Population projections 2016-2100: Main results

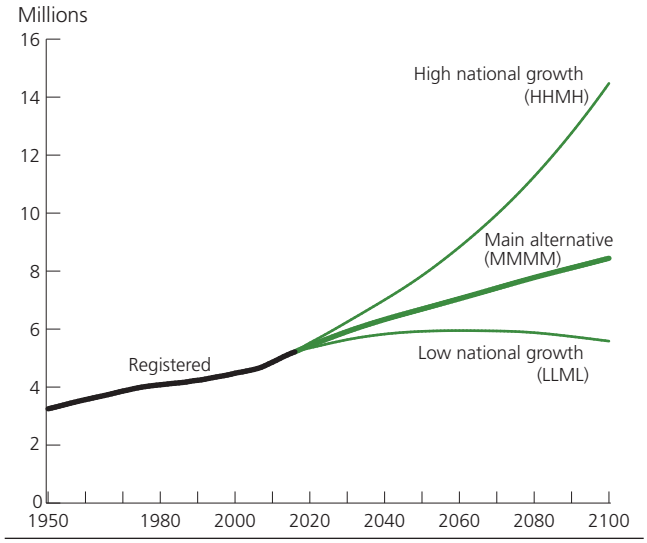
Marianne Tønnessen, Stefan Leknes and Astri Syse

More inhabitants in Norway, more elderly, more immigrants and more people in central areas. These are the future population trends projected in the main alternative.

The population of Norway has seen rapid growth over the last decade, and in 2016 stands at just over 5.2 million. Our projections show that the population will continue to grow, but the uncertainty associated with such forecasts becomes greater the farther ahead we look (Figure 1). In the main alternative (MMMM, see box), the population of Norway will pass the 6 million mark around 2030, and will reach 7 million by 2060. This alternative assumes a medium development in fertility, life expectancy and immigration. The determining factors behind the population growth in the main alternative are a relatively high net migration and an excess of births.

In the alternative for high national growth (HHMH), Norway passes 6 million within just ten years, and the strong growth continues throughout the period. This is due to higher fertility, higher life expectancy, and a significantly higher net migration than in the main alternative (MMMM). The alternative for low growth (LLML) never reaches the 6 million mark. The population stops growing by around 2060, and the population of Norway begins to slowly decline.

Figure 1: **Population as of 1 January. Registered and projected in three alternativesr**



Source: Statistics Norway

What do the H-M-L abbreviations mean?

The results of a population projection are largely dependent on the assumptions used for the different components. Since assumptions are not absolutely certain, a number of alternative projections are drawn up, with different combinations of assumptions. These are described using four letters in the following order:

- Fertility
- Life expectancy
- Internal migration
- Immigration

The main alternative, MMMM, uses the medium level for each of the components. These are the assumptions that we consider to be the most plausible, and MMMM is the main alternative for the population projections.

The assumptions can be combined in a variety of ways. For example, the LHML alternative describes a population trend with low fertility, high life expectancy, medium internal migration and low immigration, i.e. high ageing.

For fertility, life expectancy and immigration, we create high, medium and low alternatives, but for internal migration we do not have high or low alternatives. We draw up alternatives with constant (*konstant* in Norwegian) immigration (MMMK) and constant life expectancy (MKMM), and alternatives without internal and international migration (MM00) and with zero net migration (MMM0). Although these last two are not considered to be particularly realistic, they still have analytical value.

It is unlikely that fertility, life expectancy and immigration will all remain high (or low) throughout the relevant period. Nevertheless, the span between the HHMH and LLML alternatives illustrates the potential degree of uncertainty surrounding the projections and that the results are largely dependent on the assumptions.

Marianne Tønnessen is head of the population projections and a senior adviser in the Unit for public economics and demographic models (mto@ssb.no)

Astri Syse is a senior researcher in the Unit for public economics and demographic models (sya@ssb.no)

Stefan Leknes is a researcher in the Unit for public economics and demographic models (sfl@ssb.no)

Population growth in 2015

Last year, the population in Norway increased by 48 000, which is the lowest growth in recent years: since 2007, annual growth has been between 56 000 and 66 000. Nevertheless, population growth in Norway remains strong. This is partly because immigration exceeded emigration by about 30 000 in 2015, and because there were almost 20 000 more births than deaths.

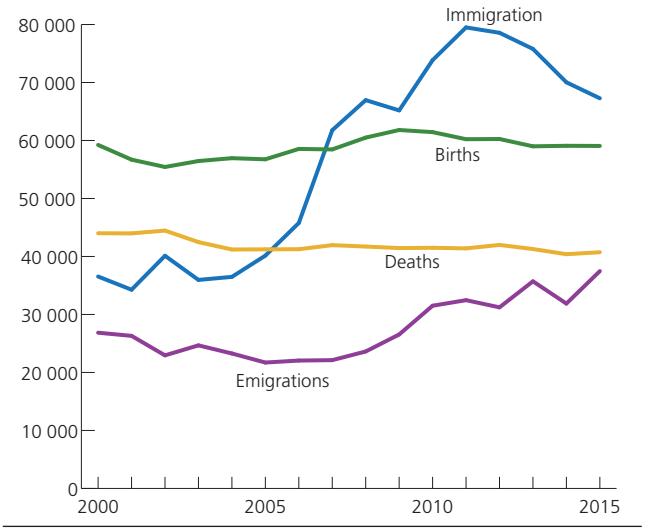
Figure 2 shows the number of births, deaths, immigrations and emigrations since 2000. The figures for births and deaths have remained relatively stable. The slight decrease in the number of births since 2009 is not due to a fall in the number of women of childbearing age; it is a result of a drop in fertility among women. This reflects the fact that women in their 20s now are having their first child later than previously, and that fewer women are having three or more children (Lappegård and Dommermuth 2015). The fall in the number of deaths is partly due to an increasing life expectancy, and partly due to cohorts from the inter-war years now reaching the end of their life expectancy. The number of deaths as a percentage of the population currently stands at an all-time low: in 2014 and 2015 only 0.8 per cent of the population died – despite the fact that today's population is older than before. This is the lowest crude mortality rate since the annual registration of deaths began in Norway in 1735.

The graphs for immigration and emigration are subject to more fluctuations than the other components. Immigration was particularly high in 2011 and 2012, but has since fallen somewhat, primarily due to a decline in labour immigration. The high number of asylum seekers who arrived in Norway in autumn 2015 has only had a slight impact on this figure since the majority of asylum applications had not been processed by the end of the year, and the applicants were not therefore included in Statistics Norway's population statistics. Emigration has increased somewhat in recent years, and in 2015 more people are estimated to have left Norway than during the largest wave of emigration to the USA at the end of the nineteenth century (Cappelen et al. 2016).

The combination of higher emigration and lower immigration results in a net migration of almost 18 000 less than in the peak years of 2011 and 2012. Figure 3 shows the proportion of population growth that is due to net migration and the proportion due to an excess of births (births minus deaths) in the last 15 years. Net migration is the main reason for the high population growth in the last decade. In 2012, net migration accounted for 72 per cent of the population growth, and by 2015 this share had fallen to 62 per cent.

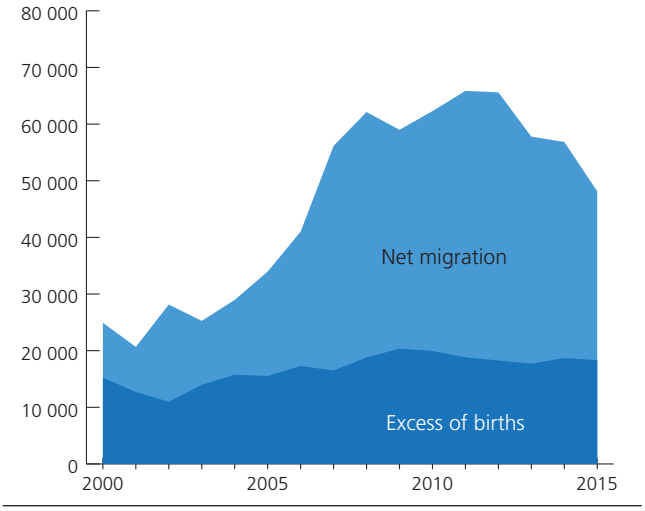
Thus, the population growth of 2011 and 2012 has slowed, and as shown in Figure 3 we are now emerging from a period of particularly high growth. This pattern is not new to Norway, and Figure 4 shows the annual

Figure 2: **Births, deaths, immigrations and emigrations, 2000-2015**



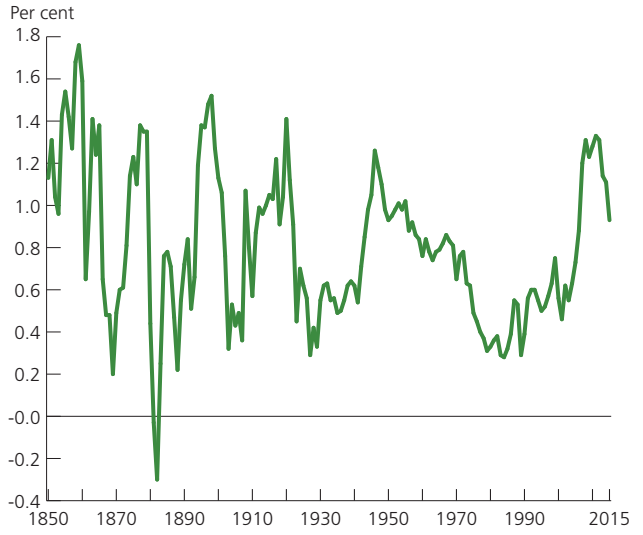
Source: Statistics Norway

Figure 3: **Population growth, net migration and excess of births, 2000-2015**



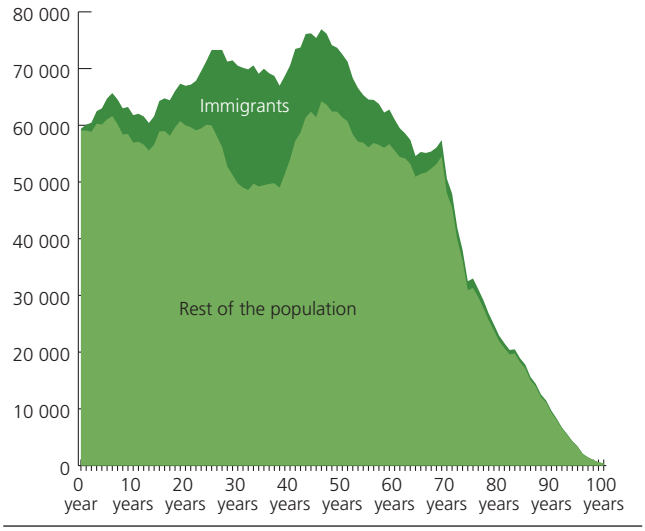
Source: Statistics Norway

Figure 4: **Population growth rate, 1850-2015**



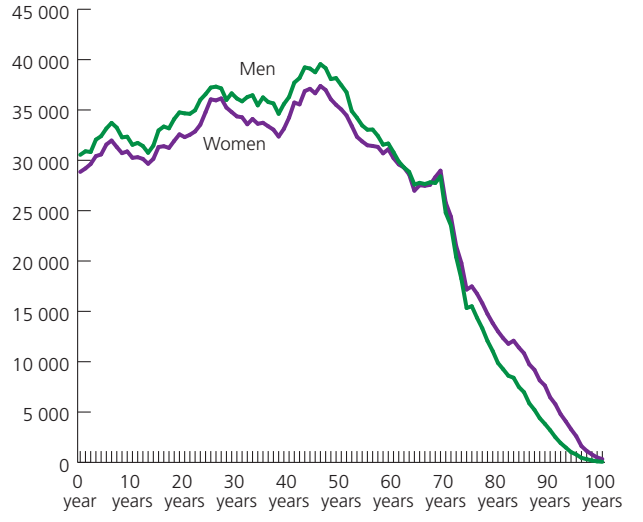
Source: Statistics Norway

Figure 5: **Immigrants and the rest of the population by age, 2016**



Source: Statistics Norway

Figure 6: **Men and women, by age, 2016**



Source: Statistics Norway

population growth rate dating back to 1850. Except for the years with high emigration in the 1880s, the population has risen every year. The high growth rate of the last decade was last seen in the years following World War II, when fertility was high and life expectancy rose sharply.

The last growth period was primarily due to high immigration. Since immigrants are often young adults when they arrive, they have a particular impact on the size of the age groups between 20 and 50 years (Figure 5). In the rest of the population, the group in their 30s is particularly small due to the low birth rate in the late 1970s and early 1980s. The smallest cohort among the non-immigrants below age 70 is the 1983 cohort – those who were 32 years old at the New Year. Thirty-two-year-olds also make up the largest cohort of immigrants in Norway. In this age group, immigrants constitute 30 per cent of the population.

Immigration has thus helped to even out the age distribution in Norway. However, cohorts that were originally large have also increased due to immigration. This includes people born in 1969, who have comprised the largest cohort since birth.

Men are in the majority in all of the younger age groups (Figure 6). This is partly because male immigrants outnumber female immigrants, and because more boys than girls are born. This pattern is reversed by the age of 67, and the 85 and above group has twice as many women as men.

Figures 5 and 6 show four peaks in the age distribution of the population as a whole. The four peaks relate to 69-year-olds, who were born in the baby boom year 1946; 46-year-olds from 1969; 25-year-olds, who were born in 1990 when fertility started to pick up again and many of whom are immigrants; and 6-year-olds from 2009, the last peak year for fertility in Norway.

Results from this year's projections

The composition of the current population by sex and age is a determining factor in the population projections. Today›s population is a core element in our assumptions, and many of the projected population changes reflect how large or small cohorts will reach ages where child birth, migration and death are more likely.

The population projections show how population growth will develop when we factor in different assumptions about future fertility, mortality, internal migration, immigration and emigration. The method behind producing population projections is explained in a separate documentation memorandum (Aase et al. 2014). In the main alternative (MMMM, also referred to as the medium alternative), we have used the assumptions we consider to be the most likely. However, as future projections are inherently uncertain, we also present other alternatives with different assumptions (see box). Table 1 summarises some of the assumptions used in this year's population projections.

More inhabitants

The main alternative in the population projections (MMMM) estimates population growth in Norway throughout this century, with a 20 per cent increase by 2040.

Figure 7 shows how the population in Norway has continued to pass new millions, reaching 5 million in 2012. The last million mark was 37 years earlier in 1975. Today, the population of Norway is 5.2 million, and the main alternative of a projected annual growth between 40 000 and 60 000 over the next two decades will see us passing 6 million by around 2030. By then, Norway will have gone from 5 to 6 million inhabitants in less than 20 years, making this the fastest acceleration to the next million in Norway's history. Growth will then continue, but at a slightly slower pace. Around 2060 we

Table 1: **Overview of assumptions in the 2016 population projections**

	Registered	Alternatives[a]		
		M	H	L
Total fertility rate (child per woman)[b]				
2015	1.73			
2016		1.72	1.90	1.55
2060		1.74	1.96	1.53
Life expectancy at birth (years). men[c]				
2015	80.2			
2016		80.3	80.8	79.9
2060		87.2	90.3	83.3
Life expectancy at birth (years). women[c]				
2015	83.9			
2016		84.0	84.4	83.6
2060		89.2	91.9	86.0
Immigrations per year[d]				
2015	64 700			
2016		71 000	83 000	60 000
2020		61 000	72 000	52 000
2040		63 000	92 000	51 000
2060		68 000	118 000	46 000
Net migration per year[e]				
2015	29 800			
2016		38 000	49 000	27 000
2020		26 000	34 000	19 000
2040		26 000	45 000	18 000
2060		27 000	58 000	15 000

[a] L = low, M = medium and H = high

[b] TFR is calculated for different groups of women. In the medium alternative, the assumption is that the ASFRs will remain stable at today's level. In the high and low alternative, respectively, they will be 13 per cent above or below those that are observed today. As the composition of the groups varies over time, the TFR fluctuates slightly

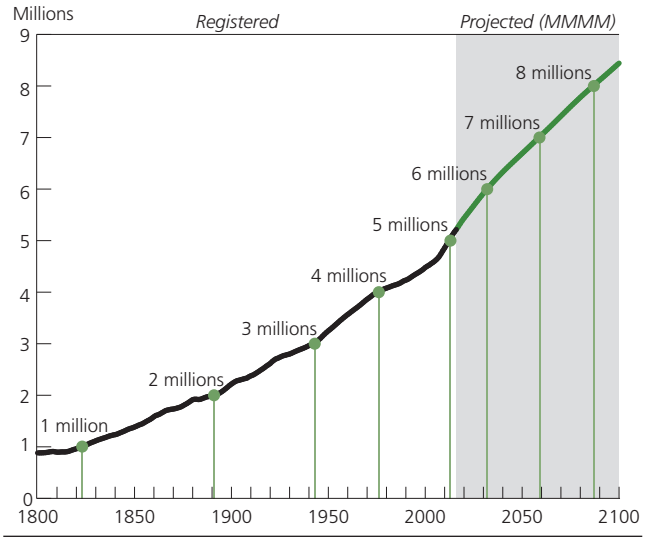
[c] The figures for registered life expectancy are not fully comparable with those presented in the population statistics.

[d] These figures do not include persons who have moved to and from Norway (or vice versa) during the calendar year.

[e] The H and L figures for net migration are taken from the MMMH and MMML alternatives.

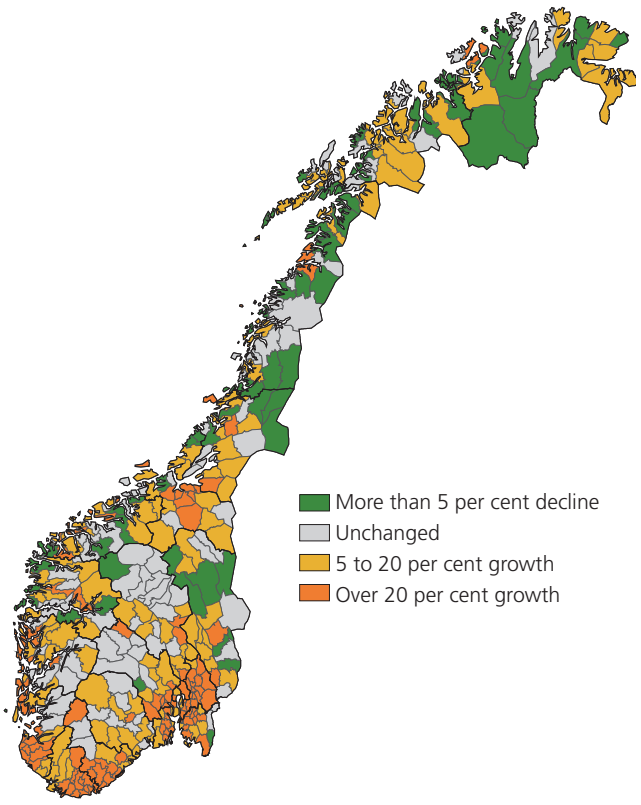
Source: Statistics Norway.

Figure 7: **Population in Norway, registered 1800-2016 and projected to 2100 in the main alternative (MMMM)**



Source: Statistics Norway

Figure 8: **Projected growth rate in the municipalities 2016-2040, main alternative (MMMM)**



Source: Statistics Norway. Map data: Kartverket

will pass the 7 million mark, and by the late 2080s the number of inhabitants will surpass 8 million.

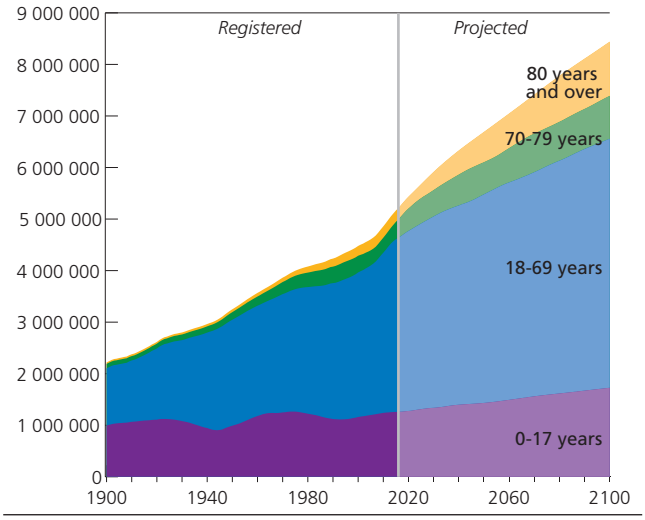
In the alternative with high national growth (HHMH), growth is even faster, and the 6 million mark will be reached in just ten years (see Figure 1). In the alternative for low national growth (LLML), however, the population will remain below 6 million, reaching 5.9 million by around 2050 before growth stagnates and the population then begins to decrease. In all other combinations of high, medium and low alternatives, we go from 5 to 6 million quicker than for any other million.

More in central areas

We assume that central areas will see the highest population growth, and that Norway's cities will grow considerably. In the main alternative (MMMM), the populations of Oslo, Bergen and Trondheim will surpass 700 000, 300 000 and 200 000 respectively over the next ten years. Strong growth will also be seen in many of the municipalities situated near regional centres. One such example is Ullensaker municipality in Akershus, where growth will be over 50 per cent by around 2040.

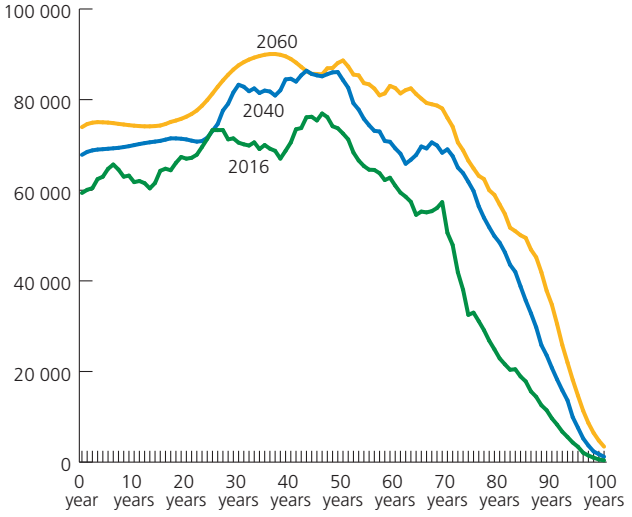
At the same time, almost 70 municipalities will see a fall of more than 5 per cent in their populations. Most of these municipalities are situated in the northern half of the country, and many are rural. The map in Figure

Figure 9: **Population in four age groups, registered and projected in the main alternative (MMMM)**



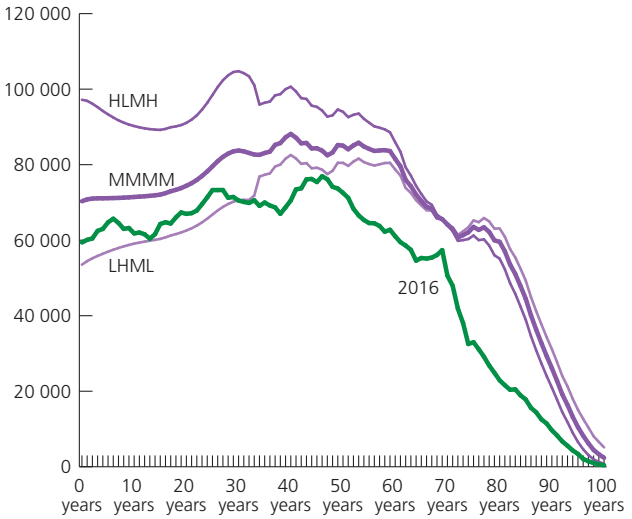
Source: Statistics Norway

Figure 10: **Population by age, registered in 2016 and projected in the main alternative (MMMM) in 2040 and 2060**



Source: Statistics Norway

Figure 11: **Population by age, registered in 2016 and projected in three alternatives in 2050**



Source: Statistics Norway

8 shows the projected population growth in municipalities. Municipalities highlighted in blue will have a declining population.

All counties will see growth, but to varying degrees. The most populous counties will grow the most, both in terms of percentage and absolute numbers. Growth will be highest in Oslo, at 30 per cent in the main alternative, followed by Akershus with 29 per cent. Two counties in the north, Nordland and Finnmark, will have the lowest growth rate, with 7 per cent by 2040. The inland counties and the northern counties will generally have the lowest growth, in addition to Sogn og Fjordane and Telemark.

The results of the regional population projections are discussed in more detail in Norwegian in the article "Regionale befolkningsframskrivinger 2016-2040: Flytteforutsetninger og resultater" (Leknes 2016).

More elderly

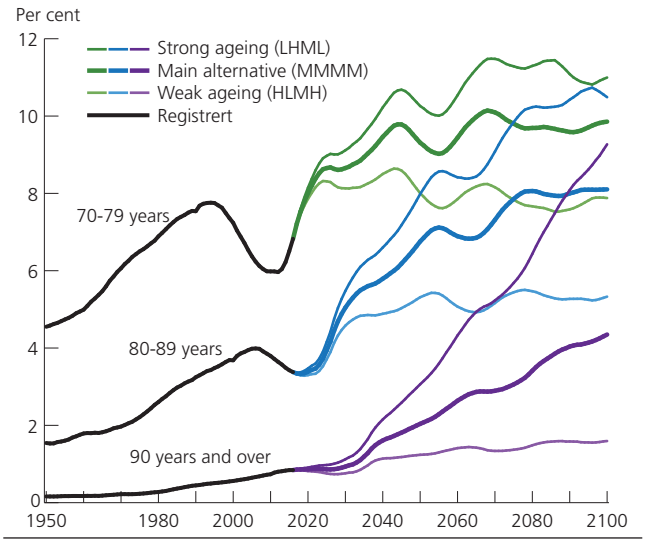
The age composition of the population is set to change appreciably in the years ahead. As Figure 9 shows, the oldest age groups will see particularly strong growth. This is primarily due to the assumption of a steadily increasing life expectancy. A more detailed discussion of these assumptions are available in Norwegian in the article "Befolkningsframskrivinger 2016: Dødelighet og levealder" (Syse et al. 2016a). In addition, the large birth cohorts from the post-war era will gradually be among the eldest in society.

The same trend is illustrated in Figure 10, which shows the current population by age in years, and the projected figures for 2040 and 2060. All age groups will experience growth, but the most pronounced will be among the most elderly.

The number of persons aged 70 years or over will double within three decades – from almost 600 000 today to nearly 1.2 million. For those aged 80 and over, the figure will double in just two thirds of that time – from 220 000 today to 440 000. These figures are taken from the main alternative (MMMM), but the sharp rise in the number of elderly persons is seen in all the population projection alternatives. Figure 11 shows the current age distribution and the projected figure for 2050 in the main alternative, and in alternatives with strong ageing (low fertility, high life expectancy and low immigration – LHML) and weak ageing (high fertility, low life expectancy and high immigration – HLMH). The increase among the eldest is roughly the same.

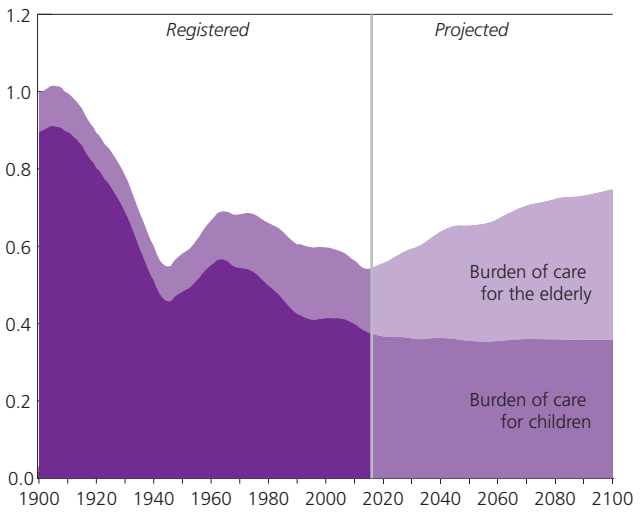
The proportion of elderly in the population, however, varies more between the different alternatives because the number of people in the younger age groups varies. Figure 12 shows the proportion of elderly people in different age groups, as projected in three ageing alternatives. The decline we have seen in recent decades, particularly in the proportion aged 70-79 years, is partly due to the small cohorts of children from the

Figure 12: **Proportion of elderly in different age groups, projected in three alternatives**



Source: Statistics Norway

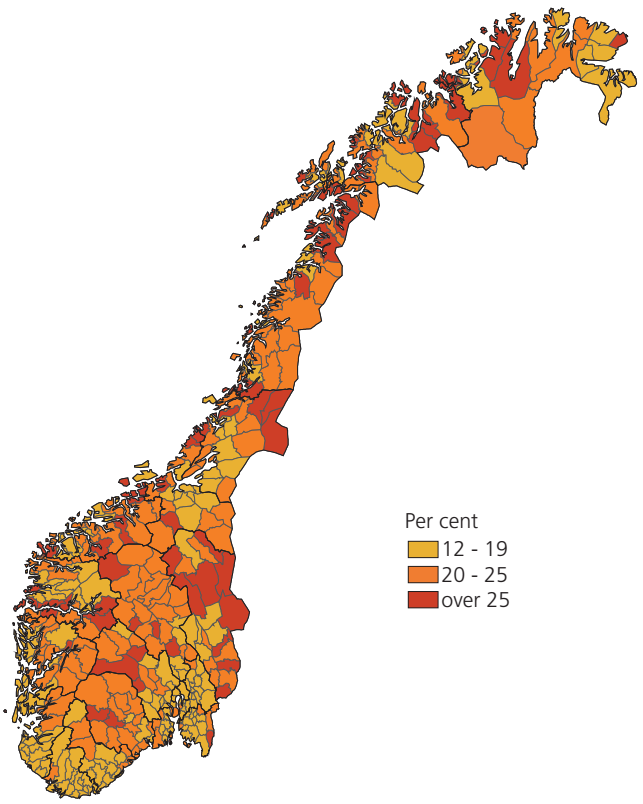
Figure 13: **Burden of care for children and the elderly, registered and projected in the main alternative (MMMM)**



Source: Statistics Norway

1930s now having reached this age, and to the generally high population growth in the younger age groups. For the same reason, the proportion of 80-89 year-olds and those who are 90 and over is not expected to rise substantially any time soon. However, these shares will start to increase sharply in all alternatives from the beginning of the 2030s. In the longer term, the shares vary considerably between the alternatives. Even in the weak ageing alternative, however, where we have assumed high fertility, low life expectancy and high immigration, the share of elderly in Norwegian society will increase. Today, 11 per cent of the population, which is about every ninth person, is aged 70 years or over. In the medium alternative, this share increases to 19 per cent in 2060, which corresponds to almost 1 in every 5 persons.

Figure 14: **Proportion aged 70+ in the municipalities, projected in the main alternative (MMMM) in 2040**

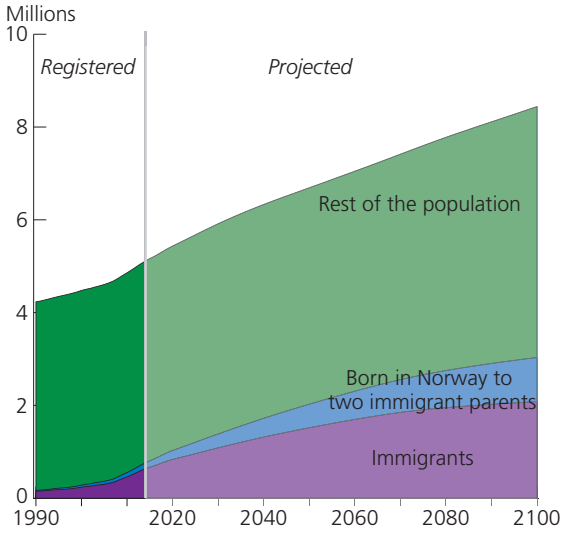


Source: Statistics Norway. Map data: Kartverket

In order to describe the relationship between people considered to be of a working age and those of a non-working age, the term "burden of care" is often used. This is defined as the number of children (0-19 years) plus the number of elderly (70+), divided by the number of people considered to be of a working age (20-69 years). Figure 13 shows the development in the burden of care, broken down into the burden of care for the elderly (the number aged 70+ divided by the number aged 20-69) and the burden of care for children (the number aged 0-19 divided by the number aged 20-69). Previously, the burden of care for children dominated, but as the projection period continues, the number of elderly among the working age population increases. Towards the end of the century, the number of people aged 70 or over surpasses the number of children and teenagers in Norway. Thus, the burden of care is almost evenly distributed for children and the elderly – but slightly higher for the elderly.

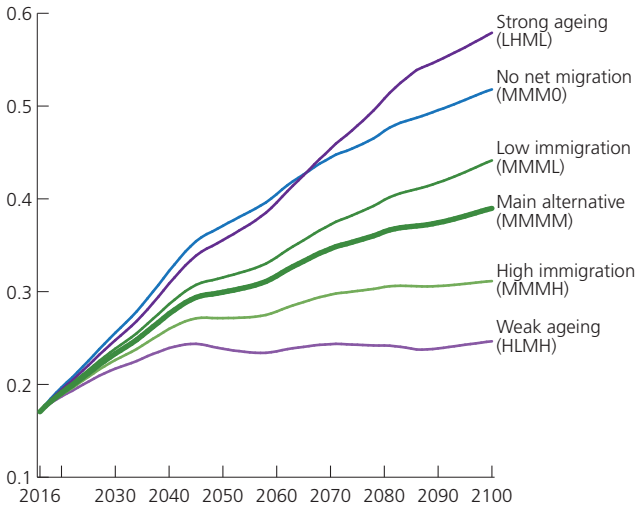
Population ageing in Norway will be much stronger in rural areas than in the towns. There are three reasons for this: young people often move to central areas; immigrants often settle in towns; and both of these groups often have children in central areas. Only about one in eight persons in Oslo will be aged 70 or over in 2040, while every third person in some rural municipalities will be 70 years or older, according to the main alternative. The map in Figure 14 shows the geographical distribution of ageing in Norway in 2040. The ageing is weaker in and around the major urban areas, and is

Figure 15: **Immigrants, persons born in Norway to two immigrant parents and the rest of the population, registered and projected in the main alternative (MMMM)**



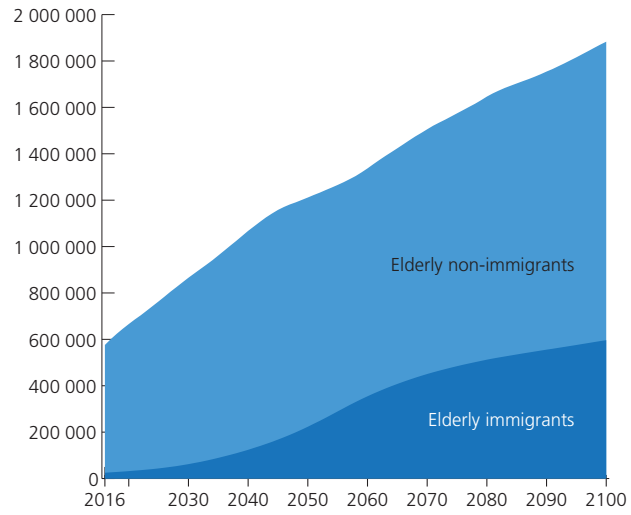
Source: Statistics Norway

Figure 16: **Burden of care for the elderly, projected in different alternatives**



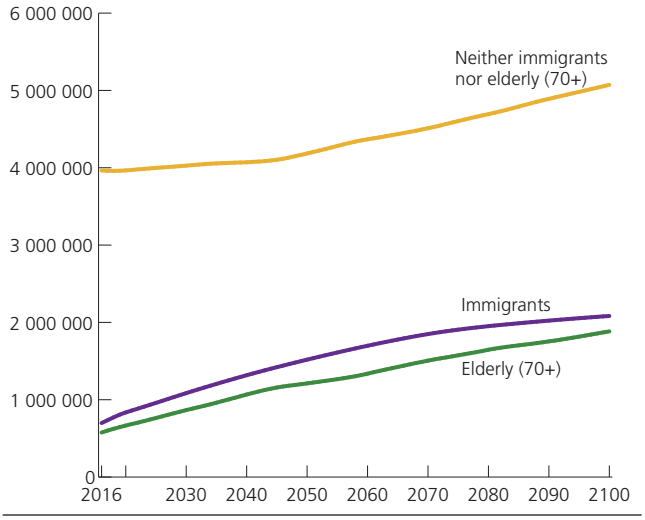
Source: Statistics Norway

Figure 17: **Immigrants and non-immigrants aged 70+, projected in the main alternative (MMMM)**



Source: Statistics Norway

Figure 18: **Number of elderly, immigrants and rest of the population, registered and projected in the main alternative (MMMM))**



Source: Statistics Norway

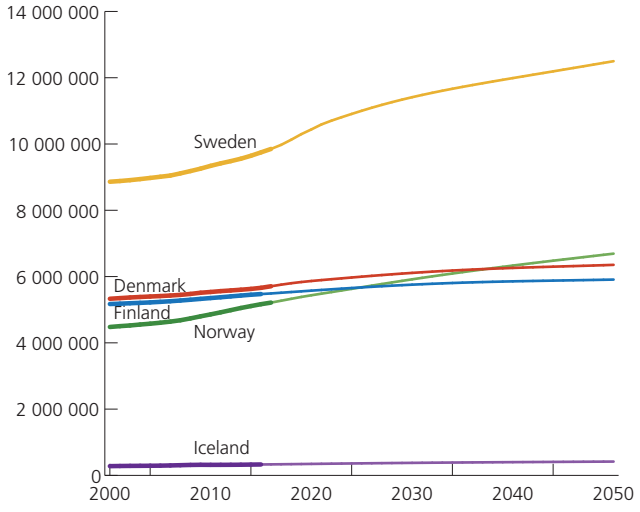
stronger inland, in the north and in rural areas. This is discussed in more detail in Norwegian, in Leknes (2016).

More immigrants

Another group that will also double over the next three decades is immigrants. In the main alternative, the figure will increase from the current 700 000 to 1.4 million by the mid-2040s, and to 1.7 million in 2060 (Figure 15). The number of persons born in Norway to two immigrant parents will also see a significant increase. This is based on the expectation of relatively high net migration, which is discussed in more detail in Norwegian in the article "Befolkningsframskrivinger 2016-2100: Inn- og utvandring" (Cappelen et al. 2016). The projections of immigration to Norway entail a large degree of uncertainty, which in turn means the number of immigrants that will live in Norway in the future is also the subject of much uncertainty. In the alternative with high immigration (MMMH), the number of immigrants in Norway in 2060 is 2.4 million, compared to 1.4 million in the low alternative (MMML).

Immigration also affects the ageing of a population. The fact that immigrants tend to be relatively young when they arrive in the country helps slow the ageing. However, even a high immigration level is not enough to stop ageing completely, partly because immigrants also age. This is illustrated in Figure 16, which shows the burden of care for the elderly (the number over 70 divided by the number aged 20-69 years) in different projection alternatives. In the MMM0 alternative, there is no net migration to Norway, while the MMMH and MMML alternatives assume high and low future immigration. All of the alternatives entail an increasing burden of care. The greatest burden of care is in the alternative with weak ageing and the alternative without net migration. The positive net migration to Norway therefore curbs the future burden of care to a degree, but even with high immigration the burden of care will

Figure 19: **Population figures in the Nordic countries, registered and projected**



Source: The Nordic statistics agencies

increase. The alternative with high immigration projects an increase in the burden of care from the current 0.17 to 0.28 in 2060, while the alternative without net migration shows an increase to 0.41 in 2060.

Today's immigrants in Norway are relatively young. However, they will gradually age, and the main alternatives will show a marked increase in the number of immigrants in the oldest age groups, as illustrated in Figure 17. At present, only 4 per cent of the population aged 70 or over are immigrants. In the main alternative, this increases to 27 per cent in 2060, when 1 in every 4 people will be in the oldest immigrant groups.

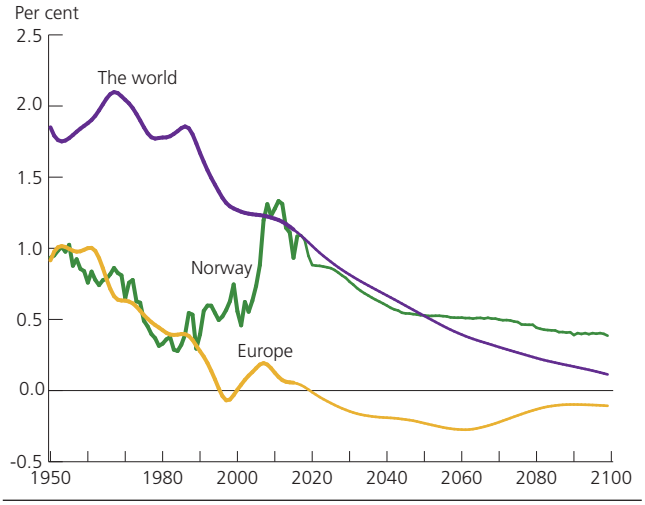
Immigrants and elderly are the two main groups that are growing the fastest, according to the main alternative. The group who are neither immigrants nor age 70 or above shows only weak growth up to 2050 due to an increase in the number of persons born in Norway with two immigrant parents. Figure 18 shows how the number of immigrants, those age 70 and above, and the rest of the population increases in the main alternative (the first two groups are not mutually exclusive; it is possible to be both an immigrant and age 70 or above).

Surpassing Finland and Denmark

Population growth in our main alternative is relatively high compared with the projected population growth in some other countries. Figure 19 shows the population figures that the Nordic countries' statistics agencies have projected for their own countries (in the main alternatives). In the event that these projections prove to be accurate, the population of Norway will be higher than that of Finland in 2025 and higher than Denmark by 2040.

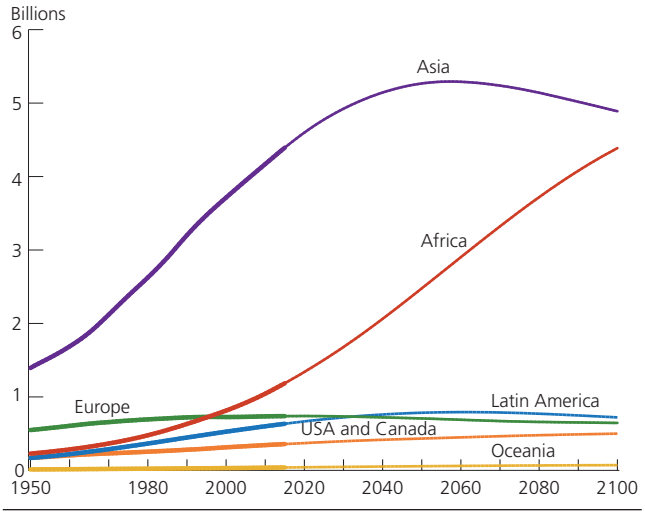
Over the past decade, the strong population growth in Norway has led to a higher growth rate in Norway than in the global population in some years. Figure 20 shows how the growth in Norway previously followed a

Figure 20: **Population growth rate in the world, Europe and Norway, registered and projected in the main alternatives**



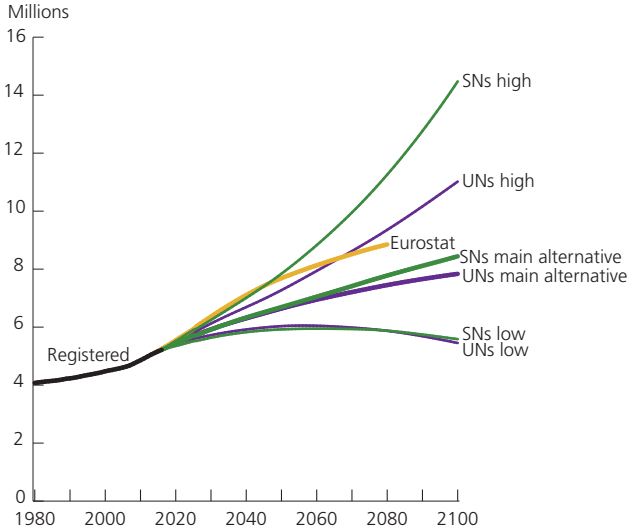
Source: World Population Prospects 2015, medium variant (Europe and the world) and Statistics Norway

Figure 21: **Population in the different continents, registered and projected**



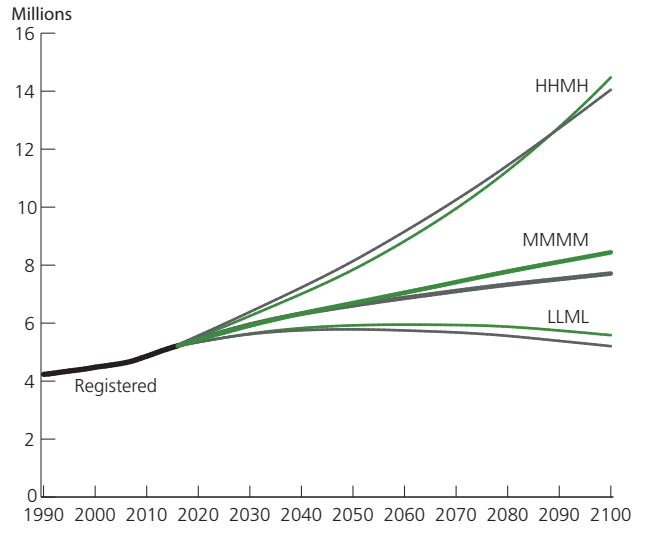
Source: World Population Prospects 2015, medium variant

Figure 22: **Population in Norway, registered and projected by the UN (purple lines), Eurostat (yellow line) and Statistics Norway (SN green lines)**



KSource: World Population Prospects 2015, Europop 2013 and Statistics Norway

Figure 23: **Population of Norway, registered and projected in 2014 (grey lines) and 2016 (green lines)**



Source: Statistics Norway

European trend, but that Europe now has virtually zero growth while annual growth in Norway is approximately 1 per cent. In our population projections, Norway will continue to follow the global growth rate for some decades to come, and towards the end of the century Norway's growth will be higher than global population growth. The figures for the expected population growth in Europe and the world are taken from the UN's latest population projections (United Nations 2015). One key reason behind the UN's projected lower global population growth for the rest of this century is the anticipated end to population growth in Asia, and the expectation that the number of Asians will fall (Figure 21). Africa is the continent where the UN still expects a considerable population growth in the future, primarily because of the high fertility rate.

Other projections for Norway

The UN produces population projections for all countries in the world, including Norway, and new UN projections were published last year (United Nations 2015). The EU's statistics agency Eurostat also produces population projections for Norway, the most recent of which was in spring 2014. Figure 22 shows the various projections for Norway. Our main alternative is lower than Eurostat's 2014 projection. Our latest projections are slightly lower in the short term compared with the new UN projections, but higher in the long term, and our alternative for high national growth (HHMH) is appreciably higher than the UN's projection.

There are also disparities between our previous projection from June 2014 and the latest one, see Figure 23. The new main alternative shows a higher population in the long term, due to both an upward adjustment of the expected immigration and a somewhat higher life expectancy. However, the population in the first two decades will be lower than in the previous projection. This is largely due to a lower population than assumed in the 2014 projection, primarily due to lower immigration, and a downward adjustment of fertility assumptions. The text box provides more details of the changes since the last projection.

Changes since last projection

Changes to the assumptions and the models have been made since the last projection. The main changes are as follows:

- New assumptions for fertility, which assume somewhat fewer children in the future (Syse et al. 2016b).
- New assumptions for mortality, which assume a slightly higher life expectancy for men than previously (Syse 2016a).
- New assumptions for internal migration, based on migration patterns in the last ten years (five-year rates were used previously) (Leknes 2016).
- New assumptions for immigration, with higher long-term immigration than previously and with a short-term addition to the immigration due to the asylum situation in Norway and Europe. This assumption also uses different UN projections to distinguish between the different immigration alternatives. The probability of emigration has also been increased somewhat for the next few years (Cappelen et al. 2016).
- The rates used in the population projections this time are based mainly on developments over the past decade, compared with five years previously. A longer time span will better reflect the different economic cycles in Norway, and the rates for small groups will also be more robust when the calculation is based on a longer period. The disadvantage of a longer time span is that we are less likely to capture any new trends, but this is partly covered by giving more weight to the most recent period.
- New for this year is that we will also publish projected probabilities of death by age in years and sex.

Update of the population projections

The population projections are now published every two years. If updates are needed in the intervening years, this can be done as follows:

- When new population figures for 1 January are published the actual figure can be compared with the projected figure.
- The difference between the projected and actual figure can then be deducted from/added to the projected figures for all future years.
- The difference can either be given as a percentage or in absolute numbers.

Compared to producing a new projection, this is a fairly simplified way of re-calculating the population. A new projection will take far greater account of the age structure and different probabilities in relation to births, deaths, internal migration, immigration and emigration for various groups, as well as new trends in these probabilities.

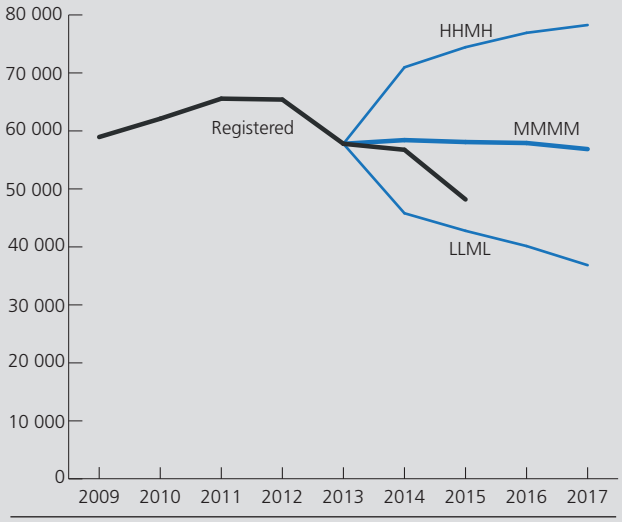
Accuracy of the 2014 projections

Population growth in 2014 was slightly lower than projected, but the deviation from the main alternative was just 1 700 (Figure 24). In 2015, the disparity was greater: actual population growth was almost 10 000 lower than the projected figure. This difference is partly due to the lower number of births than expected, and a sharp fall in immigration – which was the result of a decline in labour immigration. Most of the asylum seekers who arrived in Norway in autumn 2015 were not included in the population statistics because they had not been granted residence in Norway by the end of the year.

Among the municipalities, there were particularly large deviations for Trondheim and Bærum, where the population in 2016 was higher than projected. Just over half of the municipalities had a deviation of less than 1 per cent between the projected and actual population figure in 2016.

For a more thorough review of the accuracy of population projections, see the article in Norwegian "Hvor godt treffer befolkningsframskrivingene?" (Rogne 2016).

Figure 24. Annual population growth, registered and projected in 2014



Source: Statistics Norway

Uncertainty in the figures

All projections of the future population, its composition and geographical distribution are uncertain. The uncertainty increases the further into the future we look, and the figures are even more uncertain in projections for small groups, such as the population of municipalities by sex and age in years. Future immigration is particularly subject to a large degree of uncertainty, but fertility, mortality, immigration and internal migration can also end up rather different than expected. The assumptions used in projections determine the outcomes of the different alternatives, as evidenced by the variations between the different alternatives and the disparities between projections by other institutions.

Summary

Although all population projections are subject to varying degrees of uncertainty, there are nevertheless some trends that are highly likely to characterize Norway's future population: continued population growth, larger populations in central areas, more immigrants and more elderly.

If the main alternative (MMMM) proves to be accurate, Norway will pass the 6 million mark within 15 years. At the same time, Oslo's population will have increased from the current 660 000 to 800 000, 1 million immigrants will be living in Norway (compared to the current 700 000) and the proportion of the population aged 70 and older will have risen by over 50 per cent.

More results from the population projections, detailed figures, documentation and background material are available in English at https://www.ssb.no/en/befolkning/statistikker/folkfram and in Statistics Norway's StatBank.

References

Aase. K. N., M. Tønnessen and A. Syse (2014): The population projections: Documentation of the BEFINN and BEFREG models. Notat 2014/25, Statistics Norway (https://www.ssb.no/en/befolkning/artikler-og-publikasjoner/_attachment/182766?_ts=146956adcb8)

Cappelen, Å., T. Skjerpen and M. Tønnessen (2016): Befolkningsframskrivinger 2016-2100. Inn- og utvandring. [In Norwegian] Økonomiske analyser 3/2016, Statistics Norway

Lappegård, T. and L. Dommermuth (2015): Hvorfor faller fruktbarheten i Norge? [In Norwegian] Økonomiske analyser 4/2015, Statistics Norway

Leknes, S. (2016): Regionale befolkningsframskrivinger 2016-2040: Flytteforutsetninger og resultater. [In Norwegian] Økonomiske analyser 3/2016, Statistics Norway

Rogne, A. (2016): Hvor godt treffer befolkningsframskrivingene? [In Norwegian] Økonomiske analyser 3/2016, Statistics Norway

Syse, A., D. Pham and N. Keilman (2016a): Befolkningsframskrivinger 2016-2100. Dødelighet og levealder. [In Norwegian] Økonomiske analyser 3/2016, Statistics Norway

Syse, A., R. K. Hart and K. N. Aase (2016b): Befolkningsframskrivinger 2016-2100. Fruktbarhet. [In Norwegian] Økonomiske analyser 3/2016, Statistics Norway

United Nations (2015): World Population Projections. The 2015 Revision. http://esa.un.org/unpd/wpp/

Highlights from four articles (available only in Norwegian) describing the assumptions of fertility, life expectancy, internal migration, immigration and emigration in more detail

FERTILITY

How do we estimate future fertility in the population projections?

In the model that projects the population at a national level (BEFINN), we project the fertility for different groups of women. In addition to calculating fertility for women from Norway, we also factor in the fertility disparities between immigrant women in 15 combinations of country background and period of residence in Norway. First, we ascertain the output level for the different groups, then we make assumptions on how we think fertility will develop over time.

Fertility among immigrants

In order to estimate how many children will be born to immigrant women in the future, the immigrant women are divided into three country groups and five period of residence groups (1 year or less, 2-3 years, 4-6 years, 7-11 years and 12 years or more). In total, this constitutes (3 x 5) 15 combinations of country and period of residence groups. In order to determine the fertility output level in the 15 different groups, an age-specific fertility rate is calculated for each group as an average over the last ten years. This is a weighted average where the last year with available data counts the most. In order to calculate the number of Norwegian-born children to two immigrant parents we also make assumptions about the proportion of immigrant women who will have children with immigrant men (see Figure 19 in Cappelen et al. 2016).

Fertility among the rest of the population

Once we have calculated the fertility output level for immigrant women, we calculate the fertility of other women who are resident in Norway. Norwegian-born to one or two immigrant parents are also included in this group. In order to determine the fertility output level among the remainder of the women, age-specific fertility rates are calculated for the last year.

Regional fertility

The projections of regional fertility are based on the fertility disparities in the past decade between 68 geographic regions – referred to as fertility regions. The future regional fertility development is determined by adjusting the output level in these regions proportionally with the future national fertility development. The regional fertility disparities are thereby accounted for since the output level of each fertility region is different, but we assume that the absolute differences between fertility regions remain constant throughout the entire projection period. The number of births and 0-year-olds in the prognosis regions is then added up for the counties. Then the 0-year-olds are broken down into municipalities using 55 fertility profiles. These profiles depend on the number of women in the municipality and their fertility level.

Determining fertility assumptions

Once we have calculated the output level of fertility in the 16 groups (non-immigrant women and 15 groups of immigrant women), we need to make assumptions about how fertility will develop over time. For each year in the projection period, we use a factor that adjusts the age-specific fertility rates up or down. In order to illustrate the great uncertainty attached to future fertility levels in Norway, we create three different alternatives for the fertility assumptions: low, medium (main alternative) and high. In combination, this constitutes three annual factors. The factors are determined by Statistics Norway after discussions with an advisory reference group consisting of fertility researchers.

Fertility assumptions for 2016

Based on a summary of empirical knowledge of fertility trends and figures for the number of births in the first quarter of 2016, we believe that the decline in fertility that we have seen since 2009 is about to come to an end. In the main alternative, we assume therefore that the fertility for non-immigrant women will remain relatively constant at the 2015 level (TFR 1.69). In the low alternative, we have chosen to lower fertility relatively quickly to a level that is about 13 per cent lower than in 2015. This corresponds to a TFR of 1.48 for non-immigrant women. This level at just under 1.5 corresponds to the level in Sweden at the end of the 1990s when they experienced an economic slump (SCB 2015). This is also slightly lower than the EU average in recent years (Eurostat 2016). In 2014, the average TFR in EU countries was 1.58. In the high alternative, we have chosen to raise fertility relatively quickly to a level that is correspondingly much higher. This gives a TFR of 1.91 for non-immigrant women. This is comparable with the 2009 level for this group of women, when fertility last peaked in Norway.

LIFE EXPECTANCY

How are mortality and life expectancies calculated in the population projections?

Statistics Norway uses recognised models to project mortality in Norway. In these models, future mortality is mainly determined based on empirical trends. We use the product-ratio variant of a Lee-Carter model, where the trend in mortality for a selected time period, represented by two estimated time series, is extended using an ARIMA model. The period used as input is determined prior to each projection. This method gives us mortality rates by age in years and sex up to and including the year 2100, which are subsequently used in the models BEFINN and BEFREG. 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 and together.

In the model that projects the population at a national level (BEFINN), projected mortality rates by age in years and sex are used. We do not distinguish between immigrants and the rest of the population. The regional model (BEFREG) takes into account regional disparities in mortality. Here, our assumptions are based on the mortality in the past decade in every county and in each of Oslo's districts.

Data

Figures on the number of deaths and the population size are taken from Statistics Norway's population statistics. We calculate age-specific death rates for men and women, and the total for both sexes by age in years for each calendar for the ages 0-100, and allow for the fact that deaths do not occur linearly throughout the year. Age is defined as the age in whole years at the end of the year. When the mortality rates are calculated, an adjustment is made for extreme values. Once we have calculated the mortality rates in the period we have chosen to base our model on and made adjustments for extreme values, the actual modelling of projected rates can begin.

The models

For details of the models and references to literature in the field, see the documentation memorandum in English by Aase et al. (2014). Initially, a product-ratio method is used (Hyndman et al. 2013). The purpose of the method is to reduce the correlation between the mortality rates for men and women. A method based on the Lee-Carter model is then applied (Lee and Carter, 1992, Li and Lee 2005, Lee 2000). This model was originally developed by Lee and Carter in 1992, but has since been developed further. The method estimates parameters of change in mortality levels over time by sex and age. So far, we have only modelled the observed mortality rates. In order to make assumptions about how mortality will develop in the future, we use a so-called ARIMA model (Wei 2006), which stands for Auto-Regressive Integrated Moving Average. In this model, we include a so-called random walk with drift, which means that we factor in a mortality trend that we expect to continue in the future.

Uncertainty

Once we have calculated the age-specific mortality rates for the entire projection period with the models presented above, uncertainty from the Lee-Carter modelling is incorporated. Further uncertainty from the ARIMA modelling is estimated by simulating 2000 alternatives using boot strapping. This gives us different paths for possible developments in future life expectancy. Statistics Norway's population projections primarily use three alternative paths for the future development of life expectancy: medium (M – the main alternative), low (low life expectancy/high mortality) (L) and high (high life expectancy/low mortality) (H). The estimated projected alternative is called the main alternative, for which we give an 80 per cent prediction interval. The upper limit in the prediction interval for mortality rates gives us the low alternative, while the lower limit gives the high alternative. We also have a constant alternative (K), where the mortality rates in the main alternative for the first projection year are kept constant throughout the entire projection period.

Discretionary assessments

The period used as input is determined prior to each projection. When assessing the plausibility of the projected mortality rates, we also make other discretionary assessments. If adjustments seem appropriate, we make these in consultation with an advisory reference group consisting of mortality researchers.

Life expectancy at birth and remaining life expectancy

After we have estimated age-specific mortality probabilities in the projection period, we calculate life expectancy at birth and the remaining life expectancy at each age level in each projection year. We calculate this for the country as a whole in three alternatives; for men and women separately, and for both sexes combined. The latter is based on mortality probabilities for both sexes combined.

Life expectancy at birth refers to the number of years a newborn baby will live if the relevant age-specific mortality probabilities for a period (normally a calendar year) persist. Remaining life expectancy is defined as the remaining number of years a person at a given age will live if the age-specific mortality probabilities for the remaining ages in the period (normally a calendar year) persist. Statistics Norway calculates the remaining life expectancy for each age level up to and including 105 years.

Mortality assumptions in BEFINN and BEFREG

Projected mortality probabilities are used as assumptions for mortality in BEFINN and BEFREG. In BEFINN, the mortality probabilities are applied by sex, age in years and calendar year in four alternatives: high (H), medium (M), low (L) and constant (K) life expectancy. The same mortality is assumed for immigrants as for others, since the disparities on average are below 10 per cent (Syse et al. 2016). In BEFREG, we factor in existing regional differences in mortality. We let the mortality level vary between the counties and between Oslo's 15 largest districts. In total, this gives 33 mortality regions, where the mortality rate is allowed to vary by region, age in years and sex. In order to determine the mortality output level in the 33 mortality regions, age-specific mortality probabilities are calculated as an average of the last ten years in each mortality region. This is a weighted average where the last year with available data counts the most. Once we have ascertained the output level in each region, we add assumptions about future mortality at a national

level. The national assumptions are the same in BEFINN and BEFREG. The future regional mortality trend is determined by adjusting the output level in the 33 mortality regions proportionally to the future national development in mortality. The regional mortality disparities are thus factored in since the output level by age in years and sex is different in each mortality region. Thus, we assume that the disparities between the mortality regions remain constant throughout the entire projection period.

In the population projections, we calculate the future population by sex and age in years in 108 prognosis regions. Prognosis regions that belong to the same mortality region will therefore have the same age-specific mortality probabilities. We only calculate the number of deaths at county level and for prognosis regions, not by municipality.

Mortality assumptions for 2016

This year's projections are based on developments in mortality during the period 1990-2015. We assume that mortality will continue to decline. In our main alternative, life expectancy at birth for men will rise from around 80 years in 2015 to 87.2 and 91.6 years respectively in 2060 and 2100. This represents an increase of about seven years up to 2060, and eleven to twelve for the entire projection period. For women, we have assumed an increase from around 84 years to 89.2 and 92.5 years for the same period, which is an increase of five and just over eight years respectively.

In the low alternative, men's life expectancy showed weak growth: it is assumed to increase to 83.3 years in 2060 and 86.3 years in 2100. For women, the increase is even smaller, and the corresponding estimates are assumed to be 86.0 years in 2060 and 88.0 years in 2100. In stark contrast, our high alternatives show strong growth in life expectancy: men's life expectancy will increase to 90.3 years in 2060 and reach as much as 95.2 years in 2100, representing an increase of ten and fifteen years in total. Women's life expectancy will also see a strong increase, although somewhat less than for men, to 91.9 years in 2060 and 95.7 years in 2100. The high and low alternatives in a particular year coincide with the limits of an 80 per cent prediction interval. From 2015 to 2016, it is assumed that life expectancy will only rise by about 0.3 years for both sexes combined. This is roughly equivalent to the increase we have seen in the last 10-15 years. From 2015 to 2016, the increase is assumed to be equal for women and men, while in the longer term it is assumed that life expectancy for men will increase faster than for women. Thus, it is assumed that the disparity in men and women's life expectancy will decline further in all age groups. If our assumptions are correct, the gender disparity in pensioners' remaining life expectancy will steadily narrow.

INTERNAL MIGRATION

How is migration calculated in the population projections?

BEFREG is a projection model that calculates the population size and its regional distribution by sex and age in years. Figures are published for the counties, municipalities and districts in Oslo. Internal migration and immigration/ emigration have a large impact on population trends. The internal migration is projected in several stages. Based on observed migration, out-migration probabilities are calculated from each prognosis region and a migration matrix across the regions for groups by age and sex. For each projection year, the number of out-migrations is calculated from each region, and these are distributed into in-migrations using the migration matrix. The model also factors in migration within regions when the population is broken down at municipal level.

The migration assumptions are based on migration trends from the last decade continuing. Future migration between regions is calculated for persons aged 0-69 years, while migration within the regions is calculated for persons up to the age of 49. In addition to migration between different prognosis regions in Norway, BEFREG also calculates migration between the prognosis regions and abroad. These figures are adjusted to align them with the national figures for immigration and emigration in BEFINN.

When making assumptions about future migration, out-migration from each prognosis region is calculated first, using out-migration probabilities. These probabilities are calculated for each sex by age in years (0-69 years), and are based on observed out-migration from each prognosis region in the past ten years. Since migration can entail moving to other countries as well as other parts of Norway, separate probabilities are calculated for emigration and internal out-migration from each prognosis region.

Emigration probabilities are calculated based on observed emigration over the last ten years. The probability is calculated from all prognosis regions for sex and age by years up to 70. In order for the results of emigration probabilities to match the national emigration figures from BEFINN, an index is calculated for each year that the emigration probabilities for each prognosis region are aligned with. This depends on the immigration alternative, since high immigration, for example, entails higher emigration in subsequent years.

Internal out-migration probabilities are calculated based on registered internal migration over the last ten years. In order to ensure a smooth transition from the migration probabilities' last observed year to the migration probabilities in the long term (and which are based on observed figures from the last ten years), the long-term probabilities are gradually phased in during the first four projection years.

With regard to immigration to the prognosis regions from abroad, immigrant figures by sex and age are taken from BEFINN's national figures. This is done for each year throughout the projection period and for all immigration alternatives. Using the migration matrix, immigrants are distributed into the prognosis regions according to the percentage of the immigration over the last decade to the various regions, based on groups by sex and age.

Migration matrix

After we have projected the number of persons who out-migrated from the prognosis regions and immigrants, these must be distributed as migrants to the prognosis regions. This is done using a migration matrix. The migration matrix applies separate percentages for migration from different parts of the country and to each prognosis region based on age and sex. In order to reduce the number of migration flows and ensure that they have a robust size, we have merged the prognosis regions into 34 large out-migration areas, based on part of the country and centrality.

In the migration matrix, percentages are calculated for how much of the migration from each of the out-migration areas (and abroad) should go to each prognosis region. These are based on observed migration in the last ten years, for 20 groups of migrants by age and sex. Since people are more likely to migrate in their 20s, there are relatively many different age groups in this age range. However, the most elderly, who move relatively seldom, are made up of just a few groups.

Breakdown at municipality level

When BEFREG has projected the population in each prognosis region, the population by sex and age in years is distributed into the municipalities within the region. This breakdown takes into account migration between the municipalities within the same prognosis region of people aged 1-49 years. For this age group, growth rates are calculated for each municipality based mainly on migration within the region over the past ten years. In order to ensure that the growth rates give a population figure for the municipalities that adds up to the projected population for the prognosis region, a correction factor is used to adjust the growth rates. In addition, a moderating factor is added, which ensures a downward trend in growth rates, such that disparities in growth between municipalities within a region are reduced over time. This is to limit the effects of temporary fluctuations in the municipal population on the population distribution within the region over time. This adjustment does not affect the cities, which are separate prognosis regions.

Migration assumptions for 2016

The population projection for 2016-2040 uses the migration over the years 2006-2015 to calculate the migration rates. The tendency to move has increased in this period, since the observed mobility between the municipalities is greater. The trend over the period 2006-2015 is generally positive, except during the financial crisis in 2008 and 2009 when the migration rate was somewhat lower. Migration patterns are strongly correlated to age and are often viewed in the context of life phases. Migration is by far the highest for the age group 20-29 years, with an average of 135 migrations per 1 000 persons in the period 2006-2015, and the second highest for those aged 30-39 years, with a corresponding figure of 60. For young adults, it is natural to view this in the context of studies and starting a career. For those slightly older, migration can be associated with forming a family and income growth, and thereby other preferences, needs and opportunities with regard to housing and residence. The tendency to migrate declines steadily with age after 40, and the over 80s are the least mobile, with fewer than 5 per thousand migrating.

Internal migration and immigration lead to centralisation. A secondary effect is that internal migrants and immigrants are young and of childbearing age, which contributes to higher fertility and lower mortality. Every year in the period 2006-2015 saw a positive internal net in-migration of 5 000-9 000 to the most central municipalities (measured using Statistics Norway's centrality distribution). Municipalities that are not central, however, have an aggregate internal net out-migration, and the net out-migration generally rises with the declining degree of centrality. Net in-migration is over 25 000 for the central municipalities over much of the period and never falls below 15 000. For the other municipalities, net in-migration is almost 5 000. This means that much of the internal net out-migration in the municipalities that are not central is offset by immigrants. These municipalities therefore have a weak population growth overall. There is some heterogeneity in the growth in the central municipalities. In terms of number of inhabitants, the greatest growth is seen in the cities' peripheral municipalities. All of these characteristics of migration patterns are also projected by the model.

MIGRATION

How is immigration and emigration calculated in the population projections?

In the population projections, immigration and emigration are calculated separately. Thus, we draw up assumptions for gross immigration and gross emigration. The world is divided into three country groups for both types of migration:

1. West Europe, USA, Canada, Australia and New Zealand
2. New, eastern EU countries
3. Rest of the world

Immigration and emigration among persons with a background from Norway are also calculated. Net migration is calculated by subtracting the annual emigration from the annual immigration. The projections of immigration and emigration are also used to estimate the number of immigrants and Norwegian-born children to two immigrants who will live in Norway in the future.

Projecting future immigration

In order to project future immigration to Norway, a separate econometric model is used. A fuller description of this is given in Cappelen et al. 2015. In this model, immigration to Norway is influenced by four specific factors: disparities in income and unemployment between Norway and the three country groups; population growth in the country groups; and how many from the three country groups already live in Norway. We use empirical data to estimate the parameters in the model – i.e. to quantify the correlation between the various factors and immigration. These estimates are used in conjunction with prognoses for future income disparities, unemployment and population trends in order to calculate future immigration from each of the country groups. The high and low alternatives for immigration differ from the medium alternative in that they are based on different alternatives for future Norwegian and international income growth, and that they use the UN's high and low alternatives for population growth in the world. It is also possible to raise or lower the immigration trajectories emanating from the econometric model, based on a discretionary assessment of the immigration situation. This was done in this year's projections (see below). Immigration by people with a background from Norway is projected as a weak linear increase of last year's immigration level. When the figures for future immigration to Norway from each country group are calculated, these are distributed by age and sex (and period of residence) based on the breakdown of immigration to Norway over the last ten years.

Projection of future emigration

Emigration is determined by emigration probabilities. These probabilities are based on observed figures for emigration over the last decade, and vary by age and sex. They also vary according to whether they are immigrants, Norwegian-born to two immigrants or are in the rest of the population. For immigrants and their children, we have various emigration probabilities by country group and (for immigrants) by period of residence. Immigrants from country groups 1 and 2 with a short period of residence have a particularly high probability of emigration.

Net immigration and number of immigrants in Norway

Once we have made assumptions about immigration and emigration, we can easily calculate the projected net migration. By combining this with the assumptions about mortality, we calculate the number of immigrants who will remain in the country in the years ahead. We also calculate how many of the future inhabitants will be Norwegian-born to two immigrant parents. This requires assumptions about the proportion of immigrant women's children whose father is also an immigrant, in addition to assumptions on future fertility among immigrant women.

Migration assumptions for 2016

The results of the econometric model's main alternative show a clear decline in immigration in the coming years. This is related to the expected high unemployment in Norway. The decline is particularly strong for immigration from country group 2 – Eastern European EU countries. For country groups 1 and 3, immigration increases again after the first few years, and country group 3 shows weak growth throughout most of the century. For country group 3, we have this time also included a discretionary addition in immigration in the coming years, due to the asylum situation in Europe and Norway. Emigration from Norway will increase somewhat throughout the century, in line with the growing number of immigrants in Norway. Net migration is set to stabilise at between 25 000 and 30 000 annually in the long term. The number of immigrants living in Norway will increase from around 700 000 today to 1.7 million in 2060, according to the main alternative (MMMM).