Vienna Yearbook of Population Research 2023 (Vol. 21), pp. 211–243

How much would reduced emigration mitigate ageing in Norway?

Marianne Tønnessen[1,*] ***and Astri Syse***[2]

Abstract

Population ageing is a topic of great concern in many countries. To counteract the negative effects of ageing, increased fertility or immigration are often proposed as demographic remedies. Changed *emigration* is, however, rarely mentioned. We explore whether reduced emigration could mitigate ageing in a country like Norway. Using cohort-component methods, we create hypothetical future demographic scenarios with lower emigration rates, and we present (prospective) old-age dependency ratios, population growth and shares of immigrants. We also estimate how much fertility and immigration would have to change to yield the same effects. In different scenarios, emigration is reduced for the total population and for subgroups, while also taking into account that reduced emigration of natives will entail reduced return migration. Our results show that even a dramatic 50% decrease in annual emigration would mitigate ageing only slightly, by lowering the old-age dependency ratio in 2060 from 0.54 to 0.52. This corresponds to the anti-ageing effect of 15% higher fertility, or one-quarter extra child per woman.

Keywords: emigration; ageing; population size; population projections; population policy

1 Introduction

Ageing is a challenge facing low-fertility countries across the world. According to the United Nations (2022a), the number of people aged 65 years or older worldwide will more than double from 771 million in 2022 to 1.6 billion by 2050. In Europe and North America as well as in Eastern and South-Eastern Asia, more than 25% of the

[1]Oslo Metropolitan University, Oslo, Norway

[2]Norwegian Institute of Public Health, Oslo, Norway

*Correspondence to: Marianne Tønnessen, mariton@oslomet.no

https://doi.org/10.1553/p-g5fe-hafz

population will be aged 65 years or older by 2050 (ibid). The old-age dependency ratio (OADR), which equals the number of persons aged 65 years or older divided by the number of persons aged 20 to 64 years (the "working ages"), is also projected to increase from 0.17 in 2022 to 0.29 in 2050 worldwide. In Eastern and South-Eastern Asia and in Europe and North America, the OADRs in 2050 are expected to be around 0.5, or 50 persons aged 65+ per 100 persons aged 20–64 (United Nations, 2022b). In Norway – the country this paper focuses on – the OADR is expected to increase from 0.3 in 2020 to almost 0.5 in 2050 (Syse et al., 2020; Thomas and Tømmerås, 2022).

Population ageing may pose challenges for countries at multiple levels. A larger elderly population relative to the population of working ages is likely to increase the pressure on public and private old-age support and transfer systems as well as on the health sector (OECD, 2021; United Nations, 2020a). It is feared that future long-term care demands will exceed the resources of the family, the welfare state and other caregivers, both in quantity and in complexity (Lorenzoni et al., 2019; Muir, 2017), which could, in turn, affect the sustainability of the welfare state (OECD, 2019). Hence, the prospect of higher OADRs has been met with concern in many countries, particularly in the Western world and in Eastern Asia.

Several measures for managing the consequences of population ageing have been discussed. Some of these are non-demographic, such as lifelong education and health care for all, facilitating savings and healthy lifestyles, promoting employment among women and other low-employment groups, and raising retirement ages. Other measures are aimed at altering the demographic trends by directly affecting the determinants of demographic change.

1.1 Demographic remedies for ageing

Although there are several determinants of demographic change in a country – fertility, mortality, immigration and emigration, working in tandem with the age and sex distribution, to shape the future size and composition of the population – in most national policy debates concerning population ageing, only fertility and immigration are discussed. However, both of these "remedies" have drawbacks that warrant consideration.

The decline in *fertility* to below two children per woman has been met with concern in many advanced economies (Sobotka et al., 2019). In 2015, 66% of European governments and almost 40% of Asian governments had policies in place to raise fertility or impede further decline (United Nations, 2018). However, substantial long-term fertility increases are difficult to achieve. Policies aimed at increasing fertility tend to have a larger effect on the timing of births than on the total number of children born (Bergsvik et al., 2021). Although studies have found some correlation between extensive public support to families and higher fertility (e.g., Wood et al., 2016), the answer to the question of whether the higher fertility is caused by the costly policies or by favourable economic conditions that made such policies possible is not obvious.

And although (quasi-)experimental studies have suggested that certain policies may affect fertility, the future effects of these measures may be limited if their coverage is already wide (such as day-care in many Western countries), or these measures may have unwanted side effects, such as reducing female employment (Bergsvik et al., 2021). Moreover, changed fertility is linked to questions about climate and global sustainability. Higher fertility and, hence, a larger world population will make it more challenging to meet global food needs and to reduce global warming and biodiversity loss (Bongaarts, 1992; Bongaarts and O'Neill, 2018; Casey and Galor, 2017; Crist et al., 2017; O'Neill et al., 2010; Reher, 2007; Tamburino et al., 2020; Wilmoth et al., 2022; Wynes and Nicholas, 2017).

Increased *immigration* can reduce population ageing in the short term, since immigrants often arrive in their twenties or thirties. However, measures to increase immigration may be politically controversial. Furthermore, increased immigration has limited effects on ageing in the long term, because immigrants who remain in the destination countries also get older. Studies on replacement migration have generally concluded that to prevent low-fertility countries from experiencing demographic ageing, the volumes of immigration – or positive net migration – that would be required would have to be far higher than in the past, and would likely be politically unfeasible (Bijak et al., 2008; Blanchet, 1989; Heleniak and Sanchez Gassen, 2016; Paterno, 2011; United Nations, 2001). In the long run, immigration has tended to affect population size far more than its age structure (Alho, 2008; Bujard, 2015; Murphy, 2016); and in the even longer run, stable population theory posits that populations with sustained below-replacement fertility and constant immigration eventually become stationary, with age structures that depend on the distribution of the immigrants' arrival ages (Arthur and Espenshade, 1988; Espenshade et al., 1982; Schmertmann, 1992).

For completeness, we should also mention the effect of *mortality* on population ageing. If the long-term trend of mortality decline halts, or if mortality increases, especially in the older age groups in which deaths most commonly occur, population ageing would be counteracted. As shown by Lutz and Scherbov (2003), future old-age dependency ratios are sensitive to different future mortality trends. However, measures to actively prevent further increases in remaining life expectancies are not on the political agenda, and are unlikely to be proposed.

The literature on how changed *emigration* can affect future ageing in a Western country like Norway is scarce. There are several potential explanations for why this is the case. First, many of today's ageing nations are characterised by more immigration than emigration, and while immigration has received considerable scholarly attention, there is much less research on emigration from Western countries. Second, as data on emigration are often inadequate, and many countries and agencies instead rely on net migration figures when, for instance, projecting future migration (Cappelen et al., 2015), it is difficult to make projection scenarios in which only the rates of emigration change.[1] Third, given that leaving a country is now considered a fundamental human right, reduced emigration may be considered equivalently hard to achieve (and as controversial) as the other demographic components mentioned above. Nevertheless, countries have policies in place that may affect the incentives to emigrate or to stay, as we discuss towards the end of this paper.

The scarcity of research on emigration from wealthy countries, including on its effect on ageing, is mirrored in a lack of interest from policymakers in Western countries.[2] It is, however, documented that emigration (or negative net migration) can affect ageing in some typical net emigration countries, such as in Central American countries in close proximity to the United States (García-Guerrero et al., 2019) and in Eastern European countries (Botev, 2012; Fihel et al., 2018; Philipov and Schuster, 2010; Potančoková et al., 2021; Rees et al., 2012). Although emigration usually makes a population older, whether this is actually the case depends on the ages of those who leave and of those who remain (Gavrilov and Heuveline, 2003; Parr, 2021), and on the fertility and mortality of the emigrants and of those who remain (García-Guerrero et al., 2019).

Over the last decades, several studies have presented comprehensive scenarios for Europe's population development and ageing with different sets of assumptions regarding – among other factors – emigration and immigration, or net migration (Bijak et al., 2008; Marois et al., 2020; Potančoková et al., 2021; Rees et al., 2012). These studies often applied different scenarios for intra-EU (or intra-European) migration and migration between EU/Europe and the rest of the world, and they based their emigration scenarios on observed emigration rates (which may be adjusted up or down in different scenarios). In the scenarios, changed intra-EU emigration *from* one country would affect intra-EU immigration *to* another EU country, making it hard to estimate how a change in emigration only would affect a country's ageing rate.

This paper assesses whether reduced emigration could mitigate a country's population ageing challenges, using Norway as a case study and applying the official model for population projections employed by Statistics Norway. This model uses high-quality register data covering the entire population, and it allows us to estimate the effects of changed emigration, rather than of changed net migration only. Moreover, it allows us to explore how much each of the other components of demographic change (fertility, mortality and immigration) need to change in order to yield the same effects on ageing as reduced emigration. To our knowledge, this has not been done in the literature before. We show how reduced emigration affects a multitude of population measures, including the share of immigrants in

[1] Many also provide a "zero net migration" alternative, often used to calculate the demographic effects of migration. This may, however, be misleading (Bouvier et al., 1997), since different people leave and enter the country during a given year.

[2] At the regional level, however, a number of policies have been implemented that aim to directly affect out-migration from shrinking and ageing parts of the country.

the population and other indicators of ageing, such as the prospective old-age dependency ratio (POADR). Furthermore, we add to the literature by estimating how reduced emigration for certain subgroups only would affect the different measures of ageing and the immigrants' share, while also taking into account that the reduced emigration of natives would result in lower return migration back to Norway.

1.2 The Norwegian context

The ageing trend in Norway is similar to that of many other Western countries. Of the Norwegian population of about 5.4 million in 2022, elderly aged 65 or older comprised 18%. As shown in Figure 1, the Norwegian population is expected to continue to grow in the future, but at a slower pace than in the previous decades. The share of elderly (aged 65+) is projected to increase to 26% by 2050, and the OADR is projected to increase from 0.31 today to 0.49 in 2050, according to the main alternative in Statistics Norway's 2020 population projections (Syse et al., 2020). This is shown in the lower left panel of Figure 1. The lower right panel of the figure shows that both immigration and emigration have increased considerably over the last decades, and that they are expected to remain at relatively high levels in the future, with more immigration than emigration.

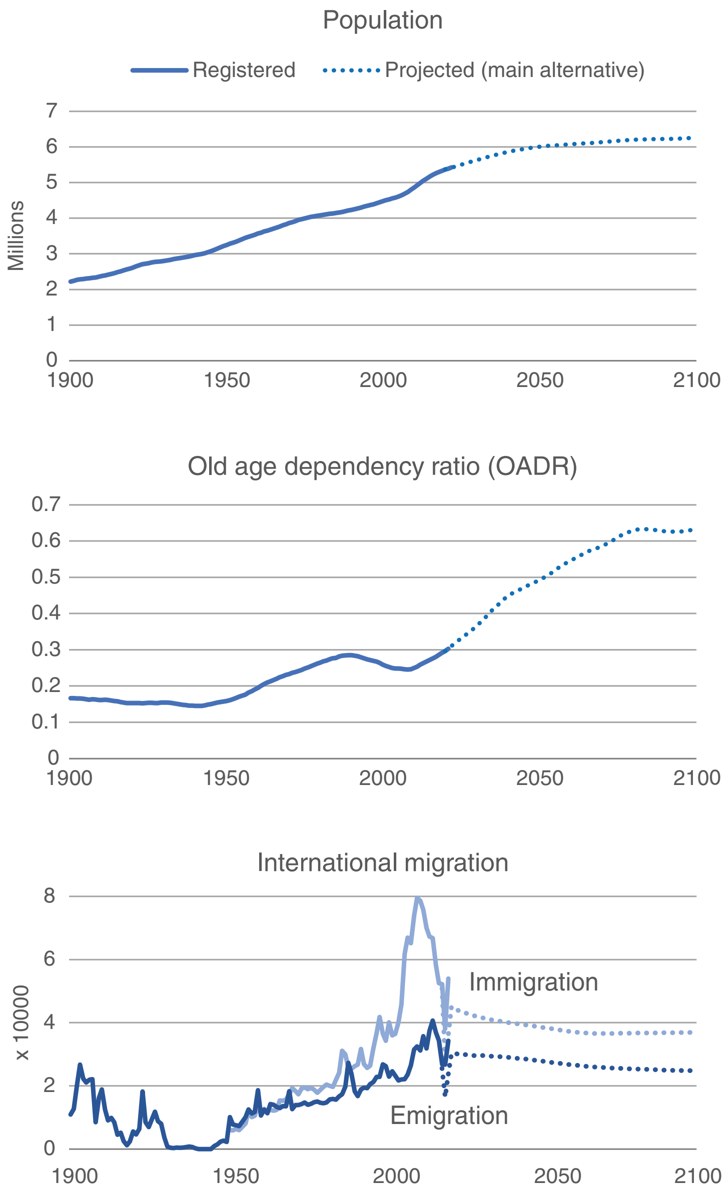
Like in many other countries, policymakers in Norway worry about the consequences of population ageing. In 2019, the prime minister expressed concerns about declining fertility (the Norwegian TFR decreased from almost two in 2009 to around 1.5 in 2019), and encouraged Norwegian couples to have more babies (Solberg, 2019).

Changes in emigration have not been part of the Norwegian discourse about remedies for ageing. However, as Figure 1 shows, about 30,000 individuals emigrate from Norway every year. This corresponds to about five emigrations per 1000 inhabitants. That rate is higher than the crude emigration rates of some other European countries, like Italy, Portugal and France, but it is clearly lower than the rates of other countries, such as Iceland, Switzerland, Ireland and Lithuania (see Figure 2).

Around 70% of emigrants from Norway are persons who have previously immigrated to Norway, while 30% are non-immigrants (natives). Most of the immigrants who emigrate have relatively short durations of stay in Norway, and immigrants from other Western countries have higher emigration rates than refugees and family migrants from less wealthy parts of the world. While most non-native emigrants return to their country of origin, especially if they are Nordic, the share of those who move on to a third country is also relatively high (almost 50%) among immigrants born in a less wealthy country such as Pakistan, Vietnam or Somalia (Pettersen, 2013; Skjerpen et al., 2015).

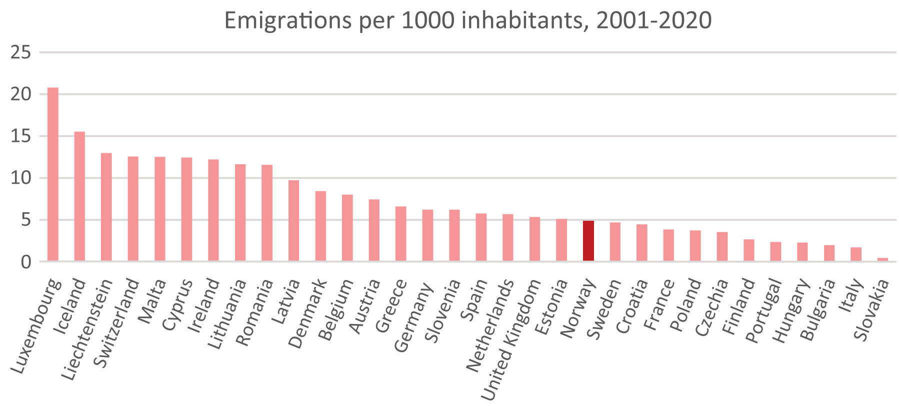
Most emigrants from Norway are 20–40 years old or below age 10 when they leave Norway. As summarised in Figure 3, the mean age of people who emigrate from Norway is almost 30 years, which is about five years higher than the mean age

Figure 1:
Norwegian population size, OADR, immigration and emigration 1900–2100 (projected in the 2020 main alternative)



Source: Statistics Norway.

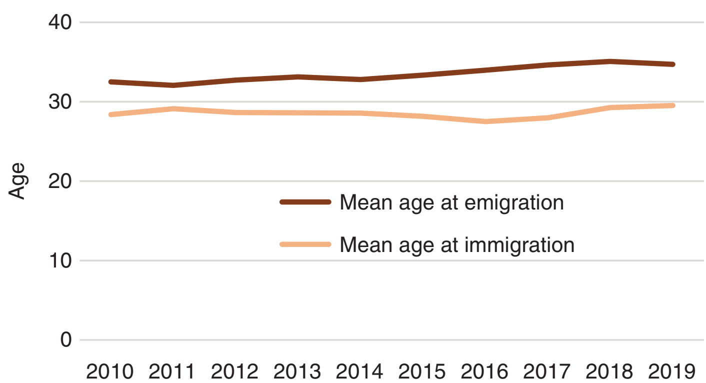
Figure 2:
Emigrations per 1000 inhabitants, 2001–2020



Source: Eurostat.

of those who immigrate. This age difference also means that women who emigrate have on average fewer remaining years for childbearing than women who immigrate. Appendix Figure A.1 shows emigration by age, in absolute numbers and per 1000, for immigrants and natives (non-immigrants). The figure indicates that the emigration rates are clearly higher for immigrants than for natives, at all ages.

Figure 3:
Mean age at emigration from and immigration to Norway, 2010–19 (based on immigrations and emigrations at ages 0–90 years)



2 Data and methods

In this study, we apply the projection model used in the official Norwegian population projections. Here, we first present the official model, and then explain how we use this model to explore the demographic effects of changed emigration rates.

2.1 The Norwegian population projection model

The Norwegian population projections are based on detailed data from the Norwegian population register, which has data on all immigrations and emigrations at the individual level, as well as on other demographic events. The projections, and the data and methods used, are further described by Syse et al. (2020). In short, the model applies deterministic cohort-component methods, and emigration is projected using registered emigration rates (the last 10 years) for different subgroups by age, sex, immigrant background and (for immigrants) area of origin (see Footnote 3) and duration of stay in Norway.[3] Future emigration from Norway is calculated from these fixed rates being applied to the projected future population of Norway. Emigration is projected to decrease slightly (cf. Figure 1 and Appendix Table A.1), mainly because of a declining share of immigrants with a short duration of stay. The other components of population change (fertility, mortality/life expectancy and immigration) are projected using a mix between expert judgements and separate models (Lee-Carter/ARIMA for mortality and a separate econometric model for immigration, Cappelen et al., 2015). Future immigration is calculated separately for three different origin areas (Western countries, Eastern EU and the rest of the world; see specification in Footnote 3), as well as for natives returning to Norway. While the total fertility rate (TFR) is projected to increase from 1.5 to a long-term level of about 1.7 children per woman, and life expectancy is projected to increase from around 81 years for men and 85 years for women to 89 and 91 years, respectively, in 2060, future immigration to Norway is projected to decline somewhat, from around 52,000 to a long-term level of around 37,000 annually.

As most emigrants are of childbearing age (cf. Appendix Figure A.1), lower emigration will also affect the number of births, since people who do not emigrate experience age- and sex-specific probabilities of both giving birth and dying.

[3] An "immigrant" is defined as a foreign-born person with two foreign-born parents and four foreign-born grandparents who has immigrated to Norway to stay for at least six months. The areas of origin are (i) *Western countries*, which comprises all of the Western European countries, i.e., countries that were part of the "old" EU (pre-2004) or the EEA and the EFTA, as well as the US, Canada, Australia and New Zealand; (ii) *Eastern EU*, which comprises the 11 countries in Eastern Europe that became EU members in 2004 or later (Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bulgaria and Romania); and (iii) 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). The legal opportunities for entering Norway and the demographic behaviour differ somewhat for immigrants from the three origin country groups. For more details, see Syse et al. (2020), box 7.1.

Whereas the age- and sex-specific probabilities of dying are the same for all subgroups in the model, the fertility rates differ between immigrants and the rest of the population, and (for immigrants) by area of origin and duration of stay in Norway.[4]

2.2 How we use the model to explore changes in emigration

In this paper, we use the official medium projections ("main alternative") as a baseline. In our first investigation of how reduced emigration affects ageing, we run the projection model with a hypothetical scenario in which all emigration rates are reduced by 50%, while the baseline assumptions are used for all the other components (i.e., fertility, mortality and immigration). Second, we run the model while changing each of the other components of demographic change (one at a time), with the aim of obtaining the same OADR in 2060 as the 50% reduction in emigration rates. We also explore the (even more) hypothetical scenario in which all emigration from Norway is stopped. Furthermore, we investigate the effect of a reduction in emigration rates for certain subgroups only (immigrants vs. natives, younger vs. older age groups).

The changes in the demographic components employed in these scenarios are large, and are, admittedly, not the most plausible ones. However, the relationships between them may provide useful information about whether a change in emigration could be an anti-ageing formula. To apply somewhat more realistic scenarios, we also make projections in which emigration is reduced for both immigrants and their Norwegian-born children, and one in which 50% lower emigration among natives leads to 50% lower return migration of natives, due to the smaller "pool" of native Norwegians living abroad. In all the other scenarios, the assumptions about future immigration to Norway are the same as in the official population projection (our baseline).

To summarise, we run the population projection models until 2100 with the following scenarios:

- The official projections' main alternative – our baseline scenario
- 50% lower emigration rates (for the whole population)
- Higher immigration (that yields the same OADR in 2060 as 50% lower emigration)
- Higher fertility (that yields the same OADR in 2060 as 50% lower emigration)
- Higher mortality (that yields the same OADR in 2060 as 50% lower emigration)
- No emigration (for the whole population)
- 50% lower emigration rates for certain subgroups only:
    - Only older persons (aged 50+)
    - Only younger persons (aged 0–49)
    - Only immigrants (all ages)

[4] Although emigrants in real life may be selected on fertility, as has been shown by Anelli and Balbo (2021) for Italy, the Norwegian population projection model does not account for such a phenomenon.

- Only immigrants and immigrants' children
- Only natives
- Only natives, with 50% lower return migration of natives

In each scenario, we explore the following measures of population change (# indicates number of persons):[5]

- Old-age dependency ratios (OADR) – # aged 65 years+/# aged 20–64 years
- Prospective old-age dependency ratios (POADR) – # in age groups with life expectancies of 15 or fewer years/# aged 20+ years with life expectancies greater than 15 years
- Population count – the size of the population
- Share of immigrants in the population – all immigrants and by three different areas of origin (see Footnote 3).

Table 1 shows historical figures of the above measures of ageing and the immigrants' share for 2020 (the baseline year for our projections) and 2022 (the most recent year).

In addition to the measures listed above, we assess how the future numbers of births, deaths, emigrations and immigrations differ between the scenarios (statistics for 2020 and 2022 are displayed in Table 1, whereas the results from the respective scenarios are shown in Appendix Table A.1).

3 Results

3.1 Reducing emigration by 50% will slow OADR growth by 10%

The results from our first analyses, in which the baseline (the main alternative from the official population projections) is compared with a scenario with 50% lower emigration rates, show that this reduction decreases the old-age dependency ratio (OADR) in 2060 from 0.54 to 0.52 (Table 2). This is still clearly higher than today's 0.31. Hence, with 50% lower emigration, the increase in the OADR from 2020 to 2060 would be 10.4% lower than in the baseline alternative.[6] Other ageing measures (median age, share aged 65+ years and aged 20–64 years and the TDR, see Appendix Table A.2) show a similar pattern, with 50% lower emigration leading to only a slim reduction in ageing. Moreover, the prospective old-age dependency ratio (POADR), which is designed to account for changes in longevity so that the threshold between "working age" and "old" changes as people live longer (Sanderson

[5] We also investigate effects on some other measures of ageing; median age, share of population aged 65+ years and aged 20–64 years and total dependency ratio (TDR). These results are shown in the Appendix.

[6] This calculation is based on non-rounded figures of the OADRs in 2020 (0.2964), baseline 2060 (0.5432) and the 50% lower emigration scenario in 2060 (0.5175).

Table 1:
Descriptive statistics, measures of ageing, population size and population composition in Norway, 2020 and 2022

	Registered statistics	
	2020[a]	**2022[a]**
Old-age dependency ratio (OADR)	0.30	0.31
Prospective old-age dependency ratio (POADR)	0.16	0.14
Population count (Pop count)	5,367,600	5,425,300
Percentage share of immigrants in the population (Share imm)	14.7	15.1
. . . from Country Group 1 (Western)	3.0	3.1
. . . from Country Group 2 (EastEU)	3.6	3.7
. . . from Country Group 3 (RestWorld)	8.1	8.3
A description of component changes[b]		
Emigrations	25,600	33,300
Immigrations	50,900	53,000
Net migration	25,300	19,700
Births (# and TFR)	54,500 (1.53)	56,100 (1.55)
Deaths (# and e_0)	40,700 (82.9)	42,000 (83.2)

Notes: Population counts have been rounded to the nearest 100. [a]Status per 1 January for all population count figures, whereas figures pertaining to the components reflect changes in the previous year, i.e., 1 January 2019–31 December 2019, and similarly for 2021. [b]The figures shown are those used in the projections, and they differ slightly from the registered figures. This pertains to immigrations and emigrations, since multiple migrations are removed (but the net migration is comparable), as well as to life expectancy at birth (e_0), which is calculated slightly differently, and is based on end-of-year ages at death.

and Scherbov, 2010), is only slightly affected: i.e., it goes down from 0.22 to 0.21, compared with 0.16 in 2020. In 2100 (lower part of Table 2), when many of the “emigrants” who never left will have grown old, the OADR in the scenario with 50% lower emigration (0.62) is even closer to the baseline OADR (0.63). Even a total stop of all emigration from Norway (right column in Table 2) only reduces the OADR from 0.54 to 0.49 in 2060 and from 0.63 to 0.60 in 2100.

3.2 A 50% reduction in emigration corresponds to 25% more immigration or one-quarter child more per woman

Table 2 further shows that reducing emigration rates by 50% would have the same effect on ageing in 2060 (OADR of 0.52) as increasing the annual immigration by 25%, increasing all mortality rates by 20%, or increasing the total fertility rate (TFR) by 15% – which corresponds to one-quarter child per woman for natives (from 1.70 to 1.95).

While the effects of increased immigration or increased mortality are relatively similar to those of decreased emigration on most of the different ageing measures,

Table 2:
Population projections for Norway in 2060 and 2100 in the official scenario (baseline), in a scenario with 50% lower emigration, and in scenarios with changes in the immigration, fertility and mortality assumptions (that yield the same OADR in 2060 as 50% lower emigration)

		Baseline	Emigration −50%	Immigration +25%	Fertility +15%	Mortality +20%	No emigration
	2020			**2060**			
OADR	0.30	0.54	0.52	0.52	0.52	0.52	0.49
POADR	0.16	0.22	0.21	0.21	0.22	0.20	0.19
Pop count	5,367,580	6,127,100	6,736,800	6,491,100	6,506,200	6,026,800	7,524,400
Share imm	14.7	19.0	21.5	20.9	17.9	19.0	24.5
...Western	3.0	3.1	4.2	3.5	2.9	3.1	5.8
...EastEU	3.6	4.0	4.5	4.3	3.8	4.0	5.2
...RestWorld	8.1	11.9	12.8	13.1	11.2	11.9	13.5
	2020			**2100**			
OADR	0.30	0.63	0.62	0.61	0.57	0.61	0.60
POADR	0.16	0.24	0.23	0.23	0.21	0.22	0.22
Pop count	5,367,580	6,349,300	7,503,100	7,057,800	7,402,200	6,265,800	9,118,400
Share imm	14.7	16.8	18.9	18.8	14.4	16.7	21.4
...Western	3.0	2.8	4.0	3.2	2.4	2.8	5.7
...EastEU	3.6	2.5	2.8	2.7	2.1	2.4	3.2
...RestWorld	8.1	11.5	12.1	12.9	9.9	11.5	12.5

Notes: The population counts have been rounded to the nearest 100. For additional age measures (median age, total dependency ratio (TDR), share aged 65+ years, share aged 20–64 years) see Appendix Table A.2.

increased fertility stands out as having a more rejuvenating long-run effect. This can also be seen in Appendix Figure A.2 and in the age profiles in Appendix Figure A.5. The effect of increased fertility on the OADR occurs later (when the additional children start reaching their twenties) and lasts longer than in the other scenarios. Hence, whereas reduced emigration may postpone the rise in the OADR in the first decades, increased fertility reduces the ageing challenges more in the long run.

Moreover, reduced emigration has a stronger effect on population growth than the other scenarios. In the −50% emigration scenario, population growth from 2020 to 2060 is 80% higher than in the baseline scenario, which is more than in the scenarios with higher fertility or immigration (and is clearly more than in the scenario with increased mortality).

3.3 Less emigration results in more Western immigrants

Different scenarios give different population compositions by immigrant background. The share of immigrants in the population is highest in the scenario with reduced emigration, and the composition of immigrants also changes; the share originating from Western countries (Country Group 1) increases the most (in relative terms), whereas the share originating from the rest of the world (Country Group 3) is higher in the scenario with higher immigration than in the scenario with 50% lower emigration. As Western immigrants have the highest emigration rates, reduced emigration rates would keep a larger share of the relatively mobile Western immigrants from leaving Norway.

The results from the second part of our analyses – in which we investigate the effects of reduced emigration for certain subgroups only – show that the strongest effects on both ageing and population size can be observed when we limit the reduction in emigration rates to those below age 50 (see Table 3, Figure 4 and Appendix Figures A.3–A.5). The effects of the other subgroup analyses are less pronounced for both the ageing measures and the population counts. The effect of the reduced emigration of immigrants (particularly if we include their Norwegian-born children) on population size is larger than that of the reduced emigration of natives, whereas this is not the case for population ageing.

However, if the emigration of natives is lower, the number of natives abroad who can potentially return “home” will shrink. In the scenario in which 50% lower emigration among natives is coupled with 50% lower return migration among natives, the effects on population ageing as well as on population size and composition are minuscule.[7]

The different scenarios presented above also result in different projected numbers of births, deaths, immigrations and emigrations. These are shown in Appendix Table A.1.

Figure 4 illustrates how the different scenarios vary across the two main dimensions in our analyses, population size and ageing (the OADR being our primary measure – for results on the POADR, cf. Appendix Figure A.4). The two upper panels show the projected results for 2060, while the lower panels display the corresponding results for 2100. The left panels compare a 50% reduction in emigration with the corresponding changes in the fertility, immigration and mortality assumptions, while the right panels present a comparison of the reduction in emigration rates across various subgroups. Thus, the figure summarises the main results from our analyses. First, although reducing emigration by 50% can mitigate ageing somewhat (reducing OADRs by around 10%), it will by no means stop it. Second, the anti-ageing effect (in 2060) of 50% less emigration corresponds to that of 25% more immigration or one-quarter child more per woman. Moreover, reduced emigration has a stronger effect on population size than the corresponding changes in fertility, immigration and mortality. Finally, whereas reduced emigration among young people has the strongest anti-ageing effect, reduced emigration among natives has a negligeable impact if lower return migration is also taken into account.

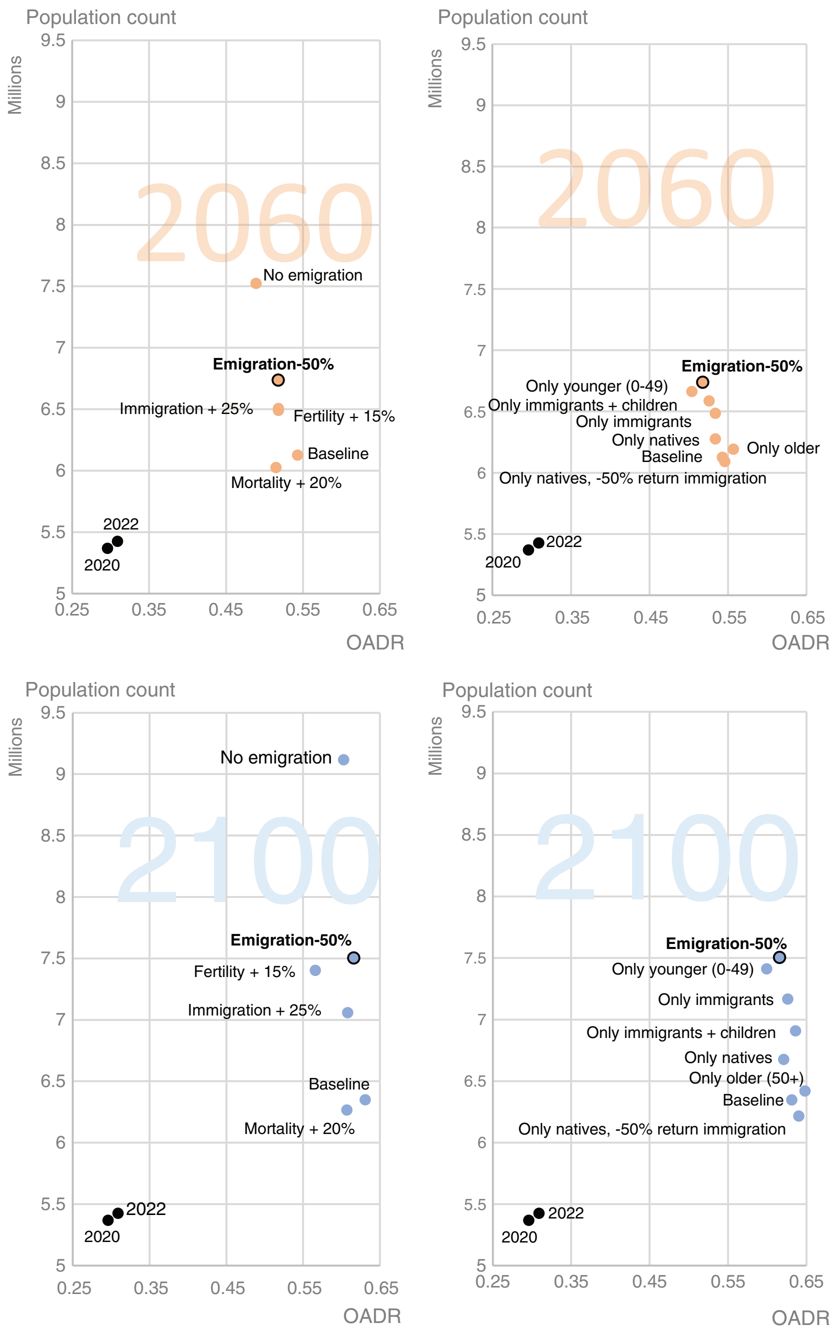
7 These results depend in part on whether or not we add a time lag before reducing the return migration. Without a lag (as shown here), ageing is actually slightly higher and population growth is slightly lower than in the baseline alternative.

Table 3:
Population projections for Norway in 2060 and 2100 in the official scenario (baseline), and in a scenario with 50% lower emigration for all and for certain subgroups only, 2060 and 2100

			Emigration rates reduced by 50% for certain groups only						
		Baseline	**For all**	**Only older (50+)**	**Only younger (0–49)**	**Only immigrants**	**Only immigrants +children**	**Only natives**	**Only natives, –50% return immigration**
	2020				**2060**				
OADR	0.30	0.54	0.52	0.56	0.50	0.53	0.53	0.53	0.55
POADR	0.16	0.22	0.21	0.23	0.21	0.22	0.21	0.22	0.22
Pop count	5,367,580	6,127,100	6,736,800	6,192,100	6,665,000	6,485,600	6,586,400	6,276,600	6,090,500
Share imm	14.7	19.0	21.5	19.6	20.8	22.3	22.0	18.5	19.1
. . .Western	3	3.1	4.2	3.3	4.0	4.3	4.3	3.0	3.1
. . .EastEU	3.6	4.0	4.5	4.2	4.3	4.7	4.6	3.9	4.0
. . .RestWorld	8.1	11.9	12.8	12.1	12.5	13.3	13.1	11.6	12.0
	2020				**2100**				
OADR	0.30	0.63	0.62	0.65	0.60	0.64	0.63	0.62	0.64
POADR	0.16	0.24	0.23	0.25	0.23	0.24	0.24	0.24	0.24
Pop count	5,367,580	6,349,300	7,503,100	6,421,500	7,413,600	6,910,000	7,167,000	6,675,900	6,217,900
Share imm	14.7	16.8	18.9	17.4	18.3	20.5	19.8	16.0	17.2
. . .Western	3	2.8	4.0	3.0	3.7	4.3	4.2	2.7	2.9
. . .EastEU	3.6	2.5	2.8	2.6	2.7	3.0	2.9	2.3	2.5
. . .RestWorld	8.1	11.5	12.1	11.8	11.9	13.2	12.7	11.0	11.8

Notes: The population counts have been rounded to the nearest 100. For additional age measures (median age, TDR, share aged 65+ years, share aged 20–64 years) see Appendix Table A.2.

Figure 4:
Ageing (OADR) and population size in Norway in 2020 and 2022 (black dots) and projected in 2060 (upper panels) and 2100 (lower panels). Scenarios with changes in all demographic components (left) and with 50% lower emigration for subgroups (right)



4 Discussion

Although the scenarios presented above are hypothetical, a comparison of different scenarios can be useful for demographers and policymakers, and can, more generally, inform the public debate on the relationship between emigration, population size and population ageing.

To our knowledge, the previous literature has not provided estimations of how the anti-ageing effect of changes in emigration would correspond to changes in fertility, immigration or mortality, or estimations of how reduced emigration would change a population's share of immigrants.

Our conclusions about the limited effect of emigration on ageing add to the literature that has demonstrated that there are no demographic "solutions" to ageing (and that has tended to focus on other components of demographic change). For instance, Chamie (2022, page 1) called the ageing of human populations "an inescapable demographic future"; and Coleman (2008, page 468) argued that "population ageing cannot be 'solved' ". Potančoková et al. (2021) concluded that declines in the potential labour force and population ageing are clearly unavoidable in all of the EU's macro-regions, and that neither increased fertility nor increased migration are viable strategies for halting population ageing. Thus, these authors advised policymakers to aim to improve economic activity and productivity to accommodate for and adjust to the projected ageing, rather than to attempt to affect the demographic trends directly. Likewise, Marois et al. (2020) concluded that demographic ageing is unavoidable, and recommended that European policymakers instead try to change labour force participation, improve educational attainment and work towards the better economic integration of immigrants.

Our estimates of how much reduced emigration would mitigate ageing in Norway can also be compared to estimates from similar studies on traditional net emigration countries. García-Guerrero et al. (2019) found that future (net) emigration from Central America would have a very limited effect on ageing in Mexico and Honduras, a somewhat larger effect on ageing in Guatemala and the largest effect on ageing in El Salvador. They also showed, however, that even in El Salvador, the no-migration alternative would not prevent ageing, but would merely reduce it (by roughly 15–20%). Furthermore, our conclusion that reduced emigration has a stronger effect on population size than on ageing is in line with results from Potančoková et al. (2021). They found that while zero intra-EU migration would reduce the population decreases in Eastern EU from 18% to 10% and in Southern EU from 8% to 6% by 2060, the effects on the total age dependency ratios would be relatively minor.

4.1 Limitations and strengths

Our conclusions are built on several assumptions that may be questioned. Furthermore, our analyses have other limitations as well. First, our measures of population ageing, dependency and support are relatively simple, relying to a large extent on chronologic age, and not on, for instance, information about whether people are in the labour force, or about their productivity, as this information is not included in the Norwegian population projections. However, ageing and dependencies are not solely driven by demographic factors. When considering the future challenges of ageing societies, the actual "dependency" and "support" of older and younger age groups will be of crucial importance. Other studies (e.g., (Bijak et al., 2008; Marois et al., 2020; Potančoková et al., 2021; Rees et al., 2012) have made projections that also take labour force participation and education into account, and most have concluded that the challenges associated with population ageing are less overwhelming when we consider the likely future development of these factors. For instance, Marois et al. (2020) showed that when labour force participation and education are included as additional variables, the projected increase in the dependency ratios is markedly lower. The authors thus concluded that the fears associated with the coming economic burdens of ageing have been unduly exaggerated by the use of conventional age dependency ratios. Other studies have, however, emphasised that the burdens will be large in terms of health and long-term care (LTC) costs (see, e.g., Marino et al., 2017 for LTC costs and Lorenzoni et al., 2019 for health costs), and in terms of costs relating to old-age pensions, driven primarily by the demographic changes associated with ageing (OECD, 2021). While Lorenzoni et al. (2019) suggested that the demographic effects account for just over a quarter of the projected growth in health expenditures, Marino et al. (2017) pointed out that there may be a stronger relationship between LTC spending and demographic change, given that a high share of LTC patients are elderly.

The OADR – our main ageing measure – appears to reflect the current situation in terms of the number of pensioners relative to the (potential) labour supply fairly well: across the OECD countries, the average effective age of labour market exit was 63.8 years for men and 62.4 years for women, albeit with considerable variation (range: 58.1–68.2) (ibid). Moreover, although the remaining life expectancy at the average age of labour market exit increased sharply between the 1970s and 2000s, it has stabilised over the past two decades as the life expectancy gains in old age have been offset by increases in the age of labour market exit. However, these trends might change in the future, and if we compare our results for the OADR vs. the POADR for the different scenarios, we see that although they largely mirror each other in relative terms (i.e., in both measures, reduced ageing is observed most markedly for the "no emigration" scenario in the first half of the period, before the 15% increase in fertility scenario takes precedence), there are some differences worth noting. For one, the 20% increased mortality scenario limits ageing considerably more when measured by the POADR rather than by the OADR. On the one hand, a benefit of the OADR is that it estimates fairly accurately the future labour supply and number of pensioners, whereas it might reflect health and LTC costs less well. The POADR, on the other hand, is likely to overestimate the future labour supply and to underestimate the future number of pensioners, but it may better reflect expenditures and resource needs relating to health and LTC. The projected life expectancy in Norway is quite high, and by the end of the century, the age cut-off for the numerator in the POADR is 80 years. Even in scenarios with healthy ageing and prolonged working lives, such a high age is unlikely to be relevant for pension and labour supply estimations.

4.1.1 Interlinkages between emigration and other demographic events

To isolate the effects of changes in emigration, we have reduced emigration without changing the other demographic measures of fertility, mortality or immigration in all our scenarios (except for the one in which we also reduce native return migration). As the only interlinkages go through the rates applied in the projection model, the people kept from emigration are subject to the model's fertility and mortality rates, and hence can contribute to the number of births or deaths. Apart from that, in all our core scenarios we have assumed that reduced emigration does not affect fertility rates and mortality rates in Norway, and that it does not affect immigration.

However, in the real world, immigration and emigration are usually closely linked, but the direction in which they are linked is not obvious. On the one hand, they may be positively correlated, as less emigration of natives would mean a reduced "pool" of possible native returnees. This mechanism is what we have tried to capture in the scenario with reduced native return migration. Furthermore, if Norway reduced the attractiveness of emigrating (by, for instance, limiting the welfare entitlements that can be taken out of the country), this could also reduce immigration, because it would likely make it less attractive for temporary migrants to enter the country. Low immigration might also reduce population pressure, and hence reduce incentives for emigration (Coleman, 2008).

On the other hand, lower emigration can go hand in hand with *higher* immigration: if, for example, emigration goes down because life in Norway becomes more attractive, immigration could increase for the same reason. Previous studies have shown that immigration to and emigration from Norway are affected by many of the same macro-economic factors, such as unemployment and income levels in Norway and in the origin countries (Cappelen et al., 2015; Skjerpen et al., 2015), but with the opposite effect, with better conditions in Norway compared to those in other countries leading to increased immigration and reduced emigration.

4.1.2 Generalisability

It is certainly possible to imagine situations in which reduced emigration could limit ageing to a larger extent than we have found, particularly in countries with very high emigration rates. In general, as indicated by Figure 2, emigration rates are often relatively high in countries with small populations, like Luxembourg, Iceland and Liechtenstein. The emigration rates from these countries have recently been around 10–15 per 1000, while Norway's rates have been around five per 1000. Hence, the rejuvenating effect of reducing emigration from these high-emigration countries can be expected to be larger than the 10% reduction in OADR growth that we have found in Norway. However, it would hardly stop the ageing process, in line with the findings of García-Guerrero et al. (2019) for Central America. Furthermore, if the emigrants from these European high-emigration countries are mainly natives who will eventually return, emigration's long-term effect on ageing will be more limited in these countries as well.

4.2 Can policymakers change emigration trends?

Although our results show that lower emigration cannot stop ageing in Norway, measures aimed at reducing emigration could help to address the challenges of population ageing. Hence, a relevant question is whether it is actually possible for policymakers to reduce emigration in a liberal and democratic society like Norway.

Historically, European states have long traditions of regulating the exit of their people. Until the post-World War II period, emigration was not perceived (socially and legally) as a right, and the states were in full control over the international mobility of their subjects (Weinar, 2019). In the post-World War II period, the approach to individual rights changed, and liberal Western democracies made emigration a fundamental human right. Hence, prohibiting emigration is now considered highly problematic. However, that does not mean that countries do not have policies in place that either encourage or discourage emigration. According to a United Nations survey, 20% of governments (26% in Europe and North America) reported having policy measures that sought to lower the emigration of citizens (United Nations, 2020b). Some of the policies are targeted directly at the retention of particular groups, such as the highly skilled (McLeod et al., 2010; Toma and Villares-Varela, 2019; Wickramaarachchi and Butt, 2014).

Moreover, a wide range of policies in other fields could also impact emigration trends. Most notably, immigration policies regulating conditions for immigrants' residence permits are closely linked to emigration, since individuals who lack permission to stay are expected (or forced) to leave the country. Furthermore, any measures that make staying in a country more attractive will also reduce the incentives to emigrate. For immigrants, whether they experience a welcoming or an unfriendly culture can incentivise them to stay or to leave. Policies aimed at improving the labour market integration of young people and of immigrants – including measures that facilitate the recognition of immigrants' skills, measures that help immigrants avoid mismatch between their skills and the jobs they get and improve their educational attainment, and general economic policies aimed at increasing employment (Marois et al., 2020; Potančoková et al., 2021) – can increase labour participation while also reducing the incentives to emigrate.

Hence, policymakers who want to reduce emigration do have some tools available. Some of these tools are linked to international agreements on mobility and to policies regarding residence permits and the integration of immigrants, and to general economic policies.

4.3 Which demographic remedy for ageing should be preferred?

As has been shown in this paper, no single demographic remedy is likely to stop ageing in a country like Norway. However, reduced emigration, higher immigration and higher fertility can contribute to a somewhat slower process of population ageing, and policymakers could consider measures encouraging all of these trends in order to meet future population challenges – in addition to important changes in labour market participation, productivity, etc.

Furthermore, policymakers should assess whether the greater challenge is population ageing or population decline. As we have shown, changes in emigration have a more pronounced impact on population size than on ageing in the Norwegian context.

Although some tools are available for policymakers who want to reduce emigration, achieving a reduction of 50% – the main scenario we explored – may prove just as hard or as controversial for policymakers as increasing fertility by one-quarter child per woman or increasing immigration by 25%. As in all policy-related questions, when comparing the different demographic remedies, the expected benefits of reducing ageing (and increasing population growth) should be weighed against the costs of the proposed policies. Reduced emigration may have several advantages compared to other demographic remedies; for example, it has little effect on environmental sustainability since does not add extra people to the earth as increased fertility does, and it may be less politically controversial than increased immigration. Some of the political measures that could reduce emigration may also have other beneficial effects, such as the better integration of immigrants, reduced labour market mismatches and higher employment rates, which could, in turn, place the society in a better position to handle population ageing.

Cost-benefit considerations should also take into account the costs and the benefits for other countries, and for the migrants themselves. The migration patterns that are most beneficial for one country may not be optimal for other countries. For instance, less emigration by young people would reduce ageing in Norway, but it would have the opposite effect in the emigrants' destination countries. These cost-benefit considerations should also include costs and benefits at the individual level for the (potential) emigrant, as well as for her/his relatives and friends.

Hence, policy measures aimed at reducing emigration should be carefully chosen, and preference should be given to policies that have low costs for individuals and other countries, and that – independent of their effects on emigration – are likely to improve the society's ability to meet the challenges associated with population ageing.

5 Conclusion

While largely overlooked in many discussions on demographic "remedies" for ageing, reduced emigration could be viewed as a welcome anti-ageing formula, with several advantages: unlike increased fertility, it does not normally result in more children to feed and raise, and it does not add extra people to the world, which is likely to be beneficial for global sustainability. And, unlike immigration, which often implies receiving newcomers with little knowledge of the host country's language and culture, reduced emigration may be less controversial, since it implies holding on to individuals who have already lived for some time in the country (natives or immigrants).

In this paper, we have explored the link between emigration and ageing, which is an understudied phenomenon in a Western European context. Our main conclusions are that even a 50% reduction in all emigration from Norway would only slightly reduce ageing (by reducing OADR growth by around 10% until 2060), but it would have a considerable effect on population size (80% higher population growth). Hence, reducing emigration may be a more forceful remedy for depopulation than for ageing. Furthermore, a 50% reduction in emigration rates would have the same effect on ageing up to 2060 as 15% higher fertility (one-quarter child per woman) or 25% lower immigration.

Although there are policy tools available that may affect emigration, and although some of the measures that could reduce emigration – such as the better integration of immigrants, reduced labour market mismatches and higher employment rates – have the added benefit of also placing the society in a better position to handle population ageing, it may be difficult in a democratic society to reduce emigration as much as has been proposed in our hypothetical scenarios. Still, our paper contributes to the literature on the demographic drivers of population change and ageing, in which the effects of emigration are often superficially treated.

Acknowledgements

We are grateful to the participants of the Wittgenstein Centre Conference 2021 and the IUSSP International Population Conference 2021, as well as to Andrea Monti, Anne Balke Staver and Michael J. Thomas for their useful comments and constructive feedback.

ORCID iDs

Marianne Tønnessen https://orcid.org/0000-0002-9727-8177
Astri Syse https://orcid.org/0000-0003-1754-1594

References

Alho, J. M. (2008). Migration, fertility, and aging in stable populations. *Demography*, *45*(3), 641–650. https://doi.org/10.1353/dem.0.0021

Anelli, M., and Balbo, N. (2021). Fertility drain or fertility gain? Emigration and fertility during the great recession in Italy. *Demography*, *58*(2), 631–654. https://doi.org/10.1215/00703370-9001598

Arthur, W. B., and Espenshade, T. J. (1988). Immigration policy and immigrants' ages. *Population and Development Review*, *14*(2), 315–326. https://doi.org/10.2307/1973574

Bergsvik, J., Fauske, A., and Hart, R. K. (2021). Can policies stall the fertility fall? A systematic review of the (quasi-) experimental literature. *Population and Development Review*, *47*(4), 913–964. https://doi.org/10.1111/padr.12431

Bijak, J., Kupiszewska, D., and Kupiszewski, M. (2008). Replacement migration revisited: Simulations of the effects of selected population and labor market strategies for the aging Europe, 2002–2052. *Population Research and Policy Review*, *27*(3), 321–342. https://doi.org/10.1007/s11113-007-9065-2

Blanchet, D. (1989). Regulating the age structure of a population through migration. *Population: An English Selection*, *44*(1), 23–37.

Bongaarts, J. (1992). Population growth and global warming. *Population and Development Review*, *18*(2), 299–319. https://doi.org/10.2307/1973681

Bongaarts, J., and O'Neill, B. C. (2018). Global warming policy: Is population left out in the cold? *Science, 361*(6403), 650–652. https://doi.org/10.1126/science.aat8680

Botev, N. (2012). Population ageing in Central and Eastern Europe and its demographic and social context. *European Journal of Ageing*, *9*(1), 69–79. https://doi.org/10.1007/s10433-012-0217-9

Bouvier, L. F., Poston, D. L., and Zhai, N. B. (1997). Population growth impacts of zero net international migration. *International Migration Review*, *31*(2), 294–311. https://doi.org/10.1177/019791839703100202

Bujard, M. (2015). Consequences of enduring low fertility–a German case study demographic projections and implications for different policy fields. *Comparative Population Studies*, *40*(2), 131–164. https://doi.org/10.12765/CPoS-2015-06

Cappelen, Å., Skjerpen, T., and Tønnessen, M. (2015). Forecasting immigration in official population projections using an econometric model. *International Migration Review*, *49*(4), 945–980. https://doi.org/10.1111/imre.12092

Casey, G., and Galor, O. (2017). Is faster economic growth compatible with reductions in carbon emissions? The role of diminished population growth. *Environmental Research Letters*, *12*(1), 014003. https://doi.org/10.1088/1748-9326/12/1/014003

Chamie, J. (2022). Population ageing: An inescapable future. *Inter Press Service*, 5 January 2022. https://www.ipsnews.net/2022/01/population-ageing-inescapable-future/

Coleman, D. (2008). The demographic effects of international migration in Europe. *Oxford Review of Economic Policy*, *24*(3), 452–476. https://doi.org/10.1093/oxrep/grn027

Crist, E., Mora, C., and Engelman, R. (2017). The interaction of human population, food production, and biodiversity protection. *Science 356*(6335), 260–264. https://doi.org/10.1126/science.aal2011

Espenshade, T. J., Bouvier, L. F., and Arthur, W. B. (1982). Immigration and the stable population model. *Demography*, *19*(1), 125–133. https://doi.org/10.2307/2061132

Fihel, A., Janicka, A., and Kloc-Nowak, W. (2018). The direct and indirect impact of international migration on the population ageing process: A formal analysis and its application to Poland. *Demographic Research*, *38*, 1303–1338. https://doi.org/10.4054/DemRes.2018.38.43

Gavrilov, L., and Heuveline, P. (2003). Aging of population. In: P. Demeny, and G. McNicoll (Eds.), *The Encyclopedia of Population*. Macmillan Reference USA.

García-Guerrero, V. M., Masferrer, C., and Saucedo, S. E. G. (2019). Future changes in age structure and different migration scenarios: The case of North and Central America. *Revista Latinoamericana de Población*, *13*(25), 36–53. https://doi.org/10.31406/relap2019.v13.i2.n25.2

Heleniak, T., and Sanchez Gassen, N. (2016). Scenarios for 2015–2080: The impact of migration on population and ageing. *Nordregio Policy Brief*, *2016*, 3. http://urn.kb.se/resolve?urn=urn:nbn:se:norden:org:diva-4651

Lorenzoni, L., Marino, A., Morgan, D., and James, C. (2019). *Health Spending Projections to 2030: New results based on a revised OECD methodology*. (OECD Health Working Papers 110). OECD. https://doi.org/10.1787/5667f23d-en

Lutz, W., and Scherbov, S. (2003). *Can immigration compensate for Europe's low fertility?* (European Demographic Research Papers 2003/1.) Vienna Institute of Demography, Austrian Academy of Sciences.

Marino, A., Morgan, D., Lorenzoni, L., and James, C. (2017). *Future trends in health care expenditure: A modelling framework for cross-country forecasts*. (OECD Health Working Papers 95). OECD. https://doi.org/10.1787/247995bb-en

Marois, G., Bélanger, A., and Lutz, W. (2020). Population aging, migration, and productivity in Europe. *Proceedings of the National Academy of Sciences*, *117*(14), 7690–7695. https://doi.org/10.1073/pnas.1918988117

McLeod, K., Henderson, A., and Bryant, J. (2010). Leaving so soon? Skilled migrants in New Zealand: Who says and who goes? *Labour, Employment and Work in New Zealand*. https://doi.org/10.26686/lew.v0i0.1693

Muir, T. (2017). *Measuring social protection for long-term care*. (OECD Health Working Papers 93). OECD. https://doi.org/10.1787/a411500a-en

Murphy, M. (2016). The effect of long-term migration dynamics on population structure in England and Wales and Scotland. *Population Studies*, *70*(2), 149–162. https://doi.org/10.1080/00324728.2016.1185140

OECD. (2019). *Health at a Glance 2019: OECD Indicators*. OECD Publishing. https://doi.org/10.1787/4dd50c09-en

OECD. (2021). *Pensions at a Glance 2021: OECD and G20 Indicators*. OECD Publishing. https://doi.org/10.1787/ca401ebd-en

O'Neill, B. C., Dalton, M., Fuchs, R., Jiang, L., Pachauri, S., and Zigova, K. (2010). Global demographic trends and future carbon emissions. *Proceedings of the National Academy of Sciences*, *107*(41), 17521–17526. https://doi.org/10.1073/pnas.1004581107

Parr, N. (2021). A new measure of fertility replacement level in the presence of positive net immigration. *European Journal of Population*, *37*(1), 243–262. https://doi.org/10.1007/s10680-020-09566-w

Paterno, A. (2011). Is immigration the solution to population aging? *Genus*, *67*(3), 65–82.

Pettersen, S. (2013). *Utvandring fra Norge 1971–2011* (Reports 30/2013). Statistics Norway.

Philipov, D., and Schuster, J. (2010). Effect of migration on population size and age composition in Europe. (European Demographic Research Papers 2010/2) Vienna Institute of Demography, Austrian Academy of Sciences.

Potančoková, M., Stonawski, M., and Gailey, N. (2021). Migration and demographic disparities in macro-regions of the European Union, a view to 2060. *Demographic Research*, *45*, 1317–1354. https://doi.org/10.4054/DemRes.2021.45.44

Rees, P., van der Gaag, N., de Beer, J., and Heins, F. (2012). European regional populations: current trends, future pathways, and policy options. *European Journal of Population/Revue Européenne de Démographie*, *28*(4), 385–416. https://doi.org/10.1007/s10680-012-9268-z

Reher, D. S. (2007). Towards long-term population decline: A discussion of relevant issues. *European Journal of Population/Revue Européenne de Démographie*, *23*(2), 189–207. https://doi.org/10.1007/s10680-007-9120-z

Sanderson, W. C., and Scherbov, S. (2010). Remeasuring aging. *Science*, *329*(5997), 1287–1288. https://doi.org/10.1126/science.1193647

Schmertmann, C. P. (1992). Immigrants' ages and the structure of stationary populations with below-replacement fertility. *Demography*, *29*(4), 595–612. https://doi.org/10.2307/2061854

Skjerpen, T., Stambøl, L. S., and Tønnessen, M. (2015). *Utvandring blant innvandrere i Norge Del 1: Litteraturstudie, makroanalyse og regionale mønstre (*Reports 2015/17). Statistics Norway.

Sobotka, T., Matysiak, A., and Brzozowska, Z. (2019). *Policy responses to low fertility: How effective are they?* (Working Paper No. 1). UNFPA.

Solberg, E. (2019). Statsministerens nyttårstale 2019 [The prime ministers New Year speach]. *Regjeringen.no*, 1 January 2019. https://www.regjeringen.no/no/aktuelt/statsministerens-nyttarstale-2019/id2623249/

Syse, A., Thomas, M., and Gleditsch, R. (2020). *Norway's 2020 population projections (*Reports 2020/25). Statistics Norway.

Tamburino, L., Bravo, G., Clough, Y., and Nicholas, K. A. (2020). From population to production: 50 years of scientific literature on how to feed the world. *Global Food Security*, *24*, 100346. https://doi.org/10.1016/j.gfs.2019.100346

Thomas, M., and Tømmerås, A. (2022). *Norway's 2022 national population projections Results, methods and assumptions* (Reports 2022/28). Statistics Norway.

Toma, S., and Villares-Varela, M. (2019). The role of migration policies in the attraction and retention of international talent: The case of indian researchers. *Sociology*, *53*(1), 52–68. https://doi.org/10.1177/0038038517750540

United Nations. (2001). *Replacement Migration: Is it a Solution to Declining and Ageing Populations?* Population Division, Department of Economic and Social Affairs, United Nations.

United Nations. (2018). *World Population Policies 2015* (ST/ESA/SER.A/374). Population Division, Department of Economic and Social Affairs, United Nations.

United Nations. (2020a). *World Population Ageing 2019* (ST/ESA/SER.A/444). Population Division, Department of Economic and Social Affairs, United Nations.

United Nations. (2020b). *World Population Policies 2019* (ST/ESA/SER.A/442). Population Division, Department of Economic and Social Affairs, United Nations.

United Nations (2022a). *World Population Prospects 2022. Summary of Results* (UN DESA/POP/2022/NO.3). Population Division, Department of Economic and Social Affairs, United Nations.

United Nations (2022b). *World Population Prospects 2022, Online Edition.* Population Division, Department of Economic and Social Affairs, United Nations.

Weinar, A. (2019). Politics of emigration in Europe. In A. Weinar, S. Bonjour, and L. Zhyznomirska (Eds.), *The Routledge Handbook of the Politics of Migration in Europe*. Routledge.

Wickramaarachchi, N., and Butt, A. (2014). Motivations for retention and mobility: Pathways of skilled migrants in regional Victoria, Australia. *Rural Society*, *23*(2), 188–197. https://doi.org/10.5172/rsj.2014.23.2.188

Wilmoth, J., Menozzi, C., and Bassarsky, L. (2022). Why population growth matters for sustainable development. (Policy brief 130). Population Division, Department of Economic and Social Affairs, United Nations.

Wood, J., Neels, K., and Vergauwen, J. (2016). Economic and institutional context and second births in seven European countries. *Population Research and Policy Review*, *35*(3), 305–325. https://doi.org/10.1007/s11113-016-9389-x

Wynes, S., and Nicholas, K. A. (2017). The climate mitigation gap: Education and government recommendations miss the most effective individual actions. *Environmental Research Letters*, *12*(7), 074024. https://doi.org/10.1088/1748-9326/aa7541

Appendix

Figure A.1:
Emigration from Norway 2010-2019 by age for immigrants and non-immigrants (natives). Absolute number of emigrations (left) and emigrations per 1000 (right)

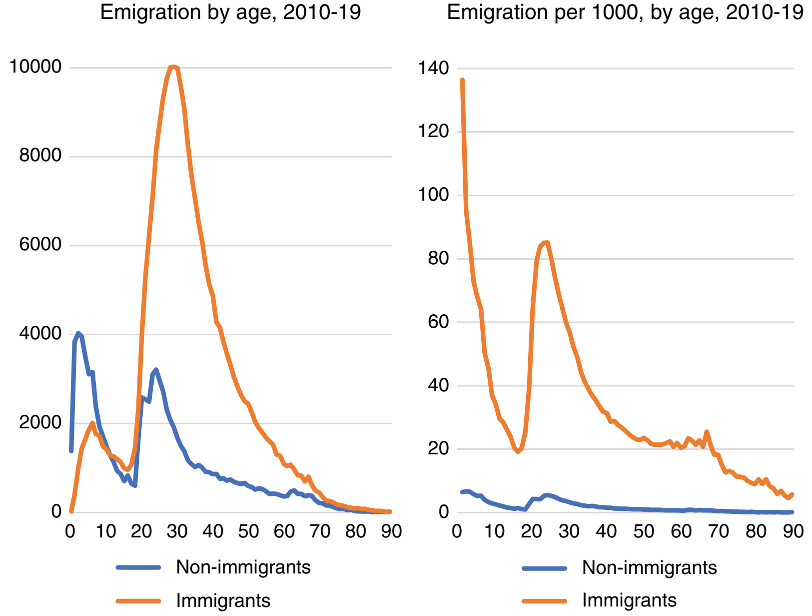


Figure A.2:
Projected old-age dependency ratios (upper panel) and population size (lower panel) in Norway, in the official projections' Main alternative ('Baseline') and in scenarios with lower emigration, higher fertility, higher immigration and higher mortality

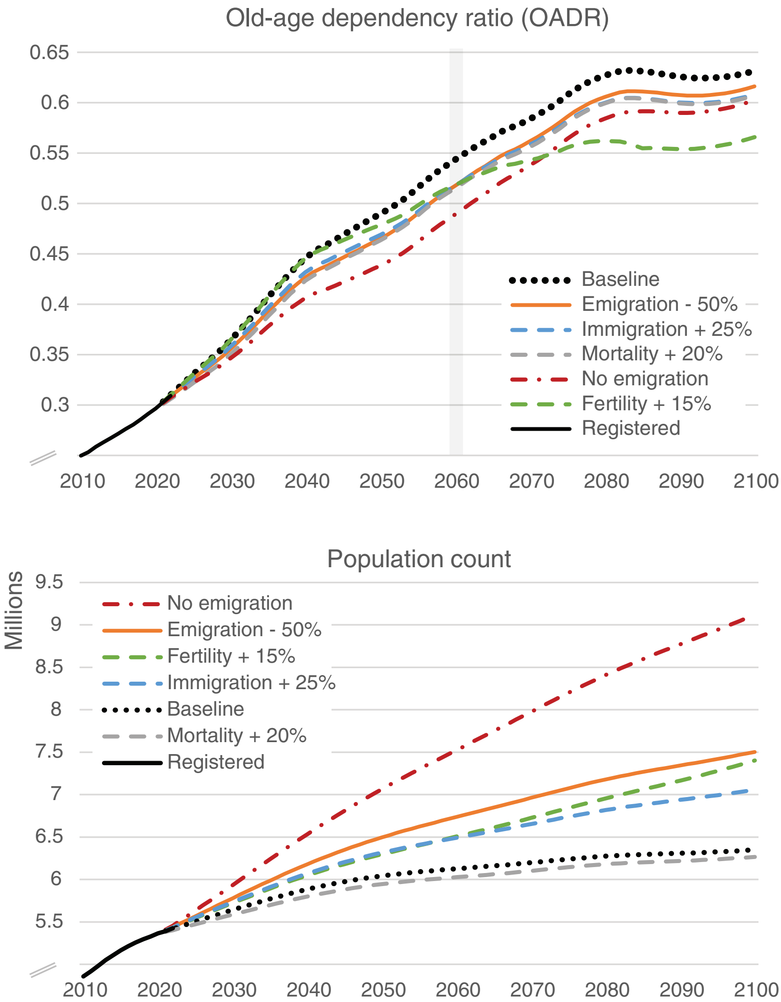


Figure A.3:
Projected old-age dependency ratios (upper panel) and population size (lower panel) in Norway, in the official population projections' Main alternative ('Baseline') and in scenarios with 50% lower emigration for certain subgroups only

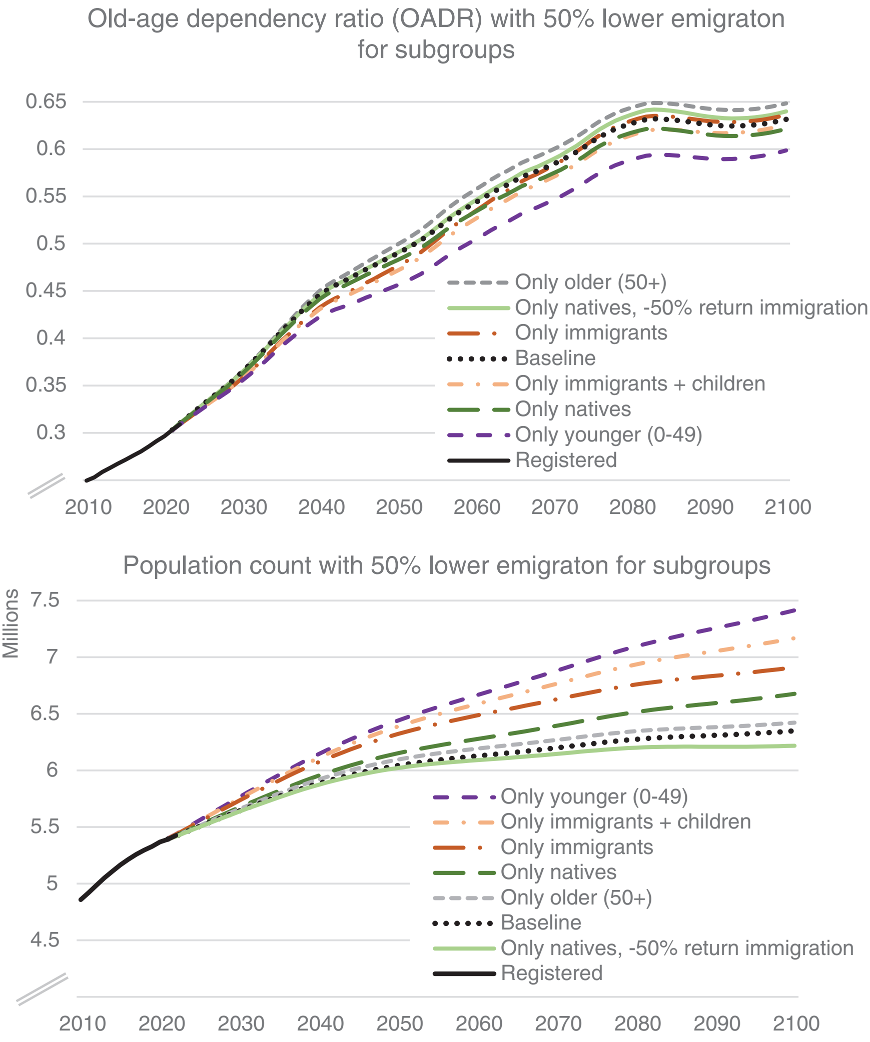
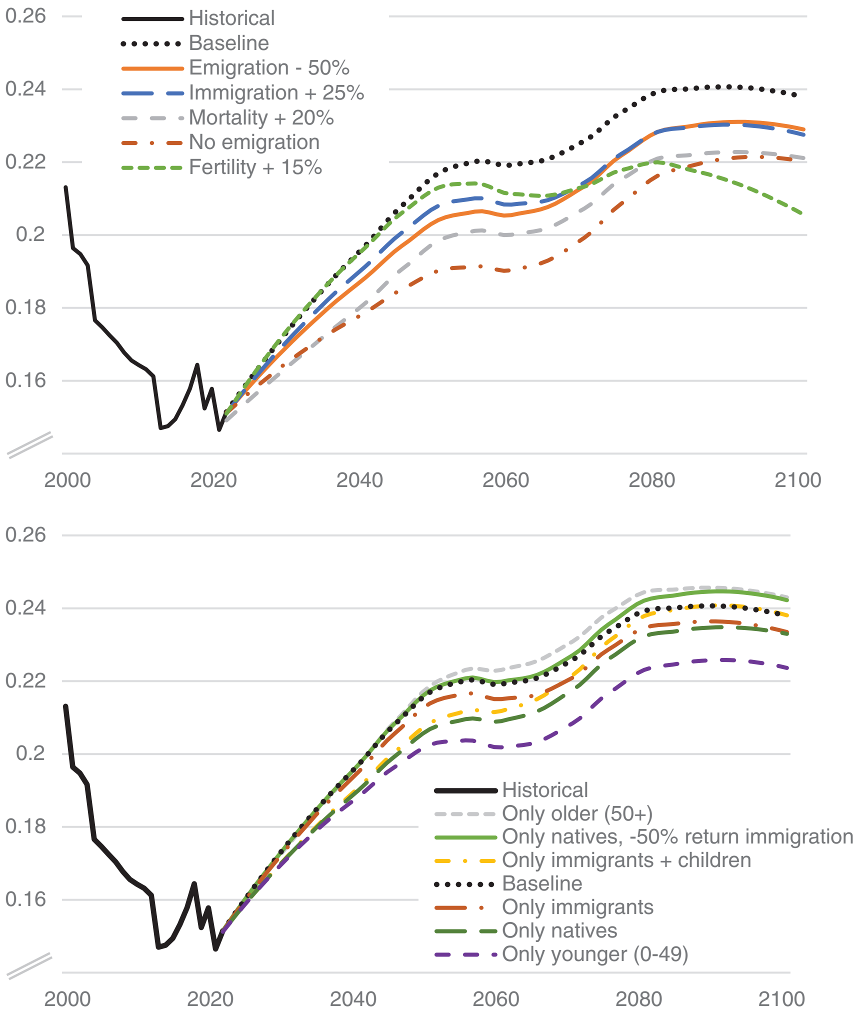


Figure A.4:
Smoothed prospective old-age dependency ratios (POADRs) in Norway, registered and projected, based on 15 or fewer years remaining life expectancy



Note: The upper panel shows our main alternatives, whereas the lower panel shows additional alternatives for subgroups. The estimates have been smoothed using LOESS, a nonparametric method for smoothing a series of data in which no assumptions are made about the underlying structure of the data (cf. https://www.itl.nist.gov/div898/handbook/pmd/section1/pmd144.htm). In the current figure, a smoothing parameter of 0.5 was employed. Also note that the axes in this Figure differ from those shown in Figures A.2 and A.3.

Figure A.5:
Population in Norway by age, registered in 2020 and projected in different scenarios in 2060 and 2100

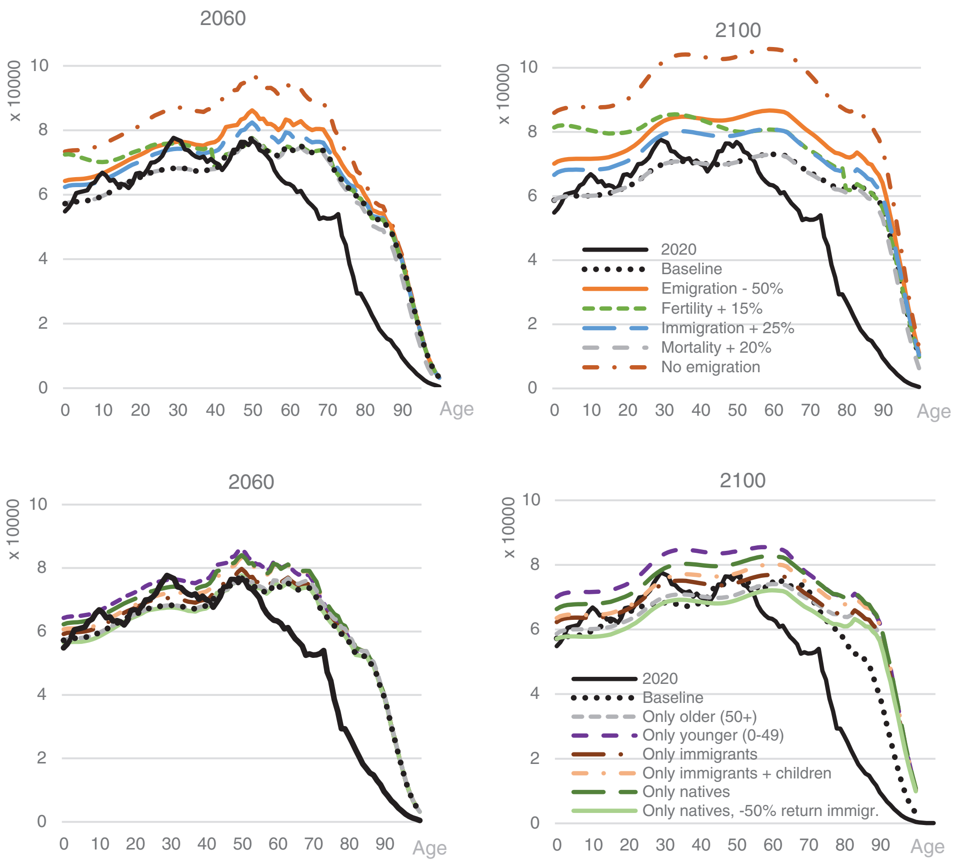


Table A.1:
An overview of the components (in terms of counts) in 2060 and 2100

	Baseline	Emigration −50%	Immigration +25%	Fertility +15%	Mortality +20%	No emigration	Emigration rates reduced by 50% for certain groups only					
							Only older (50+)	Only younger (0–49)	Only immigrants	Only immigrants +children	Only natives	Only natives −50% return immigration
2060												
Emigration	25,900	15,500	30,600	27,100	25,800	0	23,700	18,200	20,400	18,300	23,100	22,800
Immigration[a]	37,200	37,200	46,500	37,200	37,200	37,200	37,200	37,200	37,200	37,200	37,200	33,100
Net migration	11,400	21,700	15,900	10,100	11,400	37,200	13,600	19,100	16,900	18,900	14,100	10,300
Births	57,200	64,300	62,300	72,700	57,100	73,700	57,200	64,300	60,700	62,300	59,200	56,600
Deaths	61,800	63,800	62,400	61,800	61,800	66,200	63,100	62,400	63,400	63,400	62,200	61,800
Natural increase	−4600	500	−100	10,900	−4600	7400	−6000	2000	−2600	−1100	−3000	−5100
2100												
Emigration	24,000	14,800	29,100	26,300	24,000	0	22,000	17,400	19,600	17,800	21,300	20,800
Immigration[a]	36,900	36,900	46,100	36,900	36,900	36,900	36,900	36,900	36,900	36,900	36,900	31,900
Net migration	12,900	22,100	17,100	10,600	12,900	36,900	14,900	19,500	17,300	19,100	15,600	11,100
Births	58,300	69,800	66,200	81,200	58,300	85,700	58,300	69,800	63,200	66,000	62,000	56,900
Deaths	65,900	74,900	70,100	66,300	65,300	87,200	68,000	72,400	72,000	72,700	68,000	65,900
Natural increase	−7600	−5100	−3900	14,900	−7000	−1500	−9600	−2600	−8800	−6800	−6100	−9000

Notes: [a]Includes (return) immigration of natives.
Since all projected figures are inherently uncertain, the counts have been rounded to the nearest 100. Compared to Statistics Norway's June 2020 projections, minor deviations are observed in the counts for emigrations, births and deaths, as the model has been modified technically in 2021 and the updated model has been used in our work. The technical adjustments pertain to the future distribution of emigrants and immigrants by age and sex.

Table A.2:
Additional age measures (median age, total dependency ratio (TDR) and share of population age 65+ and 20–64 years) in different scenarios

	2020	Baseline	Emigration −50%	Immigration + 25%	Fertility + 15%	Mortality + 20%	No emigration
	2020	2060					
Median age	39	47	46	46	44	46	45
TDR	0.69	0.92	0.90	0.90	0.95	0.89	0.87
Share 65+	17.5	28.3	27.3	27.3	26.6	27.2	26.2
Share 20–64	59.2	52.1	52.8	52.7	51.4	52.8	53.6
	2020	2100					
Med. age	39	48	48	47	45	48	47
TDR	0.69	1.02	1.00	1.00	1.00	0.99	0.98
Share 65+	17.5	31.3	30.8	30.5	28.3	30.5	30.4
Share 20–64	59.2	49.6	50	50.1	49.9	50.2	50.4

			Emigration rates reduced by 50% for certain groups only						
		Baseline	For all	Only older (50+)	Only younger (0–49)	Only immigrants	Only immigrants +children	Only natives	Only natives, −50% return immigration
	2020	2060							
Median age	39	47	46	47	46	47	46	46	47
TDR	0.69	0.92	0.90	0.93	0.88	0.91	0.90	0.91	0.92
Share 65+	17.5	28.3	27.3	28.8	26.8	28	27.6	27.9	28.4
Share 20–64	59.2	52.1	52.8	51.7	53.1	52.5	52.6	52.3	52.1
	2020	2100							
Med. age	39	48	48	49	47	48	48	48	48
TDR	0.69	1.02	1.00	1.03	0.98	1.01	1.01	1.01	1.02
Share 65+	17.5	31.3	30.8	31.9	30.2	31.6	31.2	31.0	31.7
Share 20–64	59.2	49.6	50	49.3	50.4	49.7	49.8	49.9	49.6