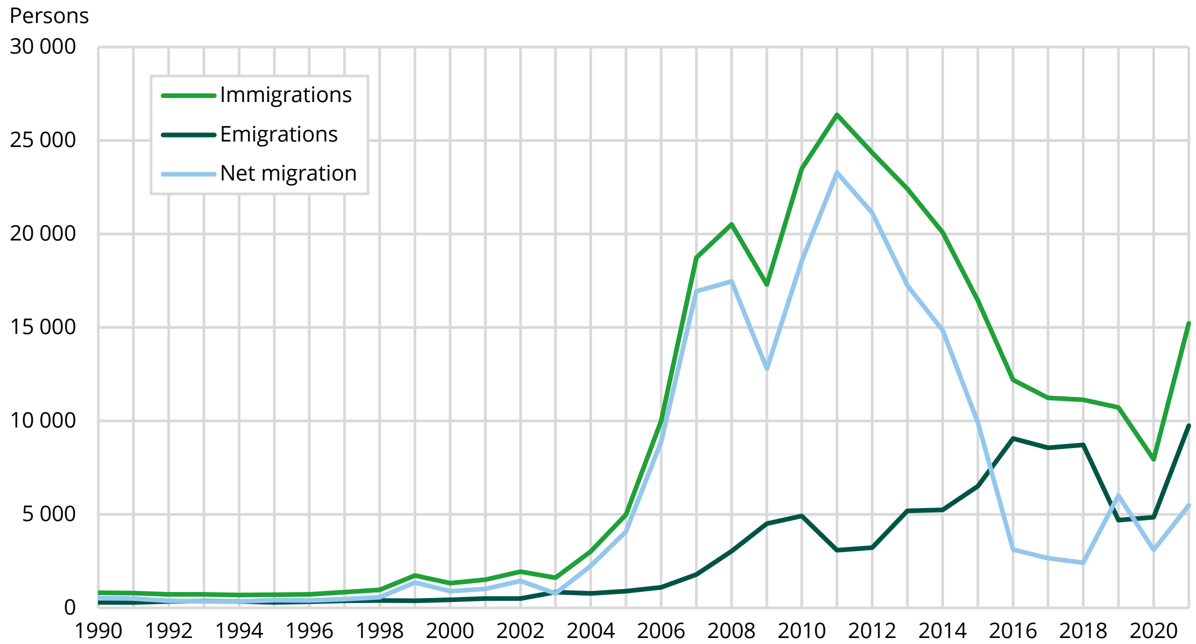
Figure 7.6 provides the total number of annual immigrations and emigrations of persons from Country Group 2 in Norway. The effect of EU-enlargements from 2004 onwards are clearly visible in the raised immigration and net migration figures. Between 2011 and 2016, immigration among this group declined rapidly, before appearing to stabilize at a level slightly above 10 000 annually up to 2019. The negative effects of COVID-19 on international migration are clear in 2020, with a sharp increase in immigration observed in 2021, again potentially driven by a catch-up of those who postponed immigration through 2020. Figure 7.6 also illustrates a general rise in emigrations from 2011, with a sharp decline observed in 2019 due to fewer administrative deregistrations (see Box 7.1). Emigration remained low in 2020, because of COVID-19-related travel restrictions, before rising again in 2021. The reduction in emigrations in 2019 translated into a clear increase in net migration in the same year. Net migration during 2016-2018 was down to pre-EU-enlargement levels, below 3 500 per year.

Figure 7.5 Immigration, emigration and net migration for Country Group 1, 1990-2021



Source: Statistics Norway

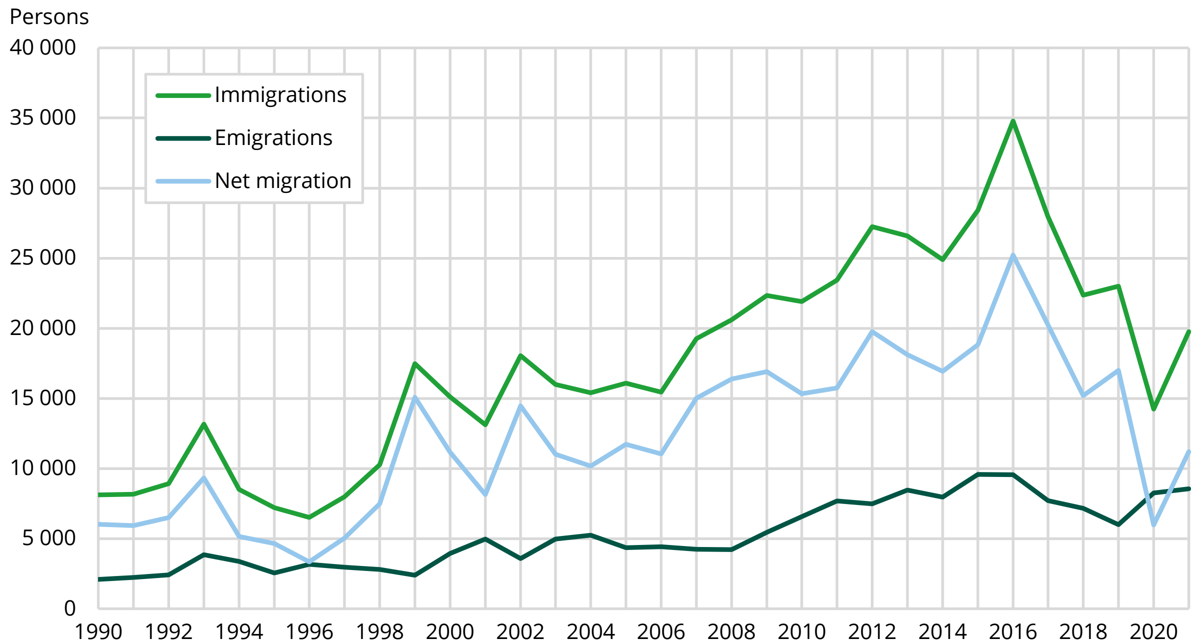
Figure 7.6 Immigration, emigration and net migration for Country Group 2, 1990-2021



Source: Statistics Norway

As is show in Figure 7.7, there had been a steady increase in immigration from Country Group 3, up to a peak of nearly 35 000 in 2016. Although levels have dropped since then, the annual figures remained above 20 000 prior to the COVID-19 pandemic. Immigrations declined to just over 14 000 in 2020, before recovering to 20 000 in 2021. The 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 between 2007 and 2019. Net migration sharply dropped to around 6 000 in 2020, before rising to 11 000 in 2021.

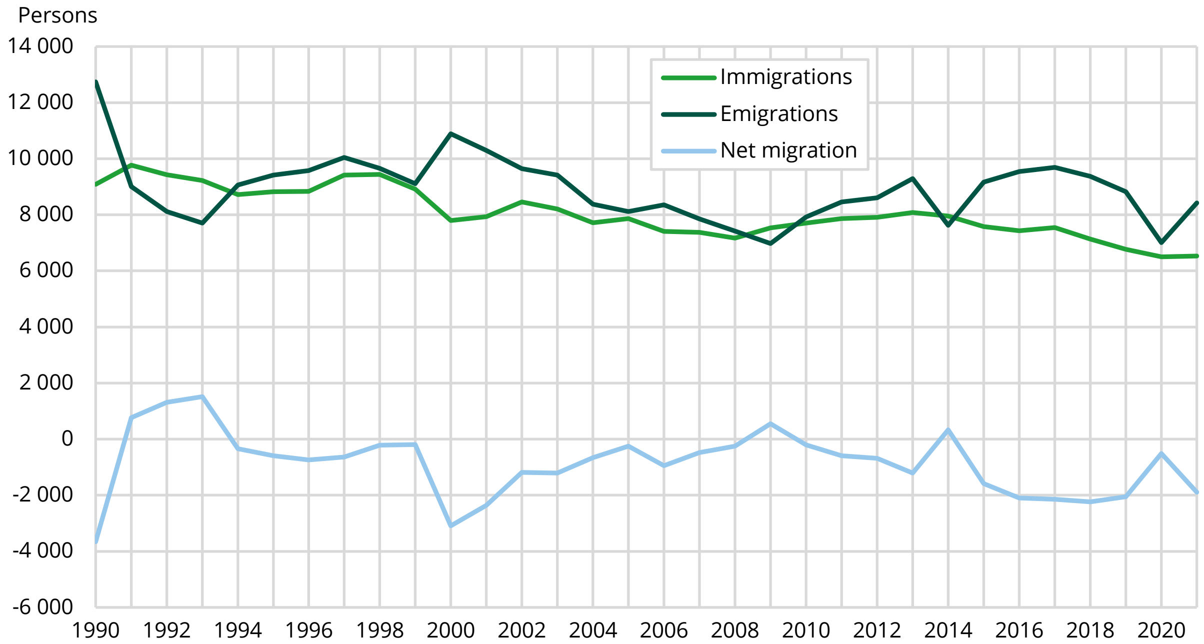
Figure 7.7 Immigration, emigration and net migration for Country Group 3, 1990-2021



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 4.4). Emigrations have typically outnumbered immigrations among this group, and thus negative net migration has been the norm.

Figure 7.8 Immigration, emigration and net migration for non-immigrants, 1990-2021

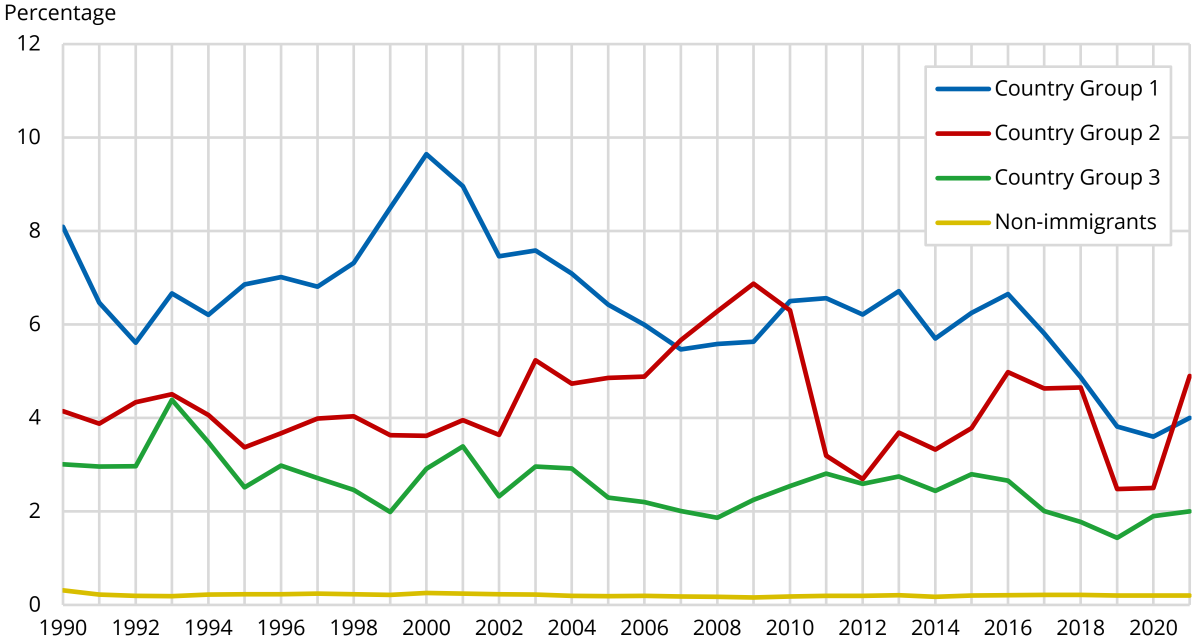


Source: Statistics Norway

To summarise, Country Group 3 has contributed most to both immigration and total positive net migration. With that said, the percentage contribution of Country Group 3 to total immigration has been declining, from over 50 percent in 2016 to 45 percent in 2019 and 37 percent in 2021. Persons from Country Group 1 usually contribute to a positive 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 net migration from the mid-2000s to mid-2010s, but since 2016 the levels have receded. The contribution of non-immigrants to net migration is usually fairly minor, although they have typically contributed to a negative net migration, i.e. there have been more people from the non-immigrant population leaving Norway than entering.

The absolute numbers of emigrations for each country group has been shown in the previous figures, but Figure 7.9 summarises emigrations relative to the stock of persons from the respective country group living in Norway. From this perspective, it is clear that the likelihood of emigrating is far greater for immigrants than for non-immigrants. It is also clear that the emigration rate for Country Group 3 is relatively low, while persons from Country Group 1 have typically had the highest propensities to emigrate. The only exceptions occurred in 2008-2009 and 2021, when a larger share of immigrants from Country Group 2 opted to emigrate.

Figure 7.9 Emigration rates by country group, 1990-2021



Source: Statistics Norway

7.3. A model for gross immigration to Norway

Statistics Norway makes projections for future immigration to Norway at an aggregate level (Cappelen et al. 2015). In this model, immigration to Norway is largely determined by the following factors, measured at the country-group level:

- 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 rate 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. Second, we present the data used as well as the results from the estimation of equations used in the projection exercise. Finally, the assumptions used when forecasting gross immigration to Norway, for the period 2022-2100, 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

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

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

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

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

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

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,[20] from the origin country is given by

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

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 common 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

[20] 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.

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

$$\sigma_{\varepsilon}^{2} = \sigma_{d}^{2} + \sigma_{o}^{2} - 2\sigma_{do}. \quad (5)$$

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 standard deviation σ_{ε}.[21] 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 labour 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 of importance.

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 as step dummies for individual country groups that have long lasting effects. 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. The enlargement of the EU in 2004 and 2007 meant a permanent institutional change that is captured by step dummies for Country Group 2.

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

Data

For immigration, the world outside Norway is divided into three country groups of origin, as shown in Box 4.3. In short, the country groups are:

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 particularly to persons from the EU (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 World Bank. [22] 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.

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 the 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

[22] In previous projections we used a combination of OECD and World Bank data, but the latter is more comprehensive and the differences between the two sources for countries that are common to both databanks are so small that we have chosen to rely only on the World Bank data in the current projections.

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:

Emigration rate = F(rel. incomes, unempl. rates, migration costs, policy) (6)

In contrast to what has been the case in the projections undertaken in 2018 and earlier, we now use a disaggregated approach when it comes to the age composition of 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 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 (2020). 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 (United Nations 2019), 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 used in the models, excluding dummies, 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 1994 (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 group index for convenience.[23] The estimated equations are (t-values in parentheses are shown below each parameter estimate):

$$\log(M/P_{0-14})_t = -\underset{(-3.91)}{1.666} + \underset{(4.86)}{0.514}*\log(M/P_{0-14})_{t-1} + \underset{(7.32)}{0.748}*\log(M/P_{15-39}) - \underset{(-4.45)}{0.550}*\log(M/P_{15-39})_{t-1} + \underset{(2.75)}{0.463}*\log(RY)_{t-1} - \underset{(-2.19)}{0.125}*[\log(U_{nor})_t - \log(U_1)_t] + \text{impulse dummies}$$

$\sigma = 0.071$; $AR_{1-2} = 0.729$ (0.49); $ARCH_{1-1} = 1.214$ (0.28); Normality = 0.763 (0.68); 1976-2021.

$$\log(M/P_{15-39})_t = -\underset{(-7.76)}{2.391} + \underset{(5.42)}{0.407}*\log(M/P_{15-39})_{t-1} + \underset{(2.10)}{0.412}*\log(RY)_t + \underset{(2.42)}{0.489}*\log(RY)_{t-1} - \underset{(-3.80)}{0.239}*[\log(U_{nor})_t - \log(U_1)_t] - \underset{(-2.39)}{0.239}*[\log(U_{nor})_{t-1} - \log(U_1)_{t-1}] + \underset{(4.80)}{0.295}*[\log(U_{nor})_{t-2} - \log(U_1)_{t-2}] + \text{impulse dummies} \quad (7)$$

$\sigma = 0.049$; $AR_{1-2} = 1.690$ (0.20); $ARCH_{1-1} = 0.833$ (0.37); Normality = 0.182 (0.91); 1977-2019.

$$\log(M/P_{40+})_t = -\underset{(-4.34)}{2.637} + \underset{(5.62)}{0.553}*\log(M/P_{40+})_{t-1} + \underset{(3.98)}{0.573}*\log(RY)_t - \underset{(-6.16)}{0.430}*[\log(U_{nor})_t - \log(U_1)_t] + \underset{(4.04)}{0.305}*[\log(U_{nor})_{t-2} - \log(U_1)_{t-2}] + \text{impulse dummies}$$

$\sigma = 0.089$; $AR_{1-2} = 0.646$ (0.53); $ARCH_{1-1} = 0.194$ (0.66); Normality = 0.336 (0.85); 1977-2021.

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 parentheses after 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 initially 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_{15-39}. However, the estimates using ordinary least squares (OLS) and IV are so similar that only the OLS estimates are shown. The two last equations are estimated using OLS. The chosen models have quite stable parameter estimates during the last 20 years according to recursive estimation results.[24] 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.[25]

Looking at the first equation in (7) we should note that the emigration rate for 'parents' (M/P_{15-39}) 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 0.41 percent when the 'parent' emigration rate increases by one percent, and by 0.95 percent when per capita income in Norway increases relative to that in Country Group 1. For the second age group, the emigration rate for 15-39 years old increases by 1.48 percent when relative incomes in Norway increase by one percent. An increase in

[23] 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.
[24] Details are available upon request.
[25] For a discussion of possible cointegration between the variables included in the equations for Country Group 1, see Cappelen and Eika (2020).

the unemployment rate in Norway from 4 to 5 percent lowers the long-run emigration rate by 7.5 percent. A similar increase in the unemployment rate in Country Group 1 increases the emigration rate by 7.5 percent because of the imposed symmetric response. From a purely statistical point of view, this is not rejected by data. The equation for the oldest age group has a long-run income effect of 1.3 percent. The unemployment effects are similar to those of the 15-39 age 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 7 percent, while a similar increase in the unemployment rate in Country Group 1 increases immigration to Norway by 7 percent. The equations in (7) include dummies for 2020 and 2021, to capture COVID-19 effects, except for the youngest groups where these dummies are present implicitly through the role of the 'parent' effect. 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 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, starting in May 2004, 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 intercept 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):

$$\log(M/P_{0\text{-}14})_t = \underset{(-5.64)}{-1.643} + \underset{(3.90)}{0.366}*\log(M/P_{0\text{-}14})_{t-1} + \underset{(3.78)}{0.505}*\log(M/P_{15\text{-}39})_t + \underset{(3.12)}{0.920}*\log(RY)_{t-2} + \text{step and impulse dummies}$$

$\sigma = 0.143$; $AR_{1\text{-}2} = 2.690\ (0.09)$; $ARCH_{1\text{-}1} = 1.263\ (0.27)$; Normality = 2.706 (0.26); 1991-2021.

$$\log(M/P_{15\text{-}39})_t = \underset{(-0.63)}{-0.161} + \underset{(19.8)}{0.677}*\log(M/P_{15\text{-}39})_{t-1} - \underset{(-5.81)}{0.667}*\log(U_{nor})_t + \underset{(5.28)}{0.722}*\log(U_{nor,t-2} / U_{nor,t-3}) + \underset{(4.33)}{0.670}*\log(RY)_{t-2} + \text{step and impulse dummies} \qquad (8)$$

$\sigma = 0.094$; $AR_{1\text{-}2} = 2.182\ (0.14)$; $ARCH_{1\text{-}1} = 0.081\ (0.78)$; Normality = 0.094 (0.95); 1991-2021.

$$\log(M/P_{40+})_t = \underset{(-2.32)}{-2.557} + \underset{(2.70)}{0.329}*\log(M/P_{40+})_{t-1} + \underset{(2.07)}{0.794}*\log(RY)_t - \underset{(-2.25)}{0.695}*[\log(U_{nor})_t - \log(U_{nor})_{t-1}] - \underset{(-2.75)}{0.617}*\log(U_{nor})_{t-2} + \underset{(2.07)}{0.357}*\log(U_2)_{t-2} + \text{impulse and step dummies}$$

$\sigma = 0.167$; $AR_{1\text{-}2} = 0.185(0.83)$; $ARCH_{1\text{-}1} = 1.013\ (0.32)$; Normality = 0.59 (0.74); 1991-2021.

For the youngest age groups for Country Group 2, the 'parent' effect is 0.8 in the long run. There are no effects of unemployment, but the long-run effect of relative incomes is large (1.4). 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 large long-run response to changes in the Norwegian unemployment rate, but no effect of unemployment in the origin country group. An increase in the Norwegian unemployment rate from 4 to 5 percentage points will, in the long run, reduce immigration by 50 percent. For the oldest age group, the income effect is 1.2 and the unemployment effect is - 0.9. Both effects are 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, in the years 2019 and 2020, a considerable share of this group were refugees (around 25 percent) and family migrants (around 45 percent), with labour migrants and education-related migrants comprising around 15 percent each.

Compared to most 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.[26] The time series used as input for Country Group 3 end in 2019, given that 2020 and 2021 were strongly affected by COVID-19. Of course, we might expect similar shocks to emerge 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 to any such occurrences. 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. Regarding the ongoing war in Ukraine, we did not attempt to account for the effects in the econometric model – i.e. short-term *ad hoc* adjustments (see Section 7.1) were made following the convergence and final estimation of the model.

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. $\log(U_{nor})$ 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.

[26] $DUM1999_t$ - An impulse dummy being 1 in 1999 and 0 in all other years. It is related to a large influx of immigrants from the Balkans 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.

The estimated equations are (t-values are shown in parentheses below each parameter estimate):

$$\log(M/P_{0\text{-}14})_t = -\,5.068 + 0.474*\log(M/P_{0\text{-}14})_{t-1} + 0.317*\log(RY)_{t-2} + 0.095*\log(STOCK)_t +$$
$$(-113)$$
$$0.614*DUM1999_t + 0.564*DUM2016_t$$
$$(2.74) \qquad (2.52)$$
$\sigma = 0.219$; 1994-2019.

$$\log(M/P_{15\text{-}39})_t = -\,4.067 + 0.474*\log(M/P_{15\text{-}39})_{t-1} + 0.317*\log(RY)_{t-2} + 0.095*\log(STOCK)_t -$$
$$(-52.0)$$
$$0.372*\log(Unor)_{t-1} + 0.205*DUM1999_t + 0.410*DUM2016_t$$
$$(-6.92) \qquad (1.47) \qquad (3.00)$$
$\sigma = 0.136$; 1994-2019. (9)

$$\log(M/P_{40+})_t = -\,5.283 + 0.474*\log(M/P_{15\text{-}39})_{t-1} + 0.317*\log(RY)_{t-2} + 0.095*\log(STOCK)_t -$$
$$(-234)$$
$$0.213*\log(U_{nor,t-1}/U_{nor,t-2}) + 0.394*DUM1999_t + 0.337*DUM2016_t$$
$$(-2.74) \qquad (3.46) \qquad (2.95)$$
$\sigma = 0.110$; 1994-2019.

For the iterations 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. 2018a). 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.

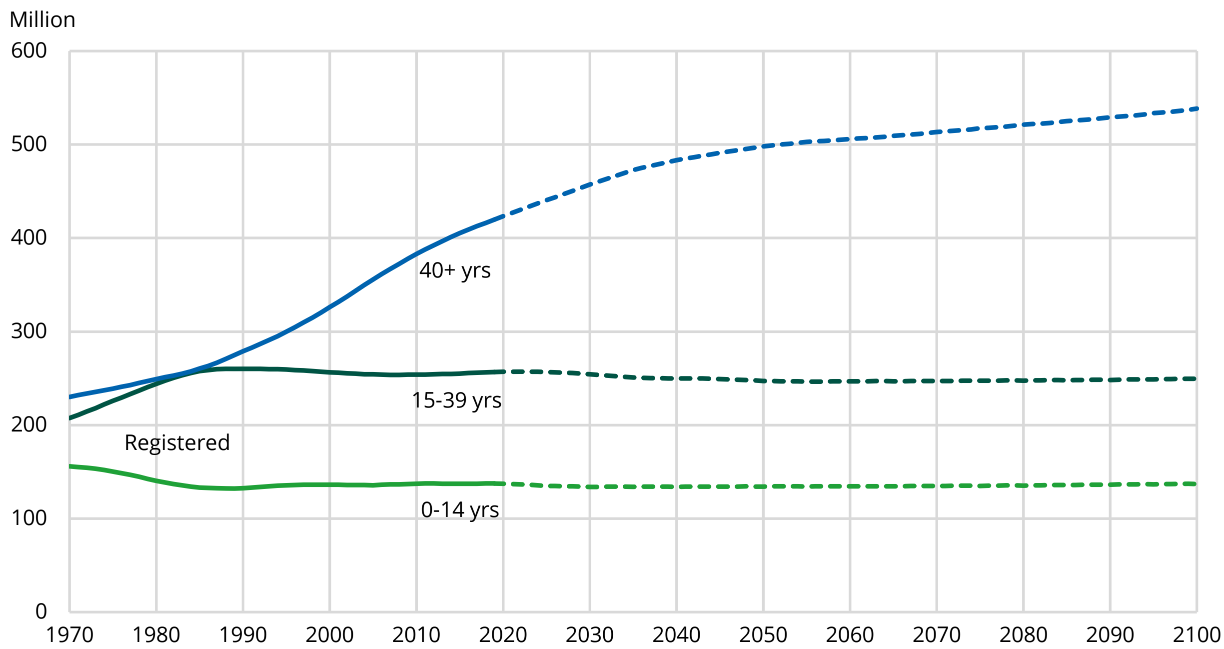
Forecasts of the variables

Once the parameters have been estimated (or 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 population in the three country groups are taken from the most recent United Nations population projections (United Nations 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

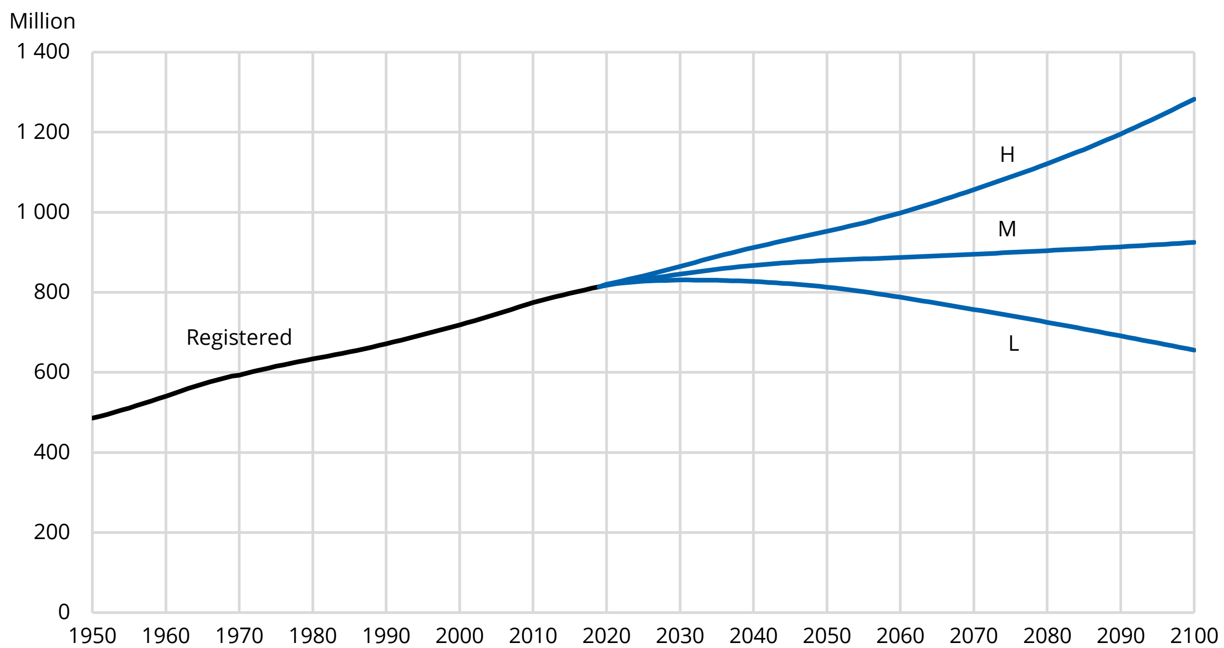
United Nations we have access to data for each fifth year, i.e. the years 2020, 2025, ..., 2100. To obtain values for each of the remaining years, we use piecewise linear interpolation to impute values.

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)

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

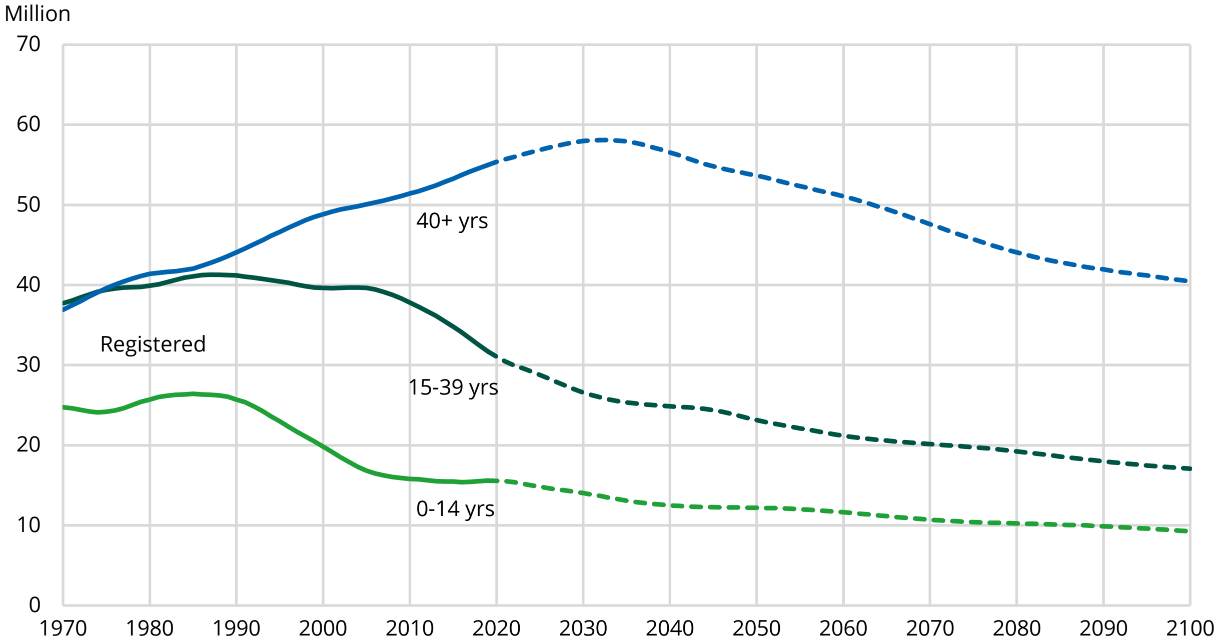


[1] The alternatives are probabilistic forecast medium variant (M), low-fertility variant (L) and high-fertility variant (H).
Source: United Nations (2019)

Figure 7.10 depicts the projected change in the age distribution for Country Group 1. While the number of children has been approximately 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 approximately 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 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, decline or increase.

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 people 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 emigrated 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.

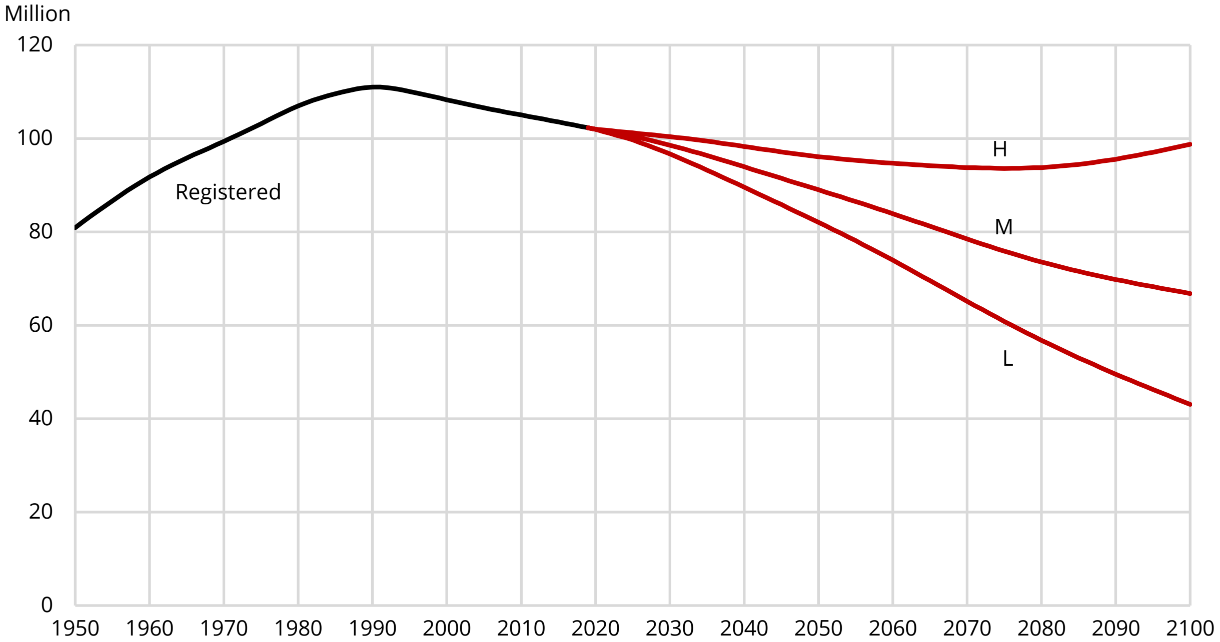
Figure 7.12 Population in Country Group 2 in three age groups, registered 1970–2019 and projected 2020-2100 by the United Nations, medium variant



Source: United Nations (2019)

The total population of Country Group 2 is currently around 100 million (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 Group 2 were constant, the decline in the population alone would lead to a strong reduction in annual immigration to Norway.

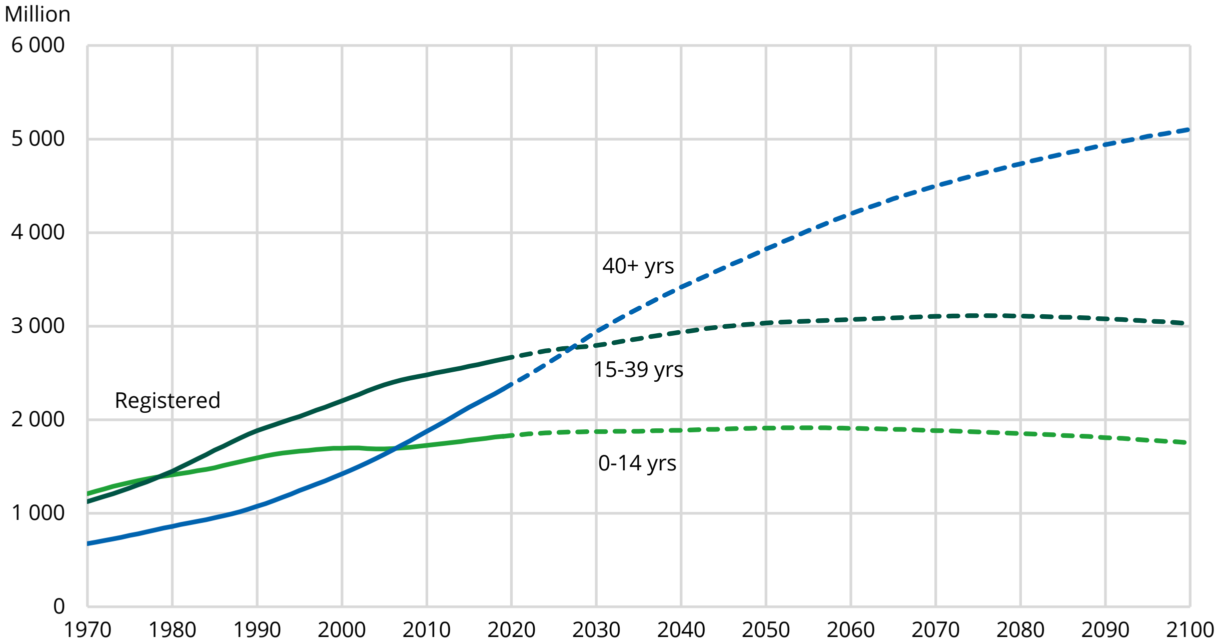
Figure 7.13 Total population in Country Group 2, registered 1950–2019 and projected 2020-2100 by the United Nations in three alternatives[1]



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

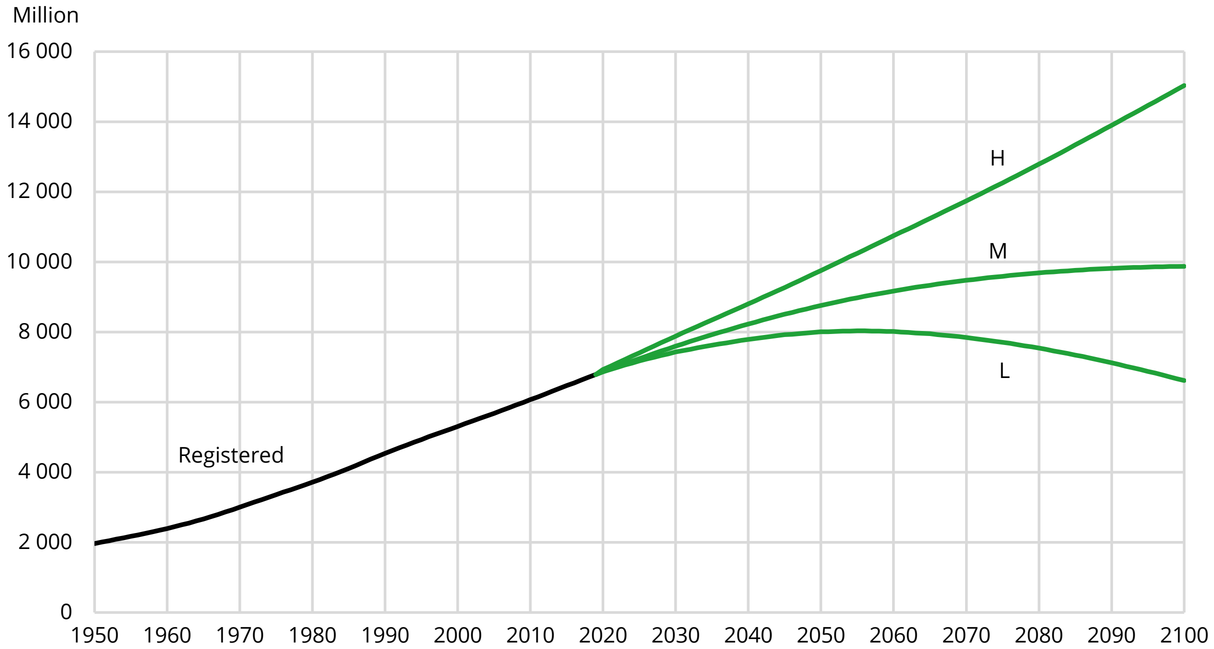
Country Group 3 has by far the largest population among the three country groups. The figures below show the historical development as well as the projected trends in the size of the three age groups (Figure 7.14) and the total population (Figure 7.15). According to the United Nations forecast, the population 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 (to 15 billion by 2100). 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]

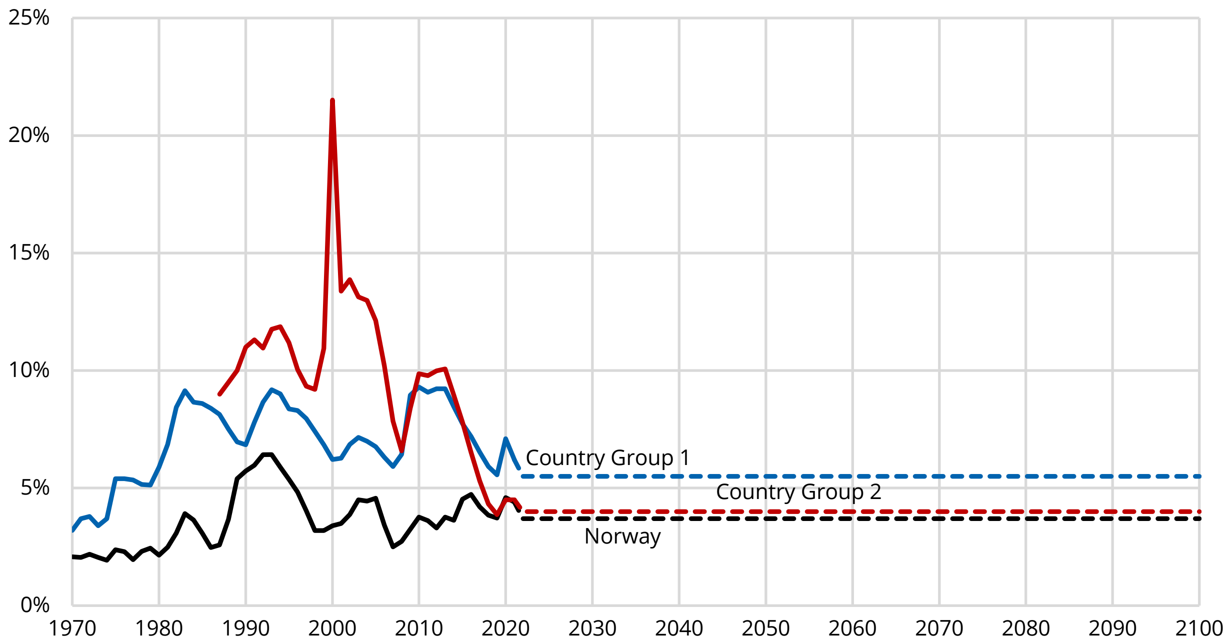


[1] The alternatives are probabilistic forecast medium variant (M), low-fertility variant (L) and high-fertility variant (H).
Source: United Nations (2019)

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 projections made in 2020. Once the number of immigrations has been predicted, the population projection model (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 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.

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 (3.7 percent). In recent years the unemployment rate in Country Group 2 has significantly reduced. We assume that it will stay at a low level (4 percent) in the long run. For Country Group 1, the unemployment rate has also recently declined. In the long term, the unemployment rate is expected to stay at a fairly low level (5.5 percent) when compared to previous decades (see Figure 7.16). The changing demographic structure in Country Groups 1 and 2 is one reason why we think this is a reasonable long-run assumption. The unemployment rates are assumed to be the same in all three scenarios.

Figure 7.16 Unemployment rates in Norway and Country Groups 1 and 2, registered 1970-2021 and assumed future values 2022-2100

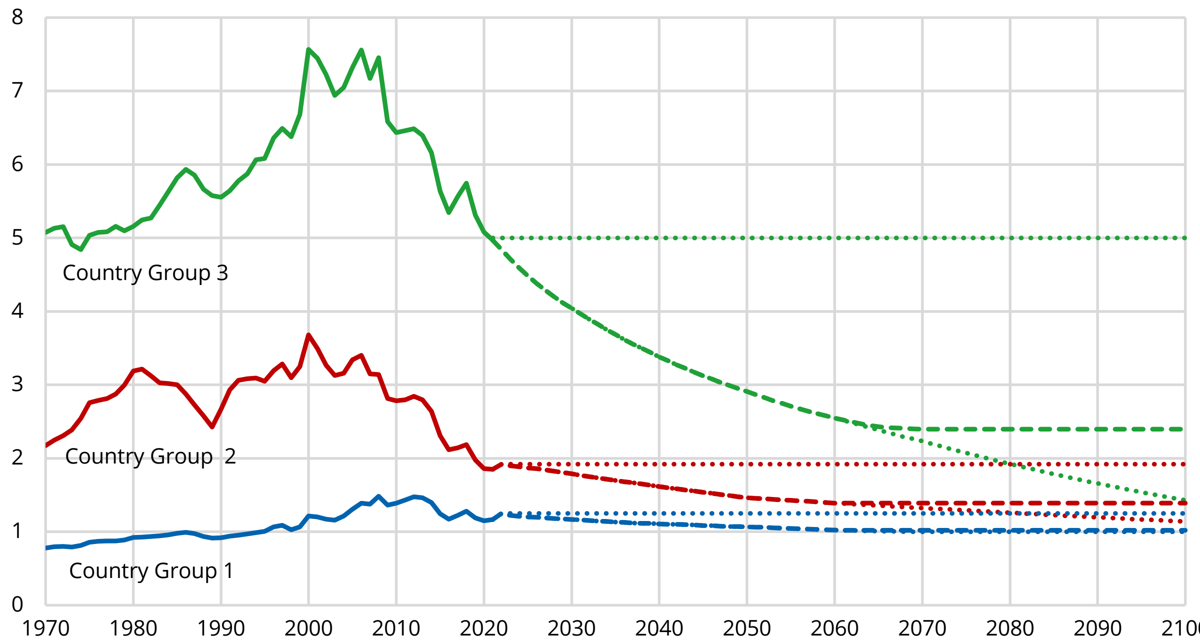


Source: OECD, Eurostat and Statistics Norway

Three alternative paths have been made for future income development (low, medium and high alternatives). They reflect 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 relative income levels have simply been extended from an estimated level in 2022. 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 absolute convergence in relative incomes between Norway and the three country groups, also in the very long run. The effects on the world economy of the COVID-19 pandemic and the war in Ukraine make it difficult to forecast relative incomes in the short run. If all countries are negatively affected in a roughly similar fashion, this moderates the effect on relative incomes. However, the Norwegian economy is highly affected by changes in the prices of crude oil and natural gas and currently enjoys dramatic terms of trade improvements, which affects relative incomes this year. We have assumed that energy prices fall from next year, onwards, to more normal levels so that the relative increase in Norwegian incomes is short lived.

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 extrapolating the 2022 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 5 in 2021 to about 2.4 in 2070 and thereafter it remains constant for the remainder 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 to the medium alternative in the income ratio until 2060. In this year the income ratio is set to about 2.55. From this level, the income ratio in the low scenario decreases further, to around 1.43 in 2100. Thus, according to the low scenario, (PPP-adjusted) GDP per capita in Norway is only 43 percent higher than the corresponding level in Country Group 3. In the high scenario, the income ratio is set to the constant value of 5 for the entire projection period.

Figure 7.17 Relative GDP per capita, registered 1970–2021 and assumed paths 2022-2100 in three alternatives



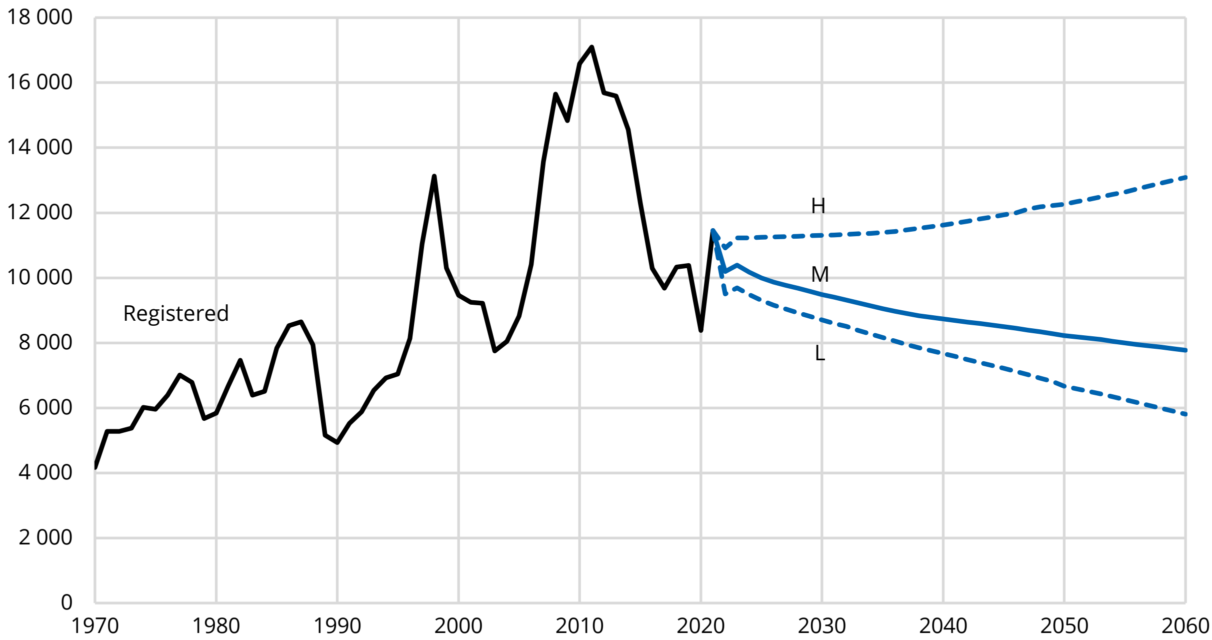
Source: World Bank and Statistics Norway

Immigration forecasts for the three country groups

The estimated equations corresponding to equations (7)-(9) are utilised for dynamic projections. First, the unknown parameters are replaced by their estimates (or calibrated values) and the residuals are set to zero. Second, the log of the immigration rate of the age groups is forecasted and the rates are then multiplied with corresponding population forecasts from the United Nations. For Country Group 3, the forecasts are based on a more elaborated procedure. 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 2022-2100. 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.

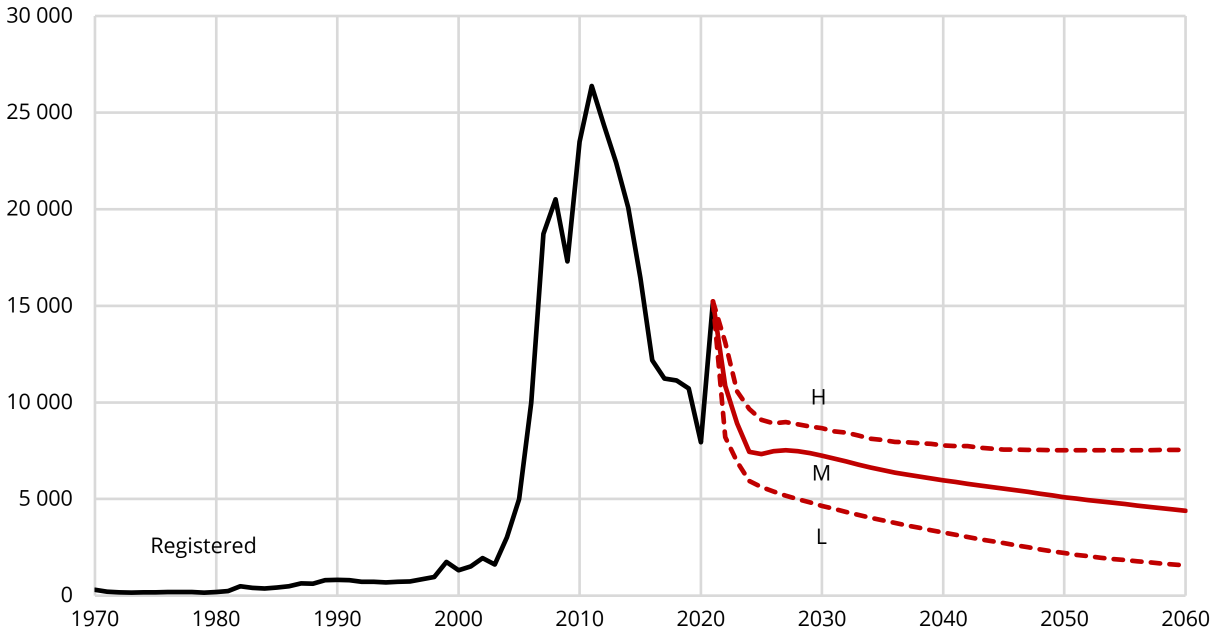
Figure 7.18 shows gross immigration to Norway from Country Group 1. Immigration from Country Group 1 in 2021 was higher than it had been since 2015, which appears to be driven by the postponement of immigration during 2020. As such, our medium alternative shows a relatively sharp initial decline in 2022, which after a small increase in 2023 is followed by a more gradual decline in annual immigrations thereafter. This decline is mainly due to lower relative incomes for Norway, making Norway a less attractive country to live and work in compared to what has been the case in previous years. According to the United Nations population projections, the growth of the population in Country Group 1 is expected to be fairly modest, primarily driven by an increase in the population aged 40 and over, and this contributes to only a moderate change in immigration to Norway. In the medium assumption scenario, gross immigration from Country Group 1 is projected to fall to 8 500 in 2040, before stabilizing at between 7 500 and 8 000 from 2060 onwards. In the high alternative, relative incomes are held constant and the small increase in immigration is mostly due to population growth in Country Group 1. This results in a gradual increase in gross immigration for Country Group 1, to 11 500 persons in 2040 and 13 000 persons in 2060. The low alternative differs only marginally from the middle alternative when it comes to relative incomes, so it is a smaller population in Country Group 1 that drives a stronger reduction in immigration to Norway. In this scenario, gross immigration falls to 7 500 in 2040 and below 6 000 in 2060.

Figure 7.18 Gross immigration to Norway from Country Group 1, registered 1970–2021 and projected 2022–2060 in three alternatives[1]



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

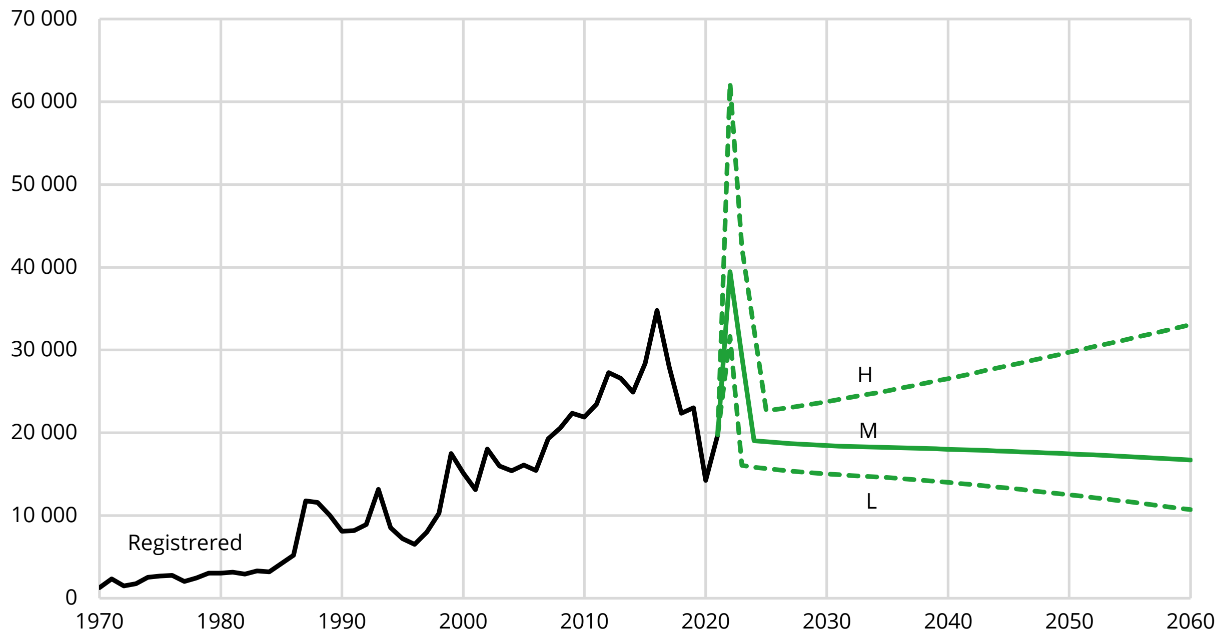
Figure 7.19 Gross immigration to Norway from Country Group 2, registered 1970–2021 and projected 2022–2060 in three alternatives[1]



[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 post-2004 EU-expansion is quite dramatic. The recent decline in immigration is mainly due to the relatively positive economic development in Eastern European EU countries over the last decade, with the sharp increase in 2021 thought linked to a temporary catch-up effect associated with the relaxation of COVID-19 travel restrictions. Our assumption regarding relative incomes in Figure 7.17, is that positive economic development in Country Group 2 will continue. Together with a decline in the population, this will lead to a decline in gross immigration to Norway in all three alternatives. In the medium assumption scenario, gross immigration from Country Group 2 is projected to fall to 6 000 in 2040, 4 500 in 2060 and 3 000 by 2100. The low assumption scenario projects the gross numbers for 2040 and 2060 to be 3 000 and 1 500, while the corresponding numbers for the high assumption scenario are 8 000 and 7 500, respectively.

Figure 7.20 Gross immigration to Norway from Country Group 3, registered 1970–2021 and projected 2022–2060 in three alternatives[1]



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

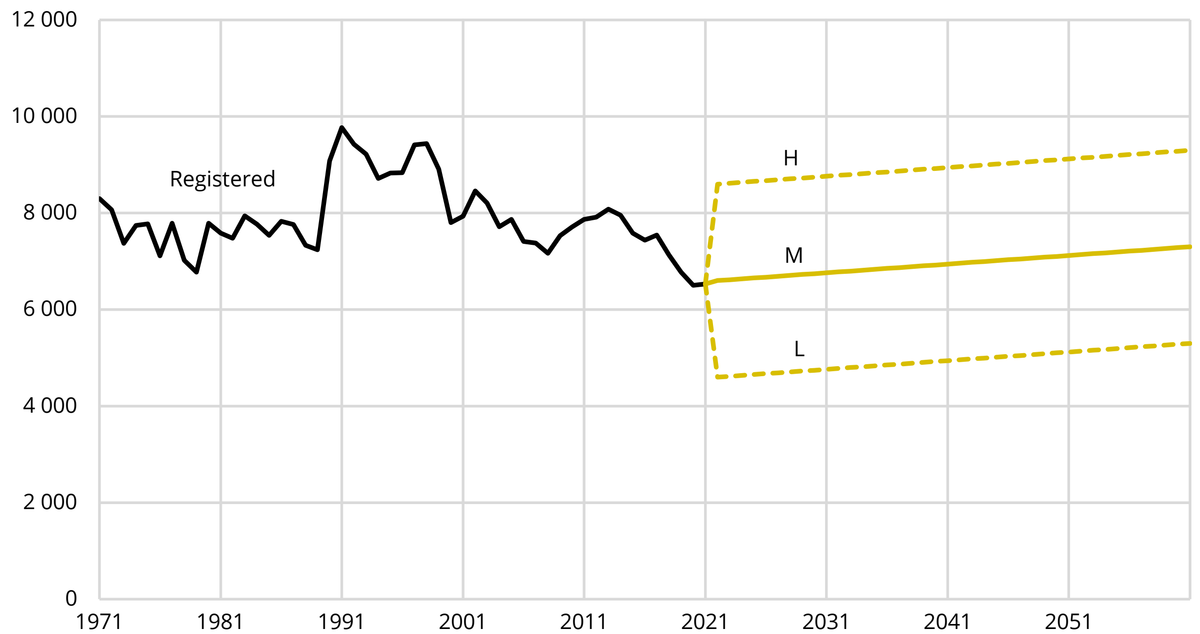
Figure 7.20 shows the projected immigration of persons from Country Group 3 according to the three alternatives. The war in Ukraine is assumed to have a strong influence on immigration from this group in the short term (see Section 7.1). In the medium assumption scenario, gross immigration from Country Group 3 is projected to be 39 500 persons in 2022 and just over 29 000 in 2023.[27] Thereafter, it shows a weak negative trend, with gross immigration projected to be about 19 000 in 2024, 18 000 in 2040, 16 500 in 2060 and 16 000 in 2100. In the low assumption scenario, gross immigration is assumed to increase to 31 500 in 2022, before falling to 16 000 in 2023, 14 000 in 2040 and 10 500 in 2060.[28] In the high assumption, gross immigration from Country Group 3 is projected to be 62 500 in 2022, 42 500 in 2023 and 32 500 in 2024.[29] Thereafter, gross immigration from Country Group 3 falls to 22 500, before gradually increasing to 26 500 in 2040 and 33 000 in 2060.

[27] The *ad hoc* adjustment to the medium alternative represents an additional 20 000 gross immigrations in 2022, followed by an additional 10 000 in 2023 (30 000 in total).
[28] The *ad hoc* adjustment to the low alternative represents an addition of 15 000 gross immigrations in 2022.
[29] The *ad hoc* adjustment to the high alternative represents an additional 40 000 gross immigrations in 2022, 20 000 in 2023 and 10 000 in 2024 (70 000 in total).

7.4. Immigration of non-immigrants

Every year, a number of people with a Norwegian background return to live in 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 assumed marginal increase in the trend towards 2100 (see Section 4.3 for details). In our medium assumption, we expect the immigration of 'non-immigrants' to increase somewhat, from around 6 500 today to 7 300 in 2060. In the high assumption, the increase is stronger, to 9 300 in 2060, and in the low assumption the number is reduced to around 5 300 in 2060 (Figure 7.21).

Figure 7.21 Gross immigration to Norway for non-immigrants, registered 1970–2021 and projected 2022-2060 in three alternatives[1]



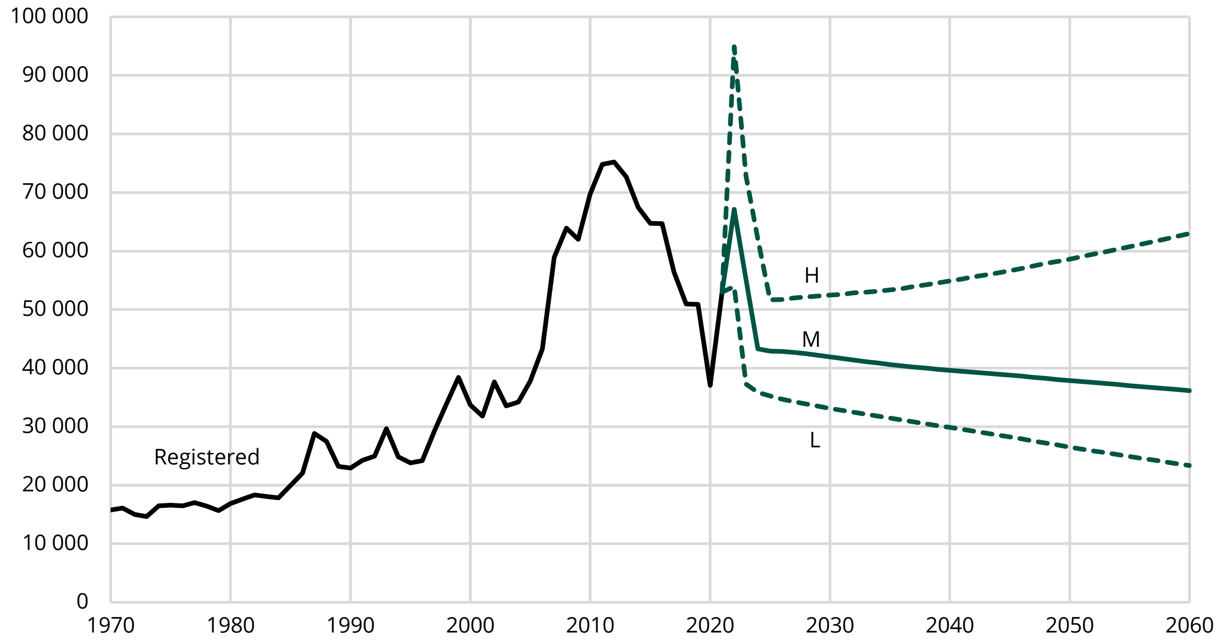
[1] The alternatives correspond to the medium (M), low (L) and high (H) immigration assumptions. They do not depend on any assumptions used for the other components.
Source: Statistics Norway

7.5. The uncertainty associated with 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 *ad hoc* adjustments made to Country Group 3 have quite substantial short-term effects on the total gross immigration to Norway. Thereafter, the yearly immigration to Norway in the medium alternative is expected to decline gradually to annual levels just over 36 000 by 2060 and 35 000 by 2100. With that said, 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. Under the low immigration alternative, all groups experience reduced immigration, and the overall annual level declines to around 23 000 in 2060 and 15 000 in 2100. Meanwhile, the high immigration alternative projects a high and increasing immigration, reaching almost 63 000 by 2060 and almost 81 000 by 2100.

In a long-term perspective, uncertainties relate to, for instance, the assumed paths for the explanatory variables in the model, such as income disparities, immigrant stocks and unemployment rates. Furthermore, despite the model accounting for several factors that influence immigration, there are many other factors that can have a large bearing on immigration but that are challenging or impossible to predict. This applies not least to future political changes, such as a future EU expansion and changes in European and Norwegian asylum and immigration policies. While these factors primarily affect the demand side, wars, conflicts and natural disasters are examples of supply side factors that can have marked impacts on immigration. Indeed, history has shown us that after large influxes, policies are often put in place to reduce future entries, such as was the case in the aftermath of the so-called refugee crisis in Europe in 2015-2016. In addition to the difficulties in predicting when and where wars will break out or end, attempts to reasonably quantify the political response to future influxes of immigration would likely prove fruitless.

Figure 7.22 Total gross immigration to Norway, registered 1970-2021 and projected 2022-2060 in three alternatives



Source: Statistics Norway

Immigration to Norway could be higher or lower than our main assumptions suggest. It will likely be higher if new wars break out or the current conflict spreads more widely. Moreover, for as long as the war in Syria continues, there remains potential for the arrival of new Syrian refugees. Refugee arrivals from Afghanistan have increased in the last year as a response to the deteriorating social and economic conditions in the country. On the other hand, immigration may realistically be lower if, for example, future global pandemics emerge.

Further enlargement of the EU is also likely to increase 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. The enlargement in 2013 (Croatia) is hardly visible, though the accession of a single (and 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 gain admission to the EU.[30] For the others, the implications for immigration to Norway may be similar to that experienced after the accession of Croatia (which has approximately 4 million inhabitants).

[30] Early stage processes and talks about possible future EU accession are also ongoing in other countries, such as Georgia, Moldova and Ukraine. Bosnia and Herzegovina applied for EU membership in 2016.

Figure 7.19 presented 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 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 2022), 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 this year's projections (and discussed in Chapter 1), 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). At the same time, countries in this group may reach levels of affluence that make emigration less attractive, while economic development could also make these countries attractive destinations for migrants from poorer parts of Country Group 3. 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. Our model does not give much consideration to how other potential destination countries may become more (or less) attractive to potential migrants, i.e. third country effects. Last, but not least, the future effects of climate change have the potential to influence the size of immigrant flows to Norway – a topic that is discussed in more detail in Tønnessen (2014).

Our model does not predict political changes, nor changes to long-term global migration patterns. 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.

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 Figure 7.34, a growing number 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. Indeed, some have arrived as children. If the network effect diminishes with duration of stay, our estimates for the future effect may be too high.

Prior to 2020, our projections did not account 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, the expected ageing of populations in many regions of the world (Figures 7.10, 7.12 and 7.14) should result in lower rates of international 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.

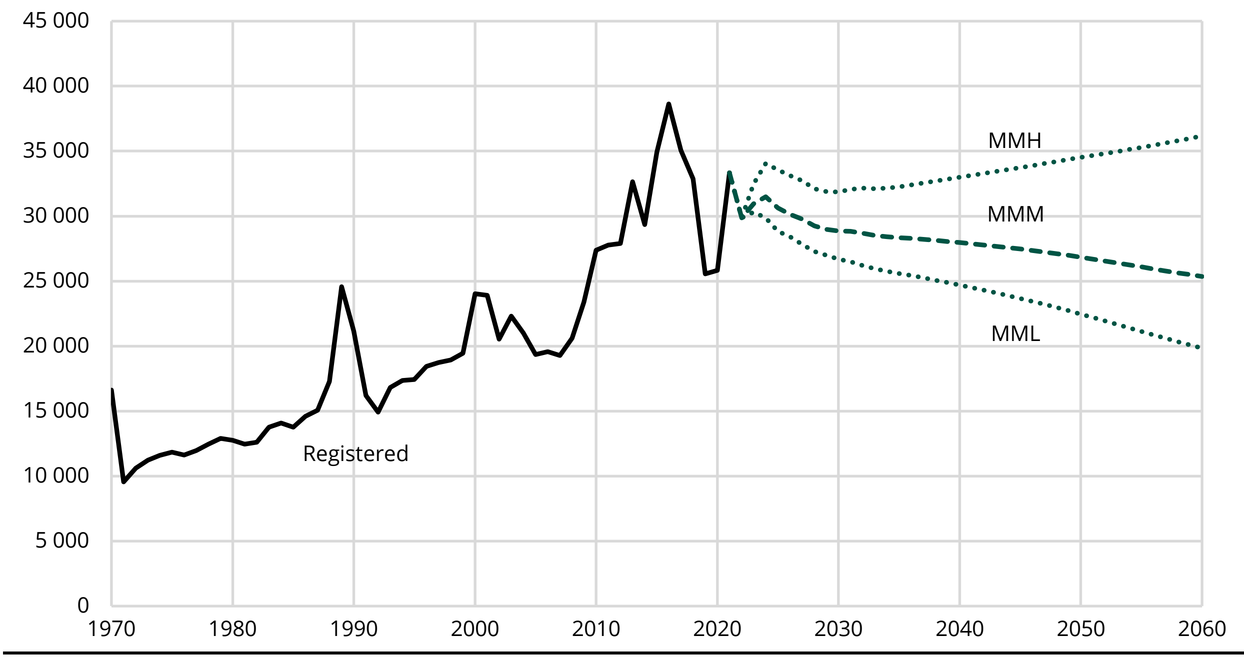
Taken together, migration projections are inherently uncertain, and often far more uncertain than those of the other two demographic components (Thomas et al. 2022). The uncertainty usually increases the further into the future we look. However, due to the ongoing war in Ukraine, it has been especially challenging to formulate even short-term migration assumptions in this year's projections. How long the war will last, how severe the refugee crisis and related economic impacts will be, is unclear. In our projections, we have assumed a return to relative normality in 2023 in the low alternative, 2024 in the medium alternative, and 2025 in the high alternative, decisions that are again open to much debate.

7.6. Emigration from Norway

Emigration in the population projections is calculated using emigration probabilities derived from recent trends in the registered data (see Section 4.3 for details). As shown in Figure 7.9, non-immigrants have the lowest propensity to emigrate, followed by immigrants from Country Groups 3, 2 and, lastly, 1. Emigration propensities are highest in the first few years following immigration to Norway and decrease 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 typically only define a medium emigration assumption.[31] 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. Given that the duration of the war in Ukraine remains unknown, we have not included any *ad hoc* adjustments to the emigration probabilities.

Figure 7.23 shows projected emigration from Norway, in three alternatives. The high and the low alternatives refer to high (MMH) and low (MML) immigration, respectively. As is evident from Figure 7.23, the main alternative projects emigration to generally decline from around 30 000 to around 25 000 in 2060. In the low immigration alternative, we assume a more pronounced decline in emigration, to around 20 000 in 2060. In contrast, in our high immigration alternative, around 36 000 are projected to emigrate in 2060.

Figure 7.23 Emigration from Norway, registered 1970–2021 and projected 2022–2060 in three alternatives



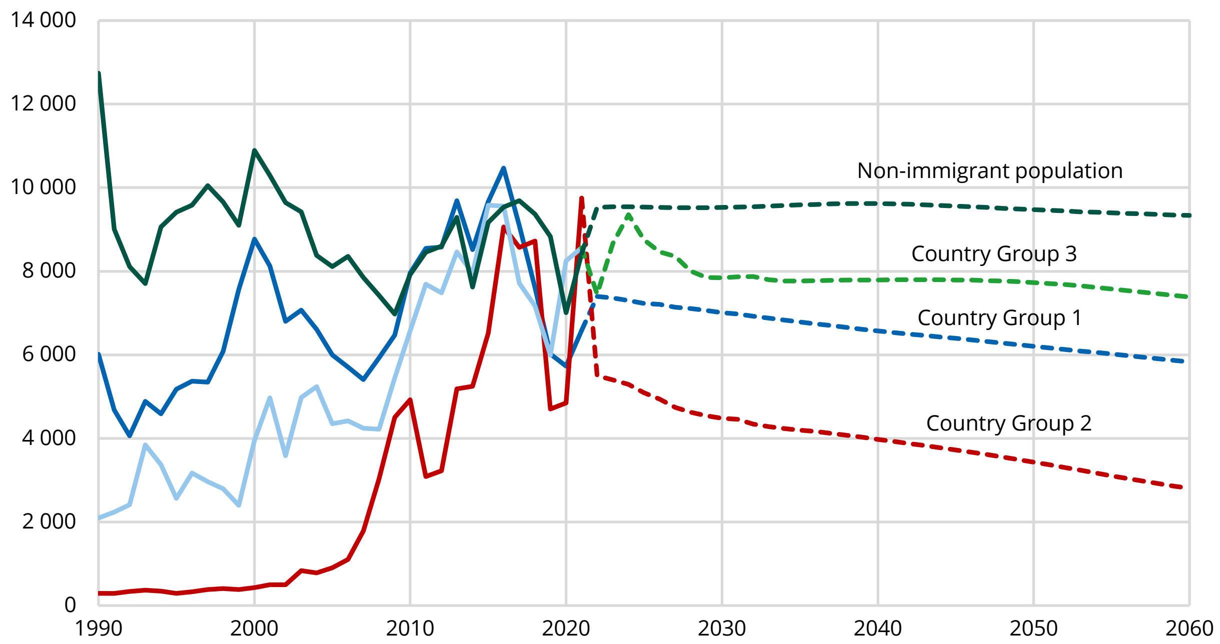
Source: Statistics Norway

As stated, emigration propensities are far higher among immigrants than among non-immigrants, although, as the population at risk is so much larger for non-immigrants, the difference in the total number of emigrations is fairly similar between the two groups. This is evident if we compare the

[31] 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).

registered number of emigrations, in Figure 7.24, with the emigration rates shown in Figure 7.9. In Figure 7.24 we see a decline in the emigration of immigrants from Country Groups 1 and 2, which results from the expected reduction in immigration from these groups. Immigrants from Country Group 3 are expected to see relatively high numbers of future emigrations in the short term, which is linked to the sharp short-term increase in immigration from this group. Thereafter, and despite the stock of immigrants from Country Group 3 increasing up to 2060, emigrations are expected to fall. The emigration numbers for non-immigrants are expected to remain stable. This latter group also includes persons born in Norway to two immigrant parents, a group that is expected to increase markedly in size up to 2060.

Figure 7.24 Emigration from Norway for immigrants from three country groups and the rest of the population, registered 1990–2021 and projected 2022–2060, 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. The recent implementation of dual citizenship, which took effect 1 January 2020 (www.udi.no/en/word-definitions/dual-citizenship/), may also affect future emigration propensities. It is, however, difficult to know whether the effects will be sizeable. Beyond this, the duration and cessation of wars can influence emigration propensities (see Section 7.1), while population ageing in the country of origin might work to encourage migrant workers to return due to an increased demand for labour or a need to assist older family members. Developments in the EU – and any changes in the practice of freedom of movement – could also have a major impact on emigration.

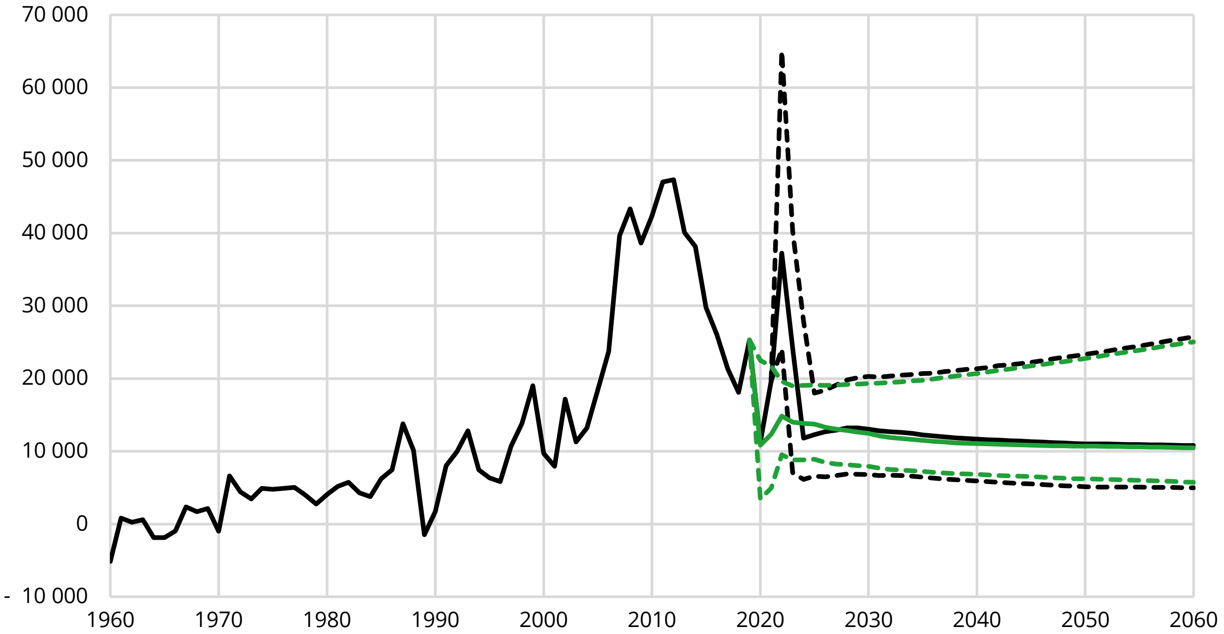
7.7. Net migration

Net migration is calculated by deducting emigrations from immigrations for a given year.[32] The projected net migration for the 2022 projections is shown in Figure 7.25, together with the net migration we projected in 2020. The current projections are very close to the previous projections, for all alternatives, except for the initial years which are affected by our *ad hoc* adjustments. Both

[32] Prior to 2011, specific assumptions about future net migration were made. Since then, net migration is simply a calculation based on the assumed gross immigrations and emigrations.

models employed the same forecasting methodologies, which forecast immigration for three age groups from each of the three country groups. The slightly lower net migration observed in the low alternative in 2022 reflects the fact that relative incomes are now lower due to revisions in the most recent GDP data. Net migration in the 2022 main alternative is 37 500 in 2022 and 24 000 in 2023, after which it broadly stabilises at between 10 000-14 000 per year to 2100.

Figure 7.25 Total net migration, registered and projected in the 2020 (green) and 2022 (black) projections in three alternatives, 1960-2060



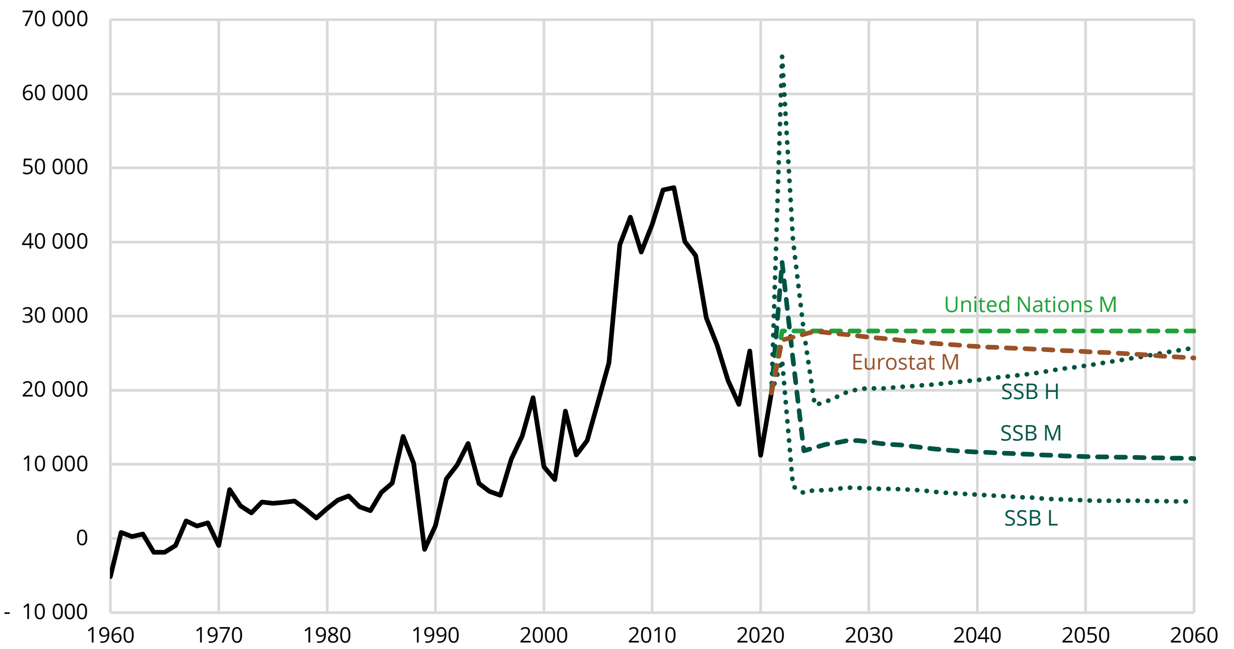
Source: Statistics Norway

7.8. Projected net migration from an international perspective

Both Eurostat (2020) and the United Nations (2019) have published 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). [33] The United Nations (2019) projections published estimates for five-year periods, with the calculated figures suggesting a yearly net migration of 28 000 (140 000 for a five-year period). It assumes a constant net migration until 2100 for Norway. The Eurostat (2020) projections published 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 7.26, 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.

[33] At the time of writing, Eurostat (2020) and United Nations (2019) remain the most recent versions of these projections. New UN projections are due in Summer 2022, while new Eurostat projections are expected in 2023.

Figure 7.26 A comparison of net migration projections from the United Nations, Eurostat and Statistics Norway, registered 1960-2021 and projected 2022-2060 in five alternatives[1]



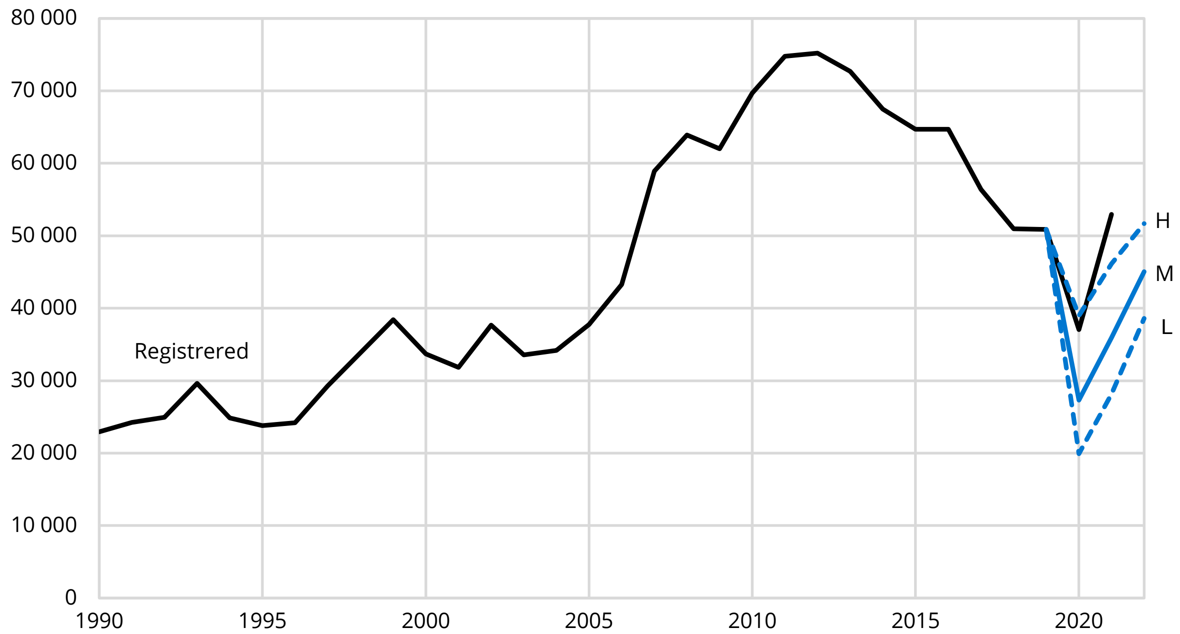
[1] The medium variant (M) is shown for United Nations, whereas the baseline scenario (M) is shown for Eurostat. Statistics Norway's (SSB) net migration figures are shown in the main (M), low immigration (L) and high immigration (H) alternatives.
Source: Statistics Norway, United Nations and Eurostat

7.9. Accuracy of the last projection

The last round of population projections was published in June 2020. It assumed a lower immigration and population growth than the 2018 projections (see Chapter 1, Figure 1.20). 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. With that said, the 2020 projections had to contend with the specific uncertainty associated with the COVID-19 pandemic. In this section, we assess the short-term accuracy of the 2020 projections. A thorough review of the accuracy of previous population projections is given in Thomas et al. (2022).

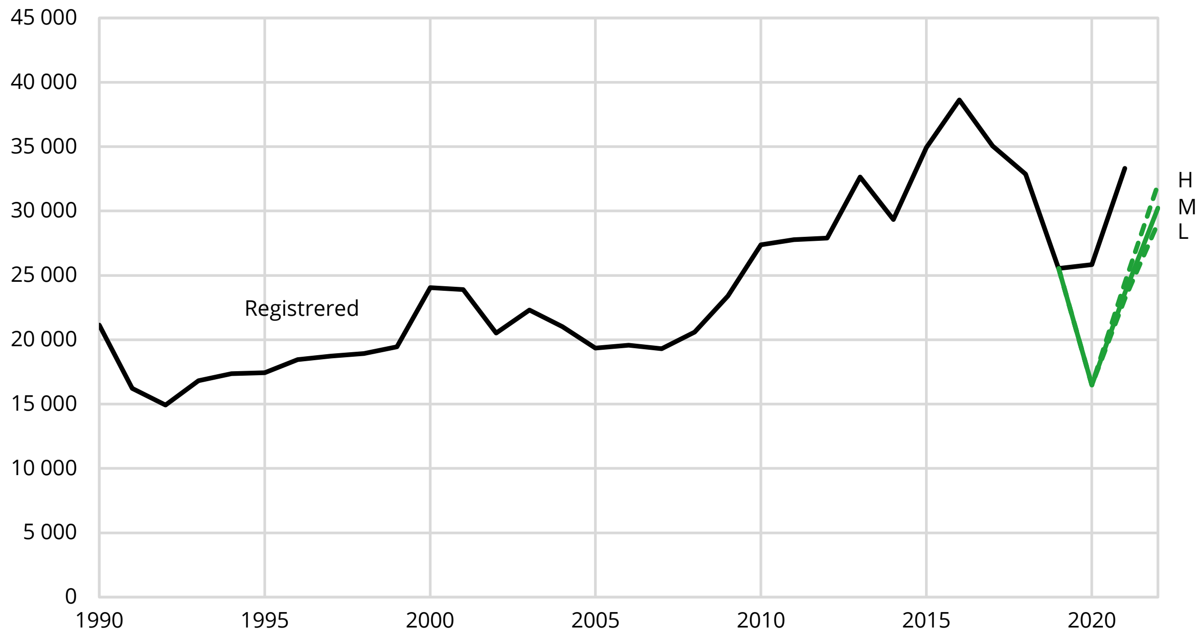
Figures 7.27-7.29 compare registered immigration, emigration and net migration for 2020 and 2021 with the comparable measures from the main (MMM), low (LLL) and high (HHH) national growth alternatives produced in 2020. The registered figures show that immigration to Norway in 2020 was almost 10 000 higher than what was assumed in the medium alternative and was close to what was assumed in the high alternative. For 2021, the actual figure was 17 000 higher than was assumed in the medium alternative and almost 7 000 higher than the high alternative. The assumed negative effects of COVID-19 on immigration in 2020 were clearly too strong, while the recovery in international migration was also assumed to be weaker than it was in reality. A similar scale of short-term discrepancies occurred in the 2016 projections, wherein an overestimation of 10 000 immigrations from Country Group 3 emerged in 2017, linked to the Syrian refugee crisis. Registered emigration was also higher than we projected, for both 2020 and 2021, as shown in Figure 7.28. If we assume part of the jump in immigrations and emigrations in 2021 was temporary in nature, linked to the postponement of people who would have otherwise immigrated or emigrated in 2020, the registered figures for 2022 may move closer to the projected figures.

Figure 7.27 Immigration to Norway, registered 1990–2021 and projected in the 2020 projection



Source: Statistics Norway

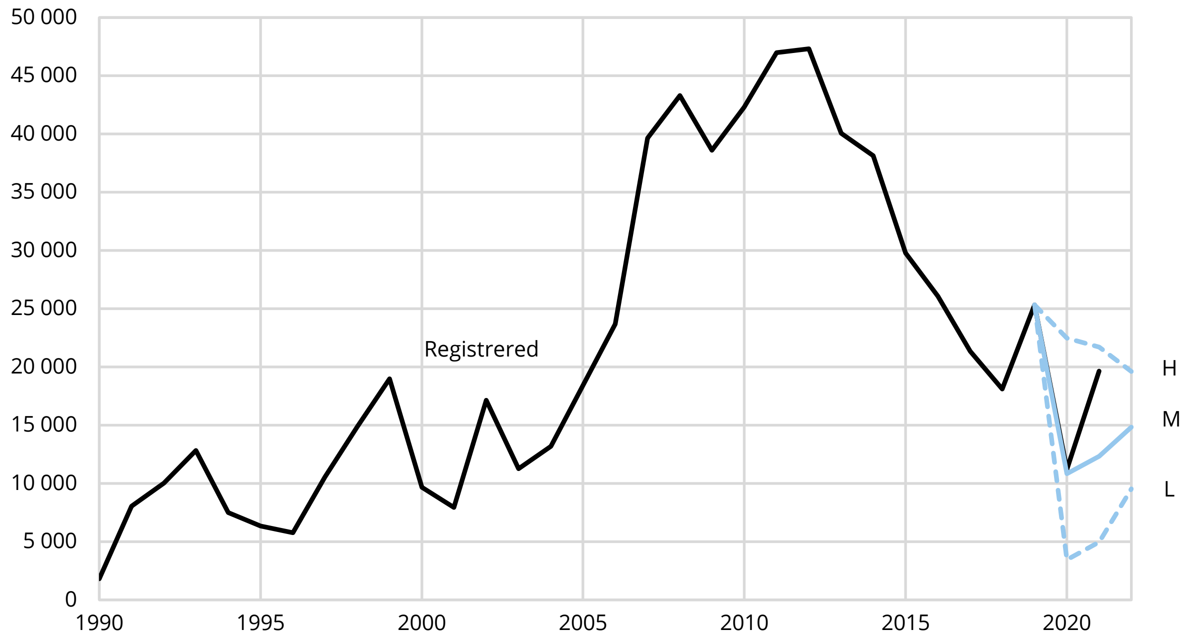
Figure 7.28 Emigration from Norway, registered 1990–2021 and projected in the 2020 projection



Source: Statistics Norway

By projecting both lower immigration and emigration than was observed in the registered data, the projected net migration fared better. As can be seen in Figure 7.29, the actual net migration was almost identical to the main alternative in 2020, with a deviation of less than 400, before the registered net migration moved closer to the high alternative in 2021.

Figure 7.29 Net migration, registered 1990–2021 and projected in the 2020 projection



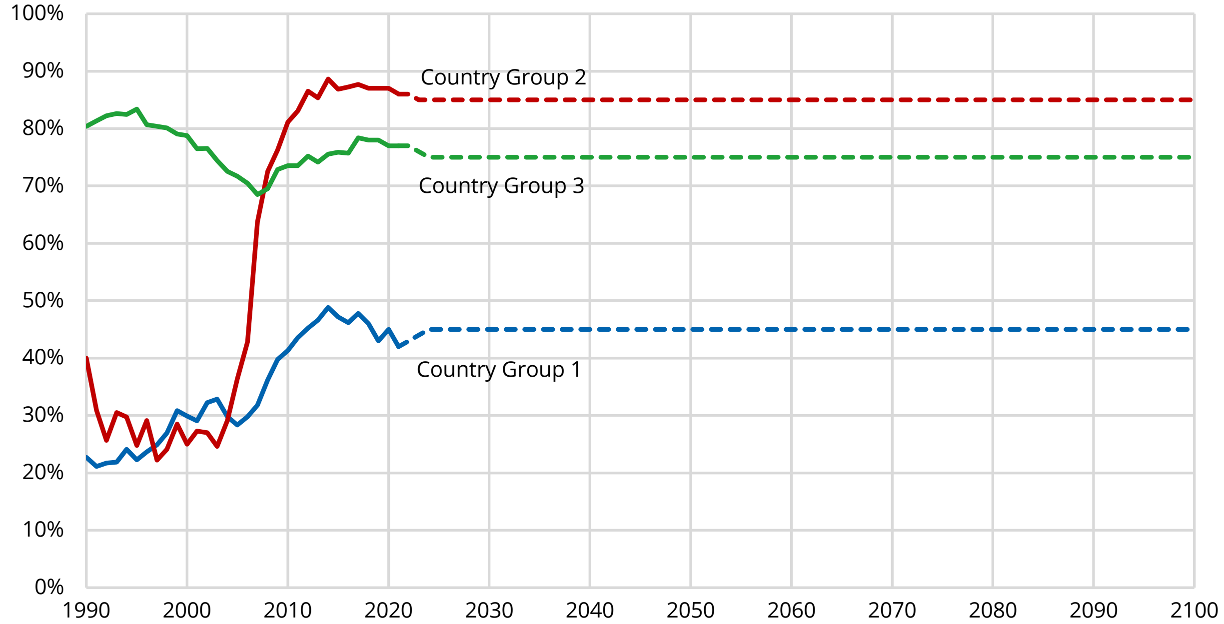
Source: Statistics Norway

7.10. Norwegian-born children with two immigrant parents

Through the projections of immigration and emigration (together with assumptions for future fertility and mortality), one may derive estimates of the future number of immigrants and Norwegian-born children with two immigrant parents. To calculate the number of Norwegian-born children with two immigrant parents, we also need to make assumptions about the proportion of immigrant women who will have children with immigrant men. These latter assumptions are based on assessments of observed trends for each of the country groups, as shown in Figure 7.30.

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 following the eastward expansion of the EU, but the growth has stopped in recent years. We have assumed a slight decline in the future share, to 85 percent, as the future immigrant population will consist of more people with longer durations of stay and thus higher likelihoods of being more closely integrated into Norwegian society. Likewise, for Country Group 3, we expect the proportion to remain at levels comparable to those seen recently (75 percent). The proportion of Country Group 1 women's children who have a father who is also an immigrant is low, at least when compared to the other groups. The proportion peaked in 2014, at 49 percent, before steadily declining to 42 percent in 2021. Despite the low proportion among this group, there is reason to believe that a rising share of immigrants in Norway will increase the number of potential immigrant partners. We have therefore set the proportion for Country Group 1 to 45 percent.

Figure 7.30 Proportion of children born to an immigrant woman, where the child's father is also an immigrant, for three country groups, registered 1990–2021 and projected 2022-2100

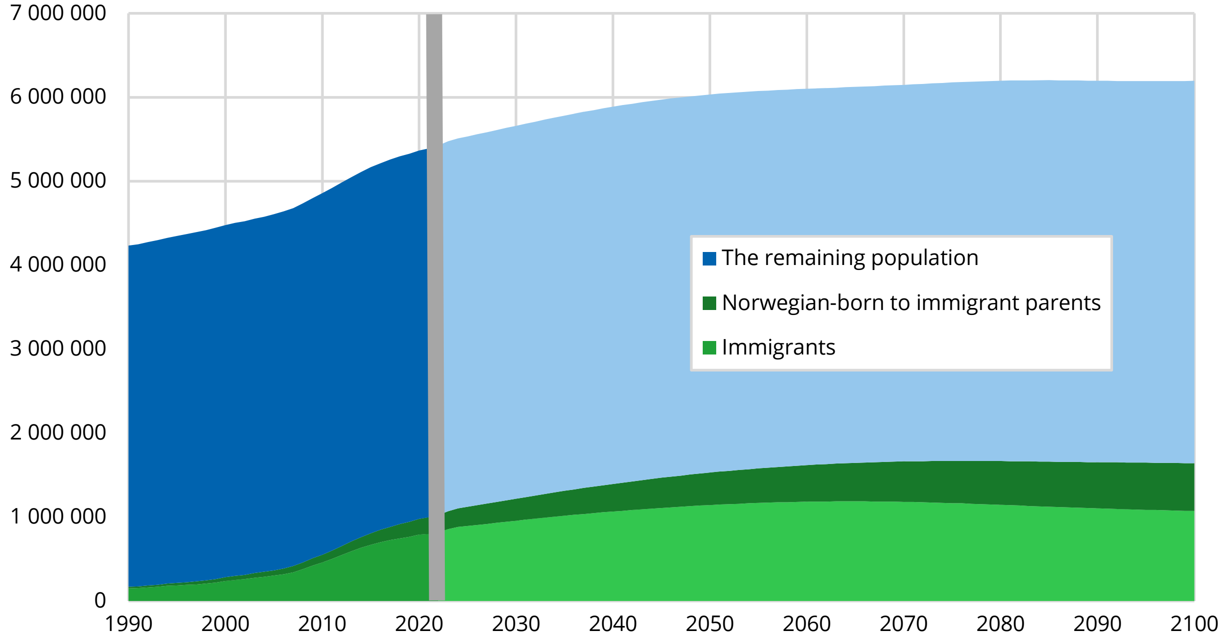


Source: Statistics Norway

7.11. Immigrants and their descendants in the years ahead

Figure 7.31 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 819 000 today, to around 1.19 million shortly after 2060, before it declines to 1.07 million by 2100.

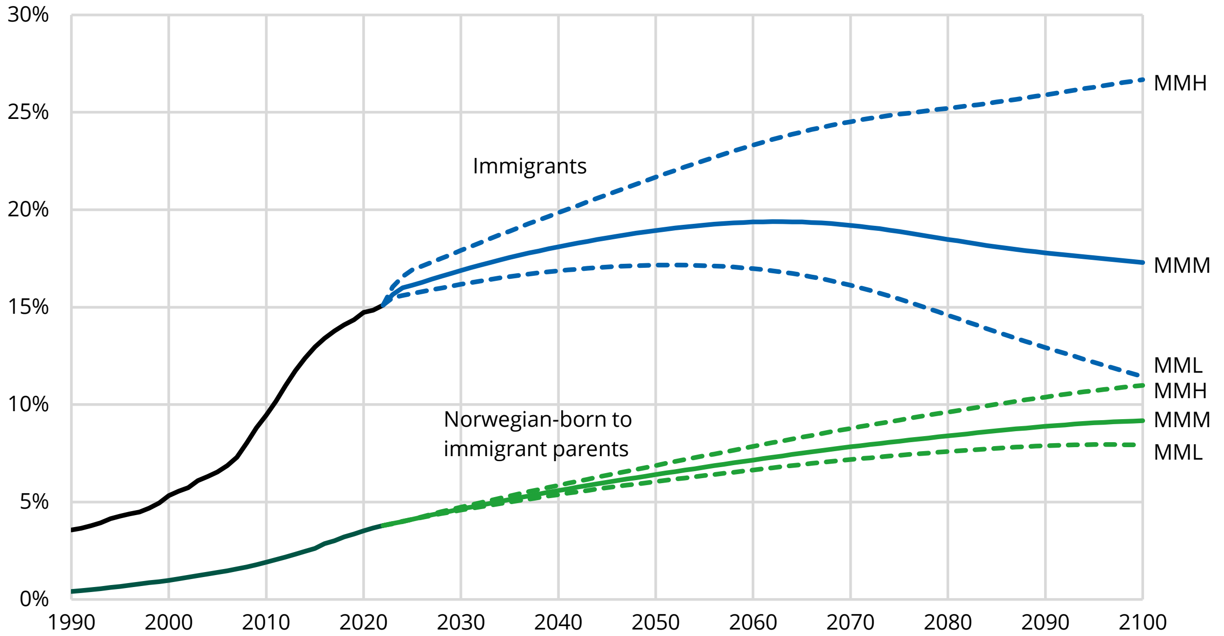
Figure 7.31 Immigrants, persons born in Norway to two immigrant parents and the rest of the population, registered 1990–2022 and projected 2023-2100, main alternative (MMM)



Source: Statistics Norway

Today, immigrants make up 15.1 percent of the population in Norway, while Norwegian-born to two immigrant parents constitute 3.8 percent. How high these proportions will be in the future largely depends on future trends in immigration and emigration. Figure 7.32 show this development in the main alternative, as well as in the alternatives for high and low immigration.

Figure 7.32 Immigrants and Norwegian-born to two immigrant parents as a relative proportion of the total population, registered 1990–2022 and projected 2023–2100 in three alternatives[1]



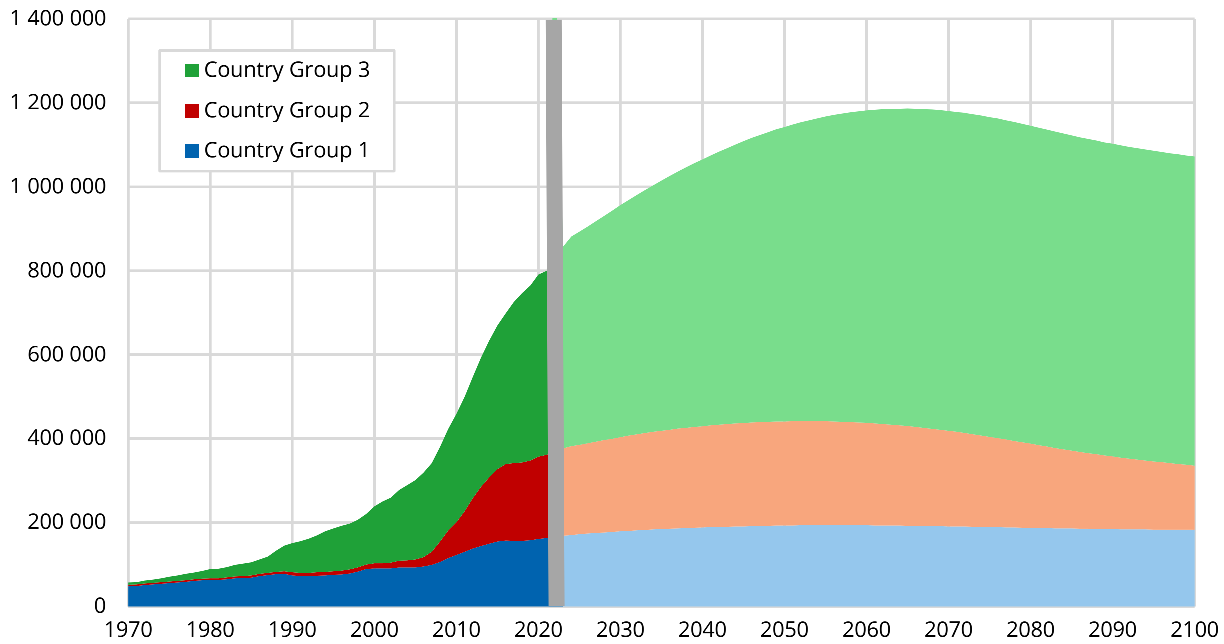
[1] The alternatives are main (MMM), low immigration (MML) and high immigration (MMH)
Source: Statistics Norway

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 17 (11, 27) percent. The Norwegian-born children to two immigrants will, however, continue to increase, and are projected to comprise 9 (8, 11) percent in 2100.

As was shown in Figures 7.18-7.20, we project a decline in immigration from all country groups in our medium alternative. In Figure 7.33, we show the number of immigrants from the three different country groups in Norway, in the main alternative. In 2022, immigrants from Country Groups 1, 2 and 3 comprised 167 000, 203 000 and 449 000 persons, respectively. In 2060, the corresponding figures are 193 000 (low immigration alternative 173 000, high immigration alternative 247 000), 244 000 (low 180 000, high 295 000) and 744 000 (low 621 000, high 1 019 000). Thereafter, the number of immigrants from Country Groups 1 and 2 declines quite markedly – 183 000 and 153 000 persons in 2100, respectively, in the main alternative. The number of immigrants from Country Group 3 continues to increase to around 763 000, in 2075, and thereafter recedes to below the 2060 level by the end of the projection period. The low immigration alternative for Country Group 3 peaks before 2060, at 621 000 persons, and then declines to around 414 000 by 2100. In the high immigration alternative, the number of immigrants from this country group increases across the entire projection period, reaching 1 million by 2060 and around 1.5 million by 2100.

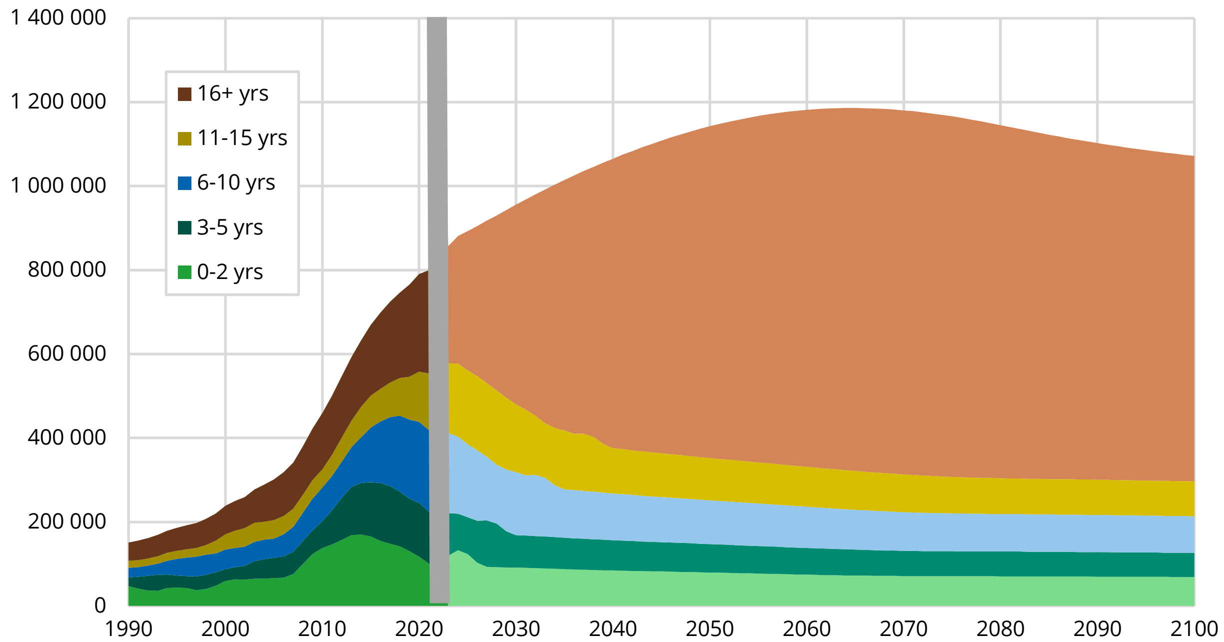
The longer a person has been living in Norway, the less likely he or she is to emigrate. Consequently, when immigration is relatively low, immigrants who have lived in Norway for a long time comprise the group that grows the most, as shown in Figure 7.34. Today, 32 percent of immigrants have lived in Norway for more than 15 years. By 2060, this share is expected to have more than doubled, to 72 percent.

Figure 7.33 Immigrants in Norway by country group, registered 1970–2022 and projected 2023–2100, main alternative (MMM)



Source: Statistics Norway

Figure 7.34 Immigrants in Norway by duration of stay, registered 1970–2022 and projected 2023–2100, main alternative (MMM)

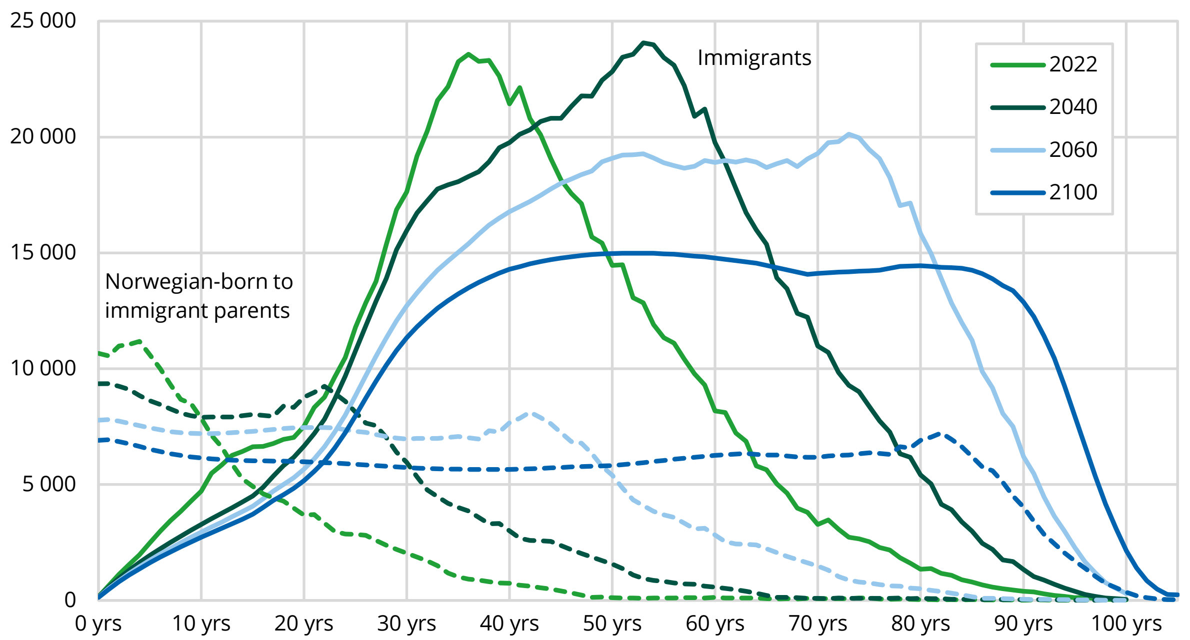


Source: Statistics Norway

As the number of immigrants does not increase in all age groups, we predict a clear ageing of the immigrant population in Norway (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 7.35. 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 dashed green line in Figure 7.35. There will continue to be a relatively large number of young children in this group, but future growth will primarily be among the older age groups.

Figure 7.35 Immigrants (solid lines) and Norwegian-born to two immigrant parents (dashed lines) by age, registered 2022 and projected in 2040, 2060 and 2100, main alternative (MMM)



Source: Statistics Norway

All the figures and estimates shown in this chapter are associated with a degree of uncertainty. 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 the other assumptions we have made – such as emigration probabilities and the distribution of immigrants by age and sex – also carry uncertainty. This of course also bears relevance to our projections of the population of immigrants and Norwegian-born to two immigrant parents. However, as with the population more broadly, demographic momentum suggests we can be reasonably confident that the immigrant population in the future will be considerably older, and with longer durations of residence, than is the case today.

7.12. Summary

We assume an initial increase in immigration in the main alternative from 53 000 in 2021 to 67 000 in 2022 (low 54 000, high 95 000), which is driven by the *ad hoc* adjustments to Country Group 3 in response to the war in Ukraine. From this peak, we assume a sharp decline in all alternatives, before the projections settle on more stable trajectories. In the main alternative, immigration to Norway will decline somewhat, from around 43 000 in 2024 to around 36 000 in 2060. The low immigration alternative assumes an even stronger decline, to around 23 000 in 2060, while our high immigration alternative assumes an increase, up to around 63 000 over the same period. Projected emigration depends partly on immigration. In the main alternative, we project emigration to gradually decline, from around 30 000 in 2022 to around 25 000 per year by 2060.

Net migration remains positive in all projected alternatives, although the magnitudes vary considerably. In the main alternative, we project net migration to rise from around 20 000 in 2021 to around 37 000 in 2022 (low 24 000, high 65 000). From this initial peak, we expect a sharp decline, corresponding to the assumed decline in arrivals from Ukraine, followed by a more gradual decline in the main and low immigration alternatives. In the main alternative, we see a decline from around 12 000 in 2024 to just under 11 000 in 2060. In the low immigration alternative, we see a decline from 6 000 to less than 4 000 over the same period, while the high immigration alternative projects a gradual increase in net migration, to around 27 000 by 2060.

Since we have assumed higher immigration than emigration throughout the projection period, we project a continued increase in the number of immigrants in Norway. In the main alternative, the number of immigrants is expected to increase from 819 000 today, to around 1.19 million shortly after 2060. This corresponds to an increase of more than 40 percent. The number of Norwegian-born to two immigrant parents will more than double, from around 210 000 today to around 440 000 in 2060, according to the main alternative.

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.

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, providing 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 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 discussion and change if, for instance, 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, most 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 presented 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. The ongoing war in Ukraine is a case in point of the implications of war on the international flow of refugees and the uncertainly of the scale of such flows, the potential durations in destination countries and the likelihood of return.

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 be sure of the future development of fertility, mortality or international migration, let alone how they might interact (see Section 8.1 below). For the total population, immigration has typically been the largest source of uncertainty in recent projection rounds. 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 projections, 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 further 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.

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 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.

Projection results are very sensitive to the assumptions that are used for each of the demographic components. This is demonstrated by the 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 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, irrespective of the ongoing war in Ukraine. However, fertility, mortality and emigration can also be very different from what was projected (Thomas et al. 2022).

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: M for medium; L for low; H for high. In addition, we use C for a constant life expectancy alternative and a constant immigration alternative, E for a zero net migration alternative and 0 for a no migration alternative.

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. 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 are multiple possibilities for the future. We 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. While some assumptions are more plausible than others, 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 useful in guiding potential interventions or policy development.

As stated, the different assumptions may be combined in different ways to produce different alternatives with differing degrees of plausibility. What characterises 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.

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 (e.g. 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. A 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 accounted for, include: Education, health and family composition. Furthermore, our current model only allows for one emigration alternative and the inclusion of, 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 a stochastic projection based around the deterministic main alternative was produced as an additional product in 2020 (Syse et al. 2020). For additional comparisons, interested readers are referred to Keilman et al. (2002) and Foss (2012).[34]

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 inability of deterministic approaches to:

- Adequately reflect the uncertain nature of population projections
- Provide a probabilistic interpretation of the results of deterministic alternatives, because no probabilities are associated with the different parameters of the inputs
- Modify the width of the high–low interval for some specific purposes, without revising the specification of the alternatives.

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, for instance, seasonal workers 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.

Net migration in the observed data was artificially elevated in 2019 due to reduced administrative out-registrations of emigration during the latter half of 2019 (see Box 7.1). This resulted in around 5 000 fewer administrative out-migrations compared to previous years. As discussed in Section 4.3, emigration assumptions are typically based on observed emigrations during the previous decade,

[34] 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 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 was deemed less difficult than might be expected, as reported by Dunstan and Ball (2016). The authors mention several benefits that the producers and users of New Zealand's probabilistic forecasts have noticed since such forecasts were first published.

although this year we use the period 2012-2019 (i.e. excluding the years affected by COVID-19). Thus, on top of variations in the timing of administrative out-registrations, fluctuations in the base period will impact future emigration assumptions.

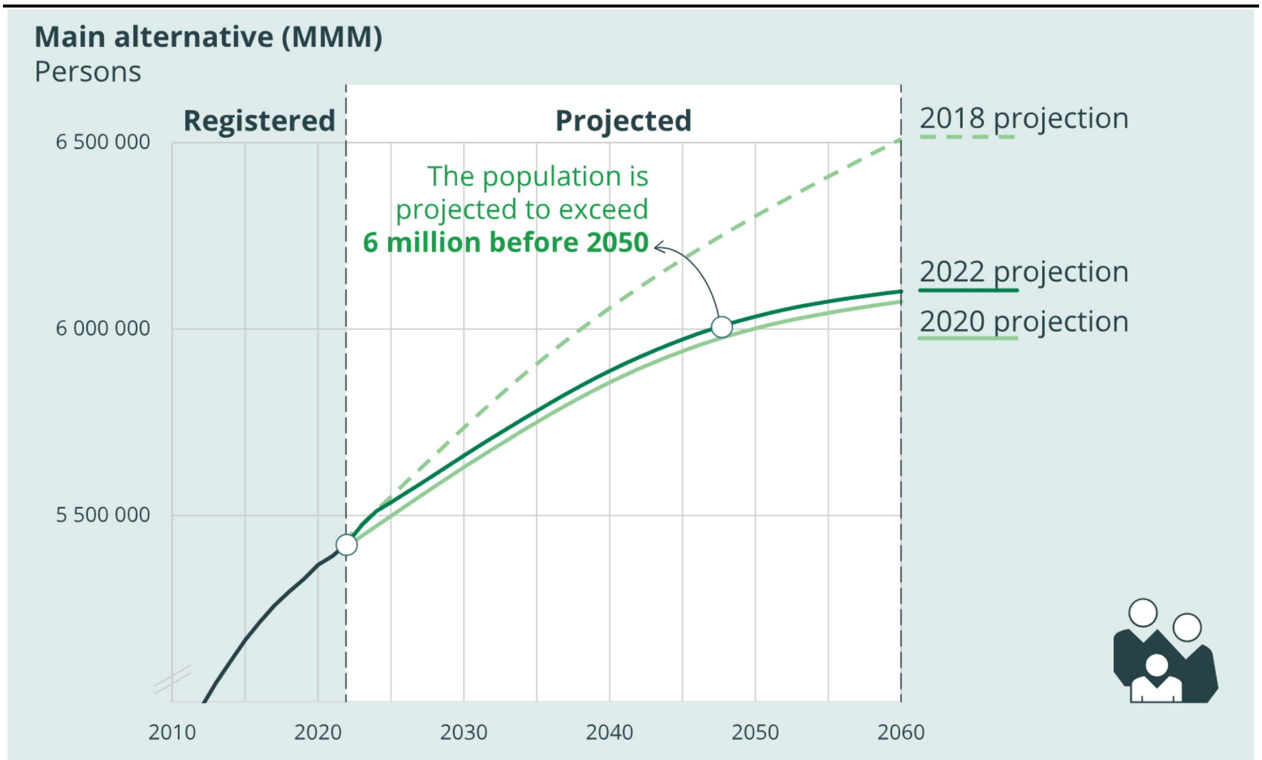
8.4. Quality assurance

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 (Thomas et al. 2022), 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. In 2020, we also provided a stochastic projection to formally assess uncertainty in future population size and structure. Finally, we examine the degree to which the various results we publish are used and attempt to clarify issues that arise from interaction with end-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 2018, 2020 and 2022 population projections



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 projected 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 rate compares to the registered fertility rate, but we also examine the number of projected and actual new-borns as well as deviations in these figures. Longer-term evaluations of national projections are also available for projections published in the period 1969-2000 (Keilman and Pham 2004) and 1996-2018 in Thomas et al. (2022).

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), with small numbers often characterised by large annual fluctuations. With regards to cohorts, the uncertainty is greatest for those who 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 in the population, where mortality is pronounced, population sizes are small, and the future course is more difficult to predict. For the population as a whole, immigration has comprised the largest source of uncertainty since EU enlargement in 2004, but emigration also represents a challenge to the accuracy of our projections. Immigration and emigration were especially pertinent in 2021, a year where severe travel restrictions were in place globally.

As shown in Table 8.1, net migration was the source of the largest discrepancy between registered and projected figures, wherein we underestimated the figure by more than 7 000 in the main alternative. Indeed, 2021 saw a rapid catch-up in immigration and emigration, beyond pre-COVID-19 levels, that was not foreseen. An underestimation of more than 1 700 births is also observed, with fertility increasing in 2021 after more than a decade of falling fertility rates. The 2020 projections also overestimated life expectancy in 2021, with a resulting underestimation of almost 1 100 deaths. Thus, while recognising that 2021 was affected by the COVID-19 pandemic, the 2020 projections ended the systematic underestimation of life expectancy hitherto observed in the Norwegian population projections.

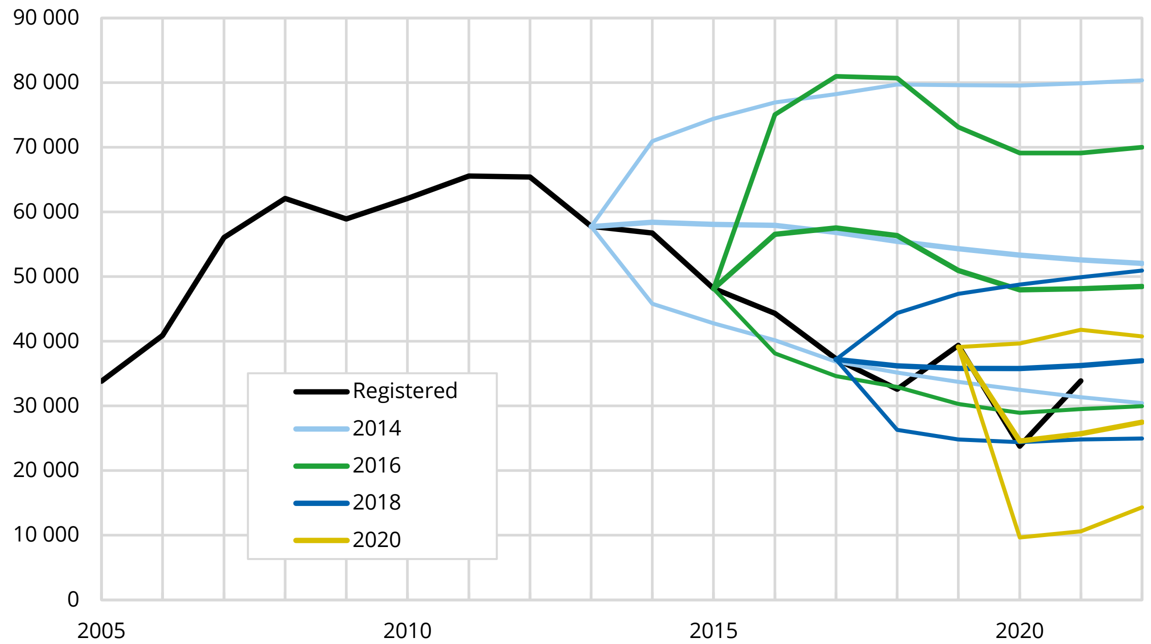
Table 8.1 Short-term comparisons of the 2020 national population projections, projected and registered figures for 2021 in three alternatives[1]

	Births	Deaths	Net migration	Pop. growth	Pop. Dec 31
Registered	56 060	42 002	19 650	33 901	5 425 270
Main (MMM)	54 300	40 900	12 300	25 700	5 417 900
Low national growth (LLL)	48 300	42 600	5 000	10 600	5 387 850
High national growth (HHH)	59 400	39 300	21 700	41 800	5 449 050
Deviation (MMM)	-1 727	-1 064	-7 321	-8 185	-7 393
Deviation (LLL)	-6 074	1 699	-7 357	-15 119	-30 031
Deviation (HHH)	11 141	-3 320	16 735	31 195	61 180

[1] The actual numbers 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 main national growth scenario both in the 2014 and 2016 projections. In fact, the real national growth was closer to the low national growth scenarios in these projections. The 2018 projections appear to have run close to the real figures in short term. The decline in national growth in 2020 was very close to that projected in the 2020 projections, however, the rapid catch-up in immigration in 2021 led to a larger discrepancy in the following year.

Figure 8.2 Short-term annual population growth in three alternatives, registered and projected in three alternatives, 2005-2022[1]



[1] The three alternatives are main, low national growth and high national growth.
Source: Statistics Norway

International comparisons

We compare our projections with those made for Norway by, for example, Eurostat and the United Nations. We do this both for the separate components and the final projected results. Examples of such comparisons are given in Chapters 1, 5, 6 and 7 of 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 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, from the perspective of international transparency, it is important that we publish our methods, assumptions and results in English (United Nations 2018, Eurostat 2018). Enabling international end users and/or researchers an opportunity to provide feedback on our work 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. 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.

User orientation

We attempt to foster a relationship with our users. End-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 via 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 population 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.
- **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 the 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. 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, if not 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, ‘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 according to the assumptions used for fertility, mortality and international migration.

9. Conclusions

The 2022 national population projections show lower population growth 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 and 6.2 million in 2100. This is mainly due to positive net migration. We expect more births than deaths until approximately 2050, after which the situation reverses. There will be an increasing number of older people in the population, with the number of persons aged 70 years or above expected to almost double by 2060 in the main alternative. By 2100, more than 25 percent of the population will be aged 70 years or over, according to the main alternative. Within a decade, the main alternative suggests the population will be composed of more older persons (65+ years) than children and teenagers (0-19 years). Indeed, by 2060, older persons are projected to outnumber children and teenagers by more than 550 000, a number that increases to almost 850 000 by 2100.

Our medium assumption (low and high in parentheses) is that the total fertility rate (TFR) will decline from its current level, 1.55 children per woman, to 1.5 by 2025. TFR is then assumed to rise and then stabilise at around 1.7 (low 1.3, high 1.9). Life expectancy is expected to increase throughout the century. For men, the medium assumption projects an increase from 81.6 years in 2021, to 89 (low 86, high 91) years in 2060 and 94 years (low 90, high 97) in 2100. For women, an increase, from 84.7 years in 2021, to 91 (low 89, high 93) years in 2060 and 95 (low 92, high 97) years in 2100 is assumed. Immigration is expected to increase in the short term due to the arrival of refugees fleeing the war in Ukraine. In the medium immigration alternative, we assume that immigration to Norway will increase from 53 000 in 2021 to 67 000 in 2022 (low 54 000, high 95 000). From this peak, we assume a sharp decline before the assumptions settle on more stable long-run trajectories. From 2025, we assume that immigration to Norway will decline somewhat, from around 43 000 (low 35 000, high 52 000), to around 35 000 (low 15 000, high 81 000) in 2100. The projected emigrations depend partly on the immigrations. In the main alternative, we project net migration to rise from almost 20 000 in 2021 to around 37 000 in 2022 (low 24 000, high 65 000). From 2025, the main alternative projects a broadly stable net migration of around 11 000-12 000 annually.

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, above 45 years in 2060 and above 50 years in 2100. Today, just 5 percent of all persons aged 70 or over are immigrants. In the future, this share will increase substantially. According to the main alternative, immigrants will account for almost 25 percent of the population aged 70 and over by 2060.

Population projections are inherently uncertain. The uncertainty usually increases the further into the future we look, and figures are most 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 being quite different to what is projected. Due to the ongoing war in Ukraine, it has been especially challenging to formulate even short-term immigration assumptions. Users must bear this in mind when they employ the different alternatives of the 2022 national population projections.

For more information about the projected population and population changes, see https://www.ssb.no/en/folkfram. Detailed figures for the projected population and registered population are available in Statistics Norway's StatBank (https://www.ssb.no/en/statbank/).

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Appendix A: Description of 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. Stateless people are included in this group.

A comprehensive list of country groups is given on Statistics Norway's Statistical Classifications and Codelists: https://www.ssb.no/en/klass/klassifikasjoner/91/varianter/1557.

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