Using Future Age Profiles to Improve Migration Projections

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Abstract

Young adults migrate much more than elderly people. As populations in many origin countries get older, this may affect out-migration – and thus immigration to other countries. This is usually not taken into account in projections of future immigration.

We show how United Nations' projections of future age profiles in origin countries can be combined with rates of emigration by age groups, in order to improve national projections of immigration to a destination country, exemplified by Norway.

Using several methods for projecting future migration, our results show that projected immigration tends to decline when taking expected changes in age profiles in origin into account. Further, we show how such declines in projected immigration affects the projections for the total Norwegian population until 2100. Our results suggest that disaggregating by age in the immigration projections could have approximately the same effect on future population size as reducing the fertility assumption in the projections by 0.1 children per woman.

Keywords*: Population projections, migration, ageing, immigration, emigration, age structure*

Introduction

Population projections are important in shaping future societies, as an essential input for planning in numerous areas.

However, producing accurate population projections is challenging because it is hard to foresee the future of fertility, mortality and migration. Of these, migration is usually considered the most difficult component to forecast (Coleman 2008, Bijak 2011, Lee 2011). The difficulty of forecasting is not only due to lack of knowledge on the determinants of international migration; a vast body of literature has already identified several important determinants such as income differences, unemployment, legal changes and political unrest. The major challenge in forecasting migration is, rather, that many of these determinants are themselves hard to make long-term forecasts of.

International and national agencies employ different approaches to projecting future migration (Cappelen et al. 2015), although models for forecasting migration are few and relatively undeveloped (Raymer and Wiśniowski 2018). Some agencies keep migration constant from the current level or make forecasts based on expert judgements. Others, such as the U. S. Census Bureau, project immigration of foreign-born using rates of emigration from origin countries (U. S. Census Bureau 2018). Origin countries may be organized into regions, and rates of emigration are calculated by dividing annual figures of immigration from each region by figures for the population in the origin regions.

However, as far as we know, no national or international agency use estimates of changing age structure in origin in their immigration projection models. However, taking this into account can be worth considering, for at least five reasons:

i) The tendency to emigrate is closely related to age (Wiśniowski et al. 2016, Raymer and Wiśniowski 2018), so there is reason to believe that changing age structure will affect out-migration.
ii) Unlike many other determinants of migration, relatively reliable forecasts exist of future age structures for all countries until 2100 (United Nations 2019).
iii) These forecasts show large expected changes in age profiles through this century, indicating possibly large effects on migration.
iv) Using different rates by age is already an integrated part of many population projections, even for projections of emigration from or internal migration within the country of interest.
v) Taking future age structure into consideration can be a quite uncomplicated exercise, as we will show in this paper.

In the rest of this paper, we show how figures on future age profiles in origin – from United Nations' population projections – can be combined with rates of emigration by age groups in order to improve projections of immigration to a destination country, using Norway as a case. First, we briefly present the data used in this paper. Second, we introduce a relatively uncomplicated way of incorporating data from United Nations on changing age structure in origin into projections of future migration, using observed rates of emigration from origin for different age groups, by several well-known methods for extrapolating trends. Third, we show the differences between estimates based on disaggregated age groups versus similar estimates with no age disaggregation, and finally we show the effect of these differences on the projected population in Norway.

Our results show that the projected future total migration to Norway declines with age disaggregation, no matter which method is used. The effect on projected total population in Norway differs somewhat by the method used. For most methods, however, the effect of this age disaggregation on the projected population in Norway is between 300,000 and 500,000 inhabitants in 2100. This is an effect similar to reducing the assumption on fertility by 0.1 children per women over the whole projection period.

Data and descriptives

In order to forecast future immigration to any country based on emigration rates by age groups, at minimum two main data inputs are needed:

1) *Data on historic and future population in origin, by age groups.*
   We use the World Population Prospects (WPP) from United Nation's Population Division, which is freely available at https://population.un.org/wpp/. WPP offers estimates of the population in all countries back to 1950 by 5-years age groups, and also provides projections of population by 5-years age groups for all countries up until 2100.
2) *Data on immigration to the country of interest, by origin and age groups.*
   We use Statistics Norway's data on immigration to Norway, which is based on the Norwegian population register and cover all immigrants who have moved to Norway. Immigrants are defined as persons born abroad to foreign-born parents and grandparents and who have immigrated to Norway in order to stay for at least six months, with legal permission to stay. Immigrants who emigrated the same years as they came are removed from this sample; they constitute around 1000 annually.

Dividing figures on annual migration from an origin area to Norway by the population in origin will result in annual migration rates – either for the total population or for given age groups. From these rates, forecasts of future rates can be made. Several methods can be used, such as average over a given number of years, or different versions of extrapolations of the observed migration rates. The methods used in this paper will be elaborated more in detail after the presentation of the origin country groups and age groups.

The country groups

The categorization of origin country groups obviously depends on the national context and migration history. Norway has received immigrants from most countries in the world. Until the mid-80s, immigration mostly came from other Western countries. Immigration from non-

Western countries has increased substantially since the mid-80s, and after the EU enlargement in 2004 there was a steep increase in immigration from the new, eastern member states.

In this paper, the immigrants' origin countries have been grouped into three areas: Country group 1 includes Western Europe, US, Canada, Australia and New Zealand, Country group 2 includes the new, eastern EU member states, whereas the rest of the world constitutes Country group 3. Figure 1 shows the immigration to Norway from these country groups since 1975. Since 2011, immigration from Country group 1 (Western countries) and Country group 2 (new, eastern EU states) has decreased markedly. This can mainly be explained by economic conditions in Norway and origin. Immigration from Country group 3 has not seen the same decrease, but reached a top in 2016, which to a large extent was due to influx of Syrian refugees.

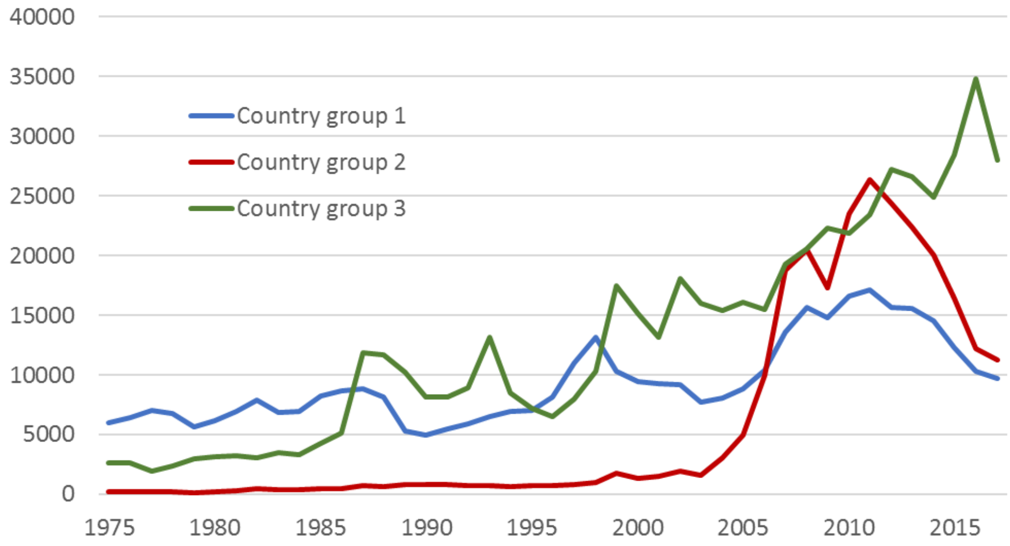

Figure 1: Immigration to Norway from three origin country groups, 1975-2017.

The history of immigration to Norway differs between the country groups, and they have to some degree met different sets of legal frameworks for entering and staying in Norway. They also tend to be driven by different reasons for migration (Statistics Norway 2019).

The age groups

Although immigrants from the three country groups differ as described above, their age profiles at immigration are relatively similar, and they also tend to be quite stable over time. Figure 2 shows the arrival age of immigrants who moved to Norway from 1975 to 2017, by country group.

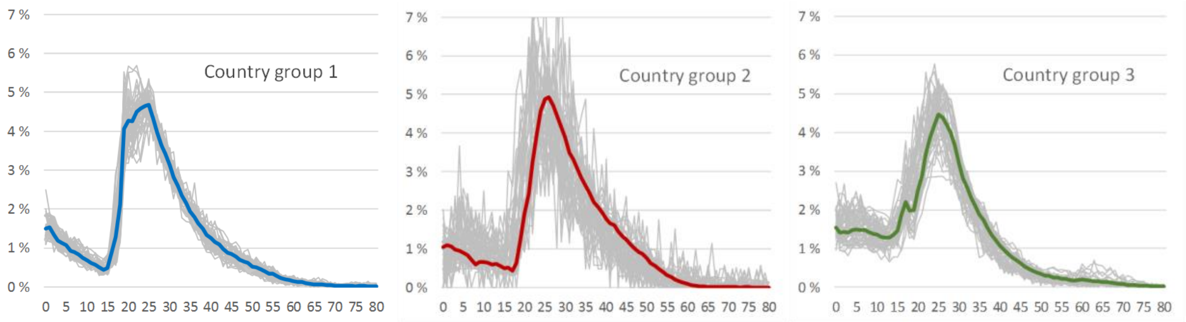

Figure 2: Age profiles of immigrant arriving in Norway by origin country group, coloured lines show average, thin grey lines show single arrival years, 1975-2017.

The patterns shown in Figure 2 are fairly similar to other patterns of migration by age: The mid-20s has been the most common arrival age for all the three groups. The youngest children also constitute a fair share of all immigrations, with declining shares until around age 15. Thereafter we see a sharp increase, before the shares fall again after the mid-20s. Very few migrants arrive at old ages.

In this paper, we use three age groups, which can roughly be described as i) children (0-14 years), ii) peak migration age (15-39 years) and iii) older ages (40 years and older), see Figure 3. Many different age group classifications could be used employing our methods. We have preferred to keep the number of groups small to avoid groups with too few observations. Since the UN data on origin populations use five-years age groups, the division lines have to be set at ages divisible by 5.

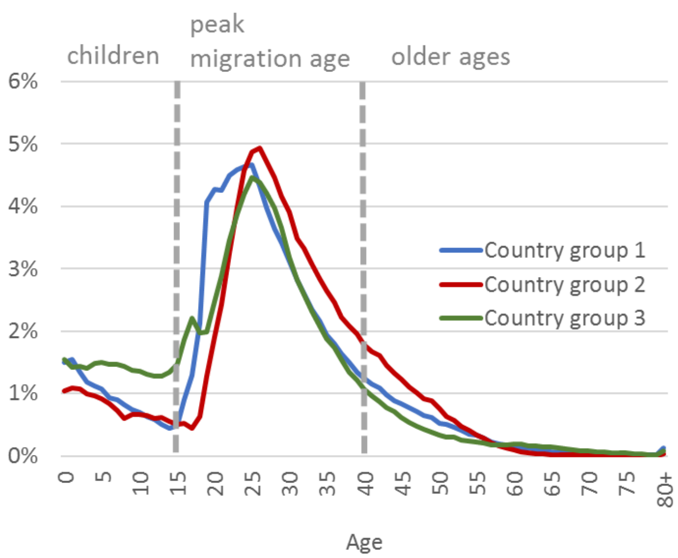

Figure 3: Classification of immigrant's arrival ages in Norway, and average age profiles for immigrants arriving 1975-2017, by origin country group.

The World Population Prospects (United Nations 2019) show that the share of the population in the peak migration ages is on the decline in most of the world. Figure 4 shows estimated and projected population (medium variant) by share in each age group, by origin country group. While the share of children is more or less constant or declining, the share of population in the more sedentary older ages increased markedly, particularly in country groups 2 (new, eastern EU member states) and 3 (rest of the world).

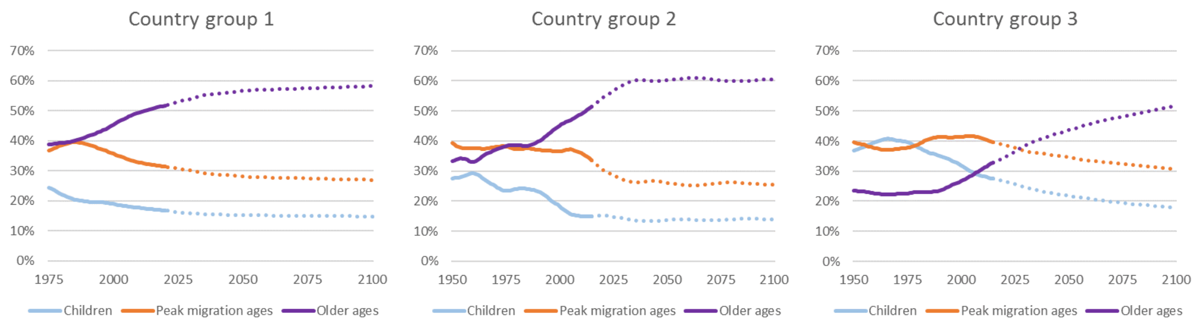

Figure 4: Share of population in different age groups, estimated and projected by the UN, by country groups.

The fact that most people migrate in ages that will constitute a decreasing share of the population in most origins, suggest that this may be an important factor to take into account when projecting future immigration. In the following, we show how this can be done.

Methods

To provide estimates of how an immigration forecast model disaggregated by age groups would affect population projections, we apply a two-step procedure. First, we extrapolate immigration trends to Norway using registered emigration rates from each of the three country groups and UN's projections of populations in these country groups. We use several methods for extrapolation (elaborated below), and for each method we make two different extrapolations: One based on emigration rates for the total population, and one that extrapolates the emigration rates for the three age groups defined above, applying them on UN projections disaggregated into the three age groups.

Secondly, the estimated differences between the two extrapolations (aggregated and disaggregated by age groups) is estimated. To illustrate the magnitude of these differences, we use the Norwegian model for official population projections to project future population in Norway with and without these differences. The Norwegian model for population projections is documented by Syse et al. (2018) and is a cohort-component model where different immigrant groups have different rates for emigration and fertility, grouped by origin area (corresponding to the country groups described above) and their duration of stay, as well as by age and sex (mortality rates are similar for immigrants and natives). By projecting the population with and without the difference in the immigration forecasts that results from disaggregating by age, we get an impression of the cumulative, long term effect such a model change may have on a population projection, exemplified by Norway.

Projecting migration rates

From observed annual migration rates, projections of future migration rates may be obtained in many ways. In this paper we consider several methods, as described below. For each method, we derive future migration rates for each of the three age groups as well as for the whole population, in order to be able to compare projections from the age-disaggregated method with the method without disaggregation. This is done for all the three country groups.

Different simple projection methods

This section shows how we can project immigration to Norway by mean of different simple techniques. To make the description clear we need to introduce some symbols and formalism. As described earlier we distinguish between 3 areas. Let P_{ajt} denote the population inn age group a (a=1,2,3) in thousand persons in area j (j=1,...,3) in year t, and let EMI_{ajt} denote the number of emigrants in age group a (a=1,2,3) from area j (j=1,2,3) to Norway in year t. We define the emigration intensities in the different age groups as

$$emiint_{ajt} = \frac{EMI_{ajt}}{POP_{ajt}}; j = 1,2,3; a = 1,2,3. \tag{1}$$

The total populations of a specific area and the total number of emigrants to Norway from this area are, respectively, given by

$$POP_{jt} = POP_{1jt} + POP_{2jt} + POP_{3jt}; j = 1,2,3. \tag{2}$$

$$EMI_{jt} = EMI_{1jt} + EMI_{2jt} + EMI_{3jt}; j = 1,2,3. \tag{3}$$

Given Eqs. (2) and (3), we define the aggregate emigration intensities as

$$emiint_{jt} = \frac{EMI_{jt}}{POP_{jt}}; j = 1,2,3. \tag{4}$$

We always consider projections for the years 2018-2100.

We may group our different methods within two main categories. The first category is based on the mean (weighted or unweighted) of emigration intensities over some years before 2018. The second category is based on using time series processes, i.e., VAR and AR models, to forecast the emigration intensities. A schematic overview of the different projection methods is given in Table 1 below. Below we give a more detailed description of the different main categories and their content.

Projections based on historical means of emigrations intensities (Category M1)

Our first method is based on using arithmetic means of emigration intensities using the period 2008-2017. These are given by

$$emiint\_10_{aj} = \frac{1}{10}\sum_{t=2008}^{2017} emiint_{ajt}; j = 1,2,3; a = 1,2,3. \tag{5}$$

and

$$emiint\_10_{j} = \frac{1}{10}\sum_{t=2008}^{2017} emiint_{jt}; j = 1,2,3. \tag{6}$$

The emigration to Norway by individual age groups from area *j* is then given by

$$EMI_{ajt}^{M1.1} = emiint\_10_{aj} \times POP_{ajt}; j = 1,2,3; a = 1,2,3; t = 2018,...,2100. \tag{7}$$

From (7) it follows that the projected aggregate emigration from area *j* to Norway is given by

$$EMI(dis)_{ajt}^{M1.1} = EMI(dis)_{1jt}^{M1.1} + EMI(dis)_{2jt}^{M1.1} + EMI(dis)_{3jt}^{M1.1}, j = 1,2,3; t = 2108,...,2100, \tag{8}$$

Using the aggregate intensities for the total emigration to Norway from area *j* instead, we have

$$EMI(agg)_{jt}^{M1.1} = emiint\_10_{j} \times POP_{jt}; j = 1,2,3; t = 2108,...,2100. \tag{9}$$

The notation (*dis*) and (*agg*) above is used to distinguish between aggregate immigration to Norway from area *j* projected by the disaggregate and the aggregate method, respectively. Our main aim of this paper is to compare aggregate emigration projections from different areas using these two approaches. This is valid for all cases not only for *M*1.1.

Our second case, which we refer to as *M*1.2 is very equal to the first method, the only difference being that the means are based on the shorter period 2013-2017.

Whereas the two cases above are based on unweighted mean the third and last case of this main category, *M*1.3, is based on a weighting scheme. In this case we have

$$emiint\_10w_{aj} = \sum_{t=2008}^{2017} \omega_{t-2008} \times emiint_{ajt}; j = 1,2,3; a = 1,2,3 \tag{10}$$

and

$$emiint\_10w_{j} = \sum_{t=2008}^{2017} \omega_{t-2008} \times emiint_{jt}; j = 1,2,3, \tag{11}$$

where the weights are given as

$$\omega_j = \frac{0.5 \times (1-0.5)^j}{1-(1-0.5)^{10}}; j = 0,...,9. \tag{12}$$

It follows from Eq. (12) that

$$\sum_{j=0}^{9} \omega_j = 1, \tag{13}$$

and that all the weights are positive. Corresponding to Eqs. (7)-(9) we now have

$$EMI_{ajt}^{M1.3} = emiint\_10w_{aj} \times POP_{ajt};\ j = 1,2,3; a = 1,2,3; t = 2108,...,2100, \tag{14}$$

$$EMI(dis)_{ajt}^{M1.3} = EMI(dis)_{1jt}^{M1.3} + EMI(dis)_{2jt}^{M1.3} + EMI(dis)_{3jt}^{M1.3},\ j = 1,2,3; t = 2108,...,2100 \tag{15}$$

and

$$EMI(agg)_{jt}^{M1.3} = emiint\_10w_j \times POP_{jt};\ j = 1,2,3; t = 2108,...,2100. \tag{16}$$

Instead of using arithmetic means, as in conjunction with methods *M1.1* and *M1.2*, one may alternatively employ geometrical or harmonic means.[1]

Projections based on time series models (Category M2)

In conjunction with this category we use either AR or VAR models with different number of lags. Altogether we consider four different cases within this category. Cases M2.1 and M2.3 are based on a lag length of 1 whereas cases M2.2 and M2.4 are based on a lag length of two. Cases M2.1 and M2.2 are based on VAR models using the disaggregate approach, whereas cases M2.2 and M2.4 are based on AR models using the disaggregate approach for total emigration from an area to Norway. All the variables are log-transformed in conjunction with category 2. In the following a detailed description for case M2.1 is presented. Consider the following VAR(1) model for the three variables $emiint_{1jt}, emiint_{2jt}$ and $emiint_{3jt}$ (j=1,…,3):

$$\begin{gathered}\log(emiint_{1jt}) = \lambda_{1j} + \eta_{11j} \times \log(emiint_{1j,t-1}) + \eta_{12j} \times \log(emiint_{2j,t-1}) + \\ \eta_{13j} \times \log(emiint_{3j,t-1}) + \varepsilon_{1jt};\ j = 1,2,3,\end{gathered} \tag{17}$$

$$\begin{gathered}\log(emiint_{2jt}) = \lambda_{2j} + \eta_{21j} \times \log(emiint_{1j,t-1}) + \eta_{22j} \times \log(emiint_{2j,t-1}) + \\ \eta_{23j} \times \log(emiint_{3j,t-1}) + \varepsilon_{2jt};\ j = 1,2,3,\end{gathered} \tag{18}$$

$$\begin{gathered}\log(emiint_{3jt}) = \lambda_{3j} + \eta_{31j} \times \log(emiint_{1j,t-1}) + \eta_{32j} \times \log(emiint_{2j,t-1}) + \\ \eta_{33j} \times \log(emiint_{3j,t-1}) + \varepsilon_{3jt};\ j = 1,2,3.\end{gathered} \tag{19}$$

In Eqs. (17)-(19) $\lambda_{aj}, \eta_{ikj}; a,i,k = 1,...,3$ are unknown parameters to be estimated and ε_{ajt} ($a, j = 1,...,3$) are error terms. The vector $\varepsilon_{jt} = \begin{bmatrix} \varepsilon_{1jt}, & \varepsilon_{2jt}, & \varepsilon_{3jt} \end{bmatrix}^{/}$ is assumed to be a white noise vector process with $E(\varepsilon_{jt}\varepsilon_{jt}^{/}) = \Omega$, where Ω is an unconstrained positive definite covariance matrix. Using this model, the emigration intensities for the three age groups in area j may be forecasted iteratively by employing the following recursive equations

[1] However, in the current study the results based on geometric and harmonic means gave broadly the same results as those based on the arithmetic means and hence not reported.

$$emiint\_M2.1_{1jt} = \exp(\hat{\lambda}_{1j} + \hat{\eta}_{11j} \times \log(emiint\_M2.1_{1j,t-1}) + \hat{\eta}_{12j} \times \log(emiint\_M2.1_{2j,t-1}) + \hat{\eta}_{13j} \times \log(emiint\_M2.1_{3j,t-1})); j = 1,2,3; t = 2018,...,2100. \quad (20)$$

$$emiint\_M2.1_{2jt} = \exp(\hat{\lambda}_{2j} + \hat{\eta}_{21j} \times \log(emiint\_M2.1_{1j,t-1}) + \hat{\eta}_{22j} \times \log(emiint\_M2.1_{2j,t-1}) + \hat{\eta}_{23j} \times \log(emiint\_M2.1_{3j,t-1})); j = 1,2,3; t = 2018,...,2100. \quad (21)$$

$$emiint\_M2.1_{3jt} = \exp(\hat{\lambda}_{3j} + \hat{\eta}_{31j} \times \log(emiint\_M2.1_{1j,t-1}) + \hat{\eta}_{32j} \times \log(emiint\_M2.1_{2j,t-1}) + \hat{\eta}_{33j} \times \log(emiint\_M2.1_{3j,t-1})); j = 1,2,3; t = 2018,...,2100, \quad (22)$$

where

$emiint\_M2.1_{aj2017} = emiint_{aj2017}, a, j$ = 1,…,3. In Eqs. (20)-(22) a ^ denotes an OLS estimate. In conjunction with the aggregate method we use an AR(1)-model, i.e.,

$$\log(emiint_{jt}) = \lambda_j + \eta_j \times \log(emiint_{j,t-1}) + \varepsilon_{jt}; j = 1,2,3, \quad (23)$$

where λ_j and η_j (j=1,…,3) denote unknown parameters to be estimated and ε_{jt} is a white noise error term. Using this model, the emigration intensity for country group *j* may be forecasted iteratively by employing the following recursive equation

$$emiint\_M2.1_{jt} = \exp(\hat{\lambda}_j + \hat{\eta}_j \times \log(emiint\_M2.1_{j,t-1})); j = 1,2,3; t = 2018,...,2100, \quad (24)$$

where $emiint\_M2.1_{j2017} = emiint_{j2017}, j = 1,...,3.$ Again a ^ denotes an OLS estimate.

The projected emigration to Norway by individual age groups from country group *j* is then, in case M2.1, given by

$$EMI_{ajt}^{M2.1} = emiint\_M2.1_{aj} \times POP_{ajt}; j = 1,2,3; a = 1,2,3; t = 2108,...,2100. \quad (25)$$

From (25) it follows that the projected aggregate emigration from country group *j* to Norway is given by

$$EMI(dis)_{ajt}^{M2.1} = EMI(dis)_{1jt}^{M2.1} + EMI(dis)_{2jt}^{M2.1} + EMI(dis)_{3jt}^{M2.1}, j = 1,2,3; t = 2108,...,2100. \quad (26)$$

Using the aggregate intensities for the total emigration to Norway from country group *j* instead, we have

$$EMI(agg)_{jt}^{M2.1} = emiint\_M2.1_j \times POP_{jt}; j = 1,2,3; t = 2108,...,2100. \quad (27)$$

Table 1. An overview of different simple projection methods for emigration rates

Main category	Case	Description
M1		Weighted and unweighted mean of historical emigration rates
	M1.1	Unweighted mean using the years 2008-2017
	M1.2	Unweighted mean using the years 2013-2017
	M1.3	Weighted mean using the years 2008-2017
M2		VAR and AR models
	M2.1	VAR(1) models employed for the three emigration intensities according to age group. AR(1) model employed for the aggregate emigration intensity (in the aggregate case).
	M2.2	VAR(2) models employed for the three emigration intensities according to age group. AR(2) model employed for the aggregate emigration intensity (in the aggregate case).
	M2.3	AR(1) models for the emigration intensities employed both in conjunction with the aggregated and age-disaggregated approach for projecting emigration from a country group to Norway.
	M2.4	AR(2) models for the emigration intensities employed both in conjunction with the aggregated and age-disaggregated approach for projecting emigration from a country group to Norway.

Results

In Figure 5, the difference between the solid and the dotted lines of the same colour shows the effect of estimating future migration using age groups. In the solid lines, no age grouping was used, whereas the dotted lines show the sum of migration estimated separately for each of the three age groups. If the dotted line lies below the solid line of the same colour, introducing age disaggregation in the forecast reduces the projected future immigration to Norway.

The results are almost univocal: For country group 1 (Western countries) estimated future migration to Norway declines with age disaggregation, no matter which method is used. The same is the case for Country group 3 (rest of the world). For country group 2, six out of seven methods yielded similar result. For the last method, M2.3, introducing age disaggregation reduced projected migration during most of the projection method, but not the last part. For the whole projection period taken together, however, the aggregate method in M2.3 yielded higher immigration figures than the corresponding age-disaggregated method.

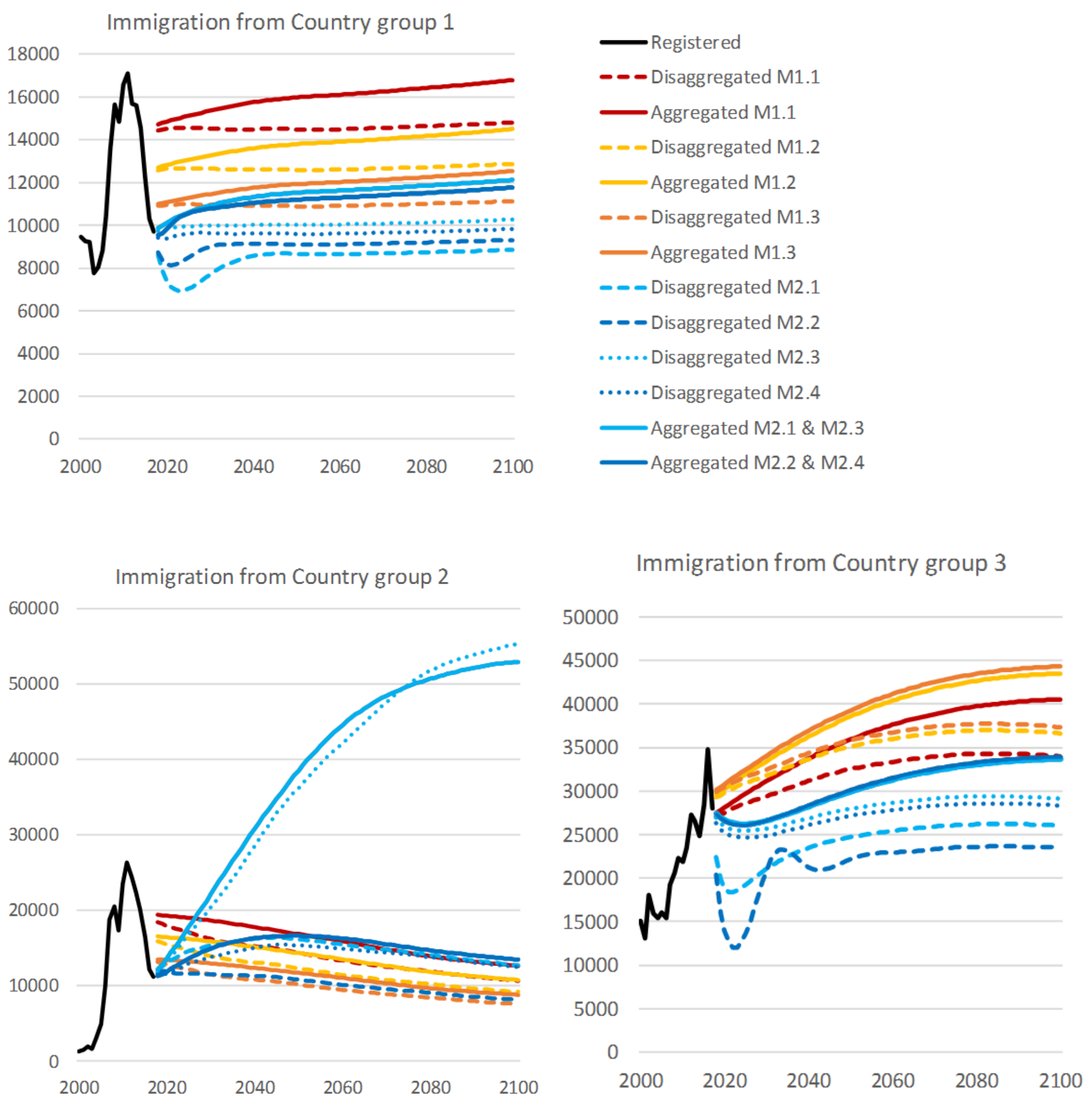

Figure 5: Projected immigration to Norway 2018-2100 by different methods (displayed by different colours), using disaggregated age groups in origin (dotted/dashed lines) or no age disaggregation (solid lines), by origin country groups.

More detailed figures on the differences by country group and model are shown in the Appendix (Figure A2). In Figure 6, only the differences between aggregated and age-disaggregated results within each model are shown, summarized over the three country groups. The lower the line, the more negative is the effect of introducing age disaggregation in projections of immigration to Norway.

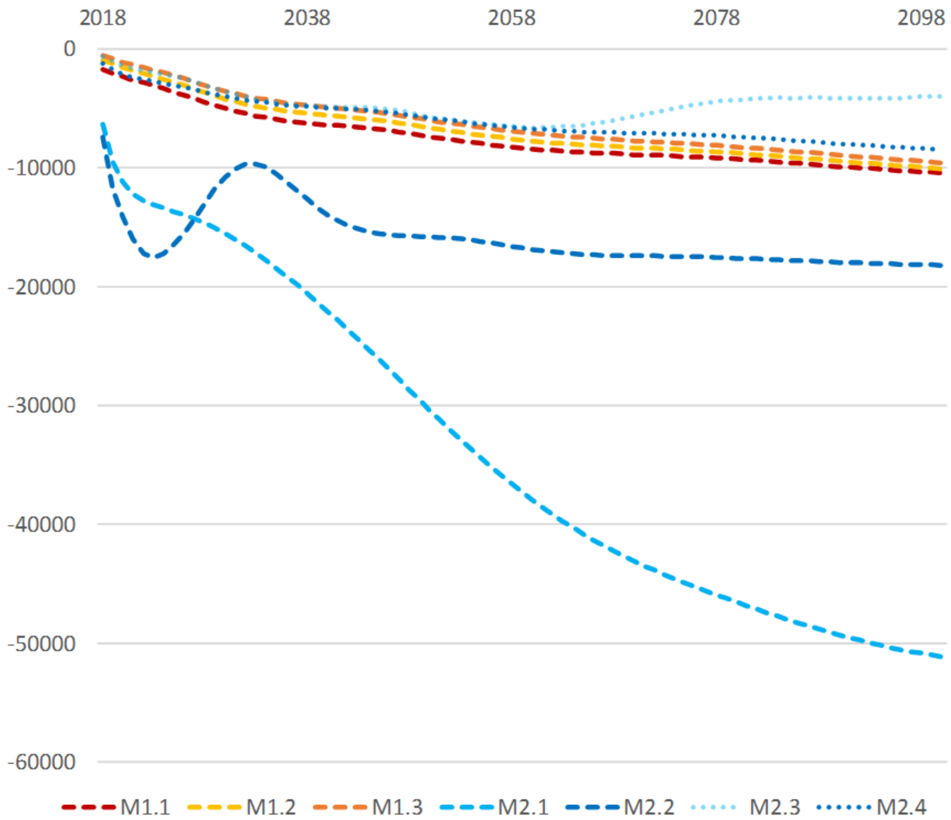

Fig 6: Difference in immigration to Norway if method disaggregates by age. Sum of the three origin country groups.

The results based on methods M2.1 and M2.2 deviate somewhat from the others in that the effects are quite large, and we judge them not to be credible. As revealed by Figure A2 in Appendix A, these results are related to Country group 2 in the case of method M2.1 and Country group 3 in case of methods M2.2. For both country groups it may also be advantageous to include intervention variables in the time series models to pick up effects of important events that have occurred during the estimation period. For most of the other methods used, annual total forecasted immigration would be between 100 and 1000 lower if future age profiles in origin were taken into account.

Effect on the projected population

One way to measure the long-term effect of this change, could be to simply add up the annual difference in projected immigration over the projection period. However, this does not necessarily correspond to the effect on the population size, since some immigrants emigrate from Norway, whereas some die and some give birth. By using the Norwegian model for (official) population projections, we have calculated the effect on the projected total population in Norway. The model uses the same rates for fertility, mortality and emigration, as were used in the last official Norwegian population projection (published in 2018). The only differences from these projections are the changes made in immigration assumptions for each country group, where the differences resulting from age disaggregation were subtracted from the original immigration assumptions.

In Figure 7 the difference in projected population size of Norway due to introduction of age disaggregation is shown. Not surprisingly, the differences are largest (more than two million inhabitants in 2100) for the M2.1 model, which also showed the largest differences in projected immigration.

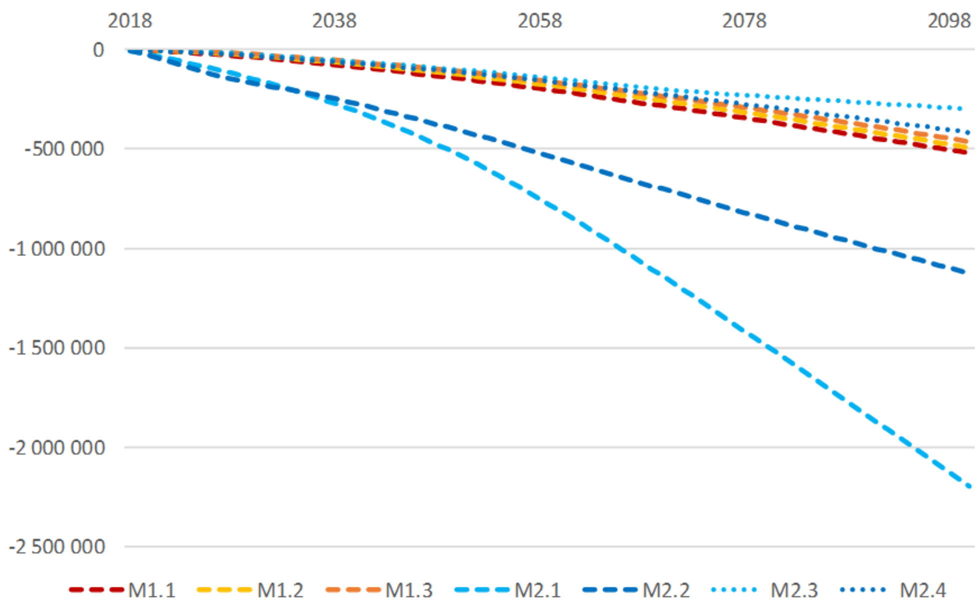

Figure 7: Difference in projected population size in Norway caused by introducing age disaggregation into migration projections.

For most methods, however, the effect on the projected population in Norway in 2100 lies between 300,000 and 500,000 inhabitants. This is a considerable effect, given that Norway's population in January 2019 was 5.3 million, and it is projected to increase to about 7.3 million in 2100 according to the official projection's main alternative. For comparison, Norway's capital Oslo has 690,000 inhabitants and the second largest city Bergen has 280,000. However, given the large uncertainty in population projections, the effect is not tremendously large. If the assumption on fertility had been reduced by 0.1 children per women, the effect on projected population size in 2100 would have been around 450,000, almost the same as the effect of disaggregating by age using most of our methods. Or to put it differently: Disaggregating by age in the immigration projections could have approximately the same effect on future population size as reducing the fertility assumption in the projections by 0.1 children per woman.

Conclusion and further work

Population projections are essential tools for planning of our future societies. However, they are uncertain, not the least because projections of future immigrations are very uncertain. In this paper, we have suggested taking into account one of the few factors which is relevant for migration and for which there exist relatively certain forecasts: Changing age profiles in origin areas.

Using different simple projections method, we have found that accounting for ageing in origin areas tends to lower the projected immigration to Norway in the period 2018-2100. We have compared two strategies for projecting immigration to Norway from three different areas. In one we neglect the age structure and project emigration rates from the areas to Norway for all ages in total. Alternatively, we operate with specific emigration rates for three age groups in each of the three areas. We find that the effects of disaggregating by age are sizeable, although they vary somewhat between the different methods.

In addition to the relatively simple methods shown here, other methods can also be employed for projecting future migration rates. In this paper we have not utilized economic (incentive) variables when projecting the emigration intensities. In conjunction with the most recent official population published by Statistics Norway, we have employed econometric models that resemble those reported by Cappelen et al. (2015). These are dynamic single equation models for the total emigration intensities. As economic incentive variables we utilize relative income variables, operationalized as the ratio between purchasing power adjusted GNP per capita in Norway and GNP per capita in an origin area, unemployment rates both in the origin area and in Norway, and in the case of Country group 3 also the stock of immigrants from this country group living in Norway. Furthermore, some dummy variables are included to capture the effects of special events. In the future, we plan to use a similar, but more disaggregated approach, in which we for each of the three areas, will operate with a set of regression equations, in which the left-hand variables are (logs of) emigrations rates for the three age groups we have considered in this paper. Another future line of work includes adapting the age profiles used when distributing immigrants by single years age into the cohort-component model, so that it corresponds to the immigrations projected in each age group.

Anyway, the results of this study make a case for taking changing age profiles into account when projecting future immigration to any country, no matter what method is currently in use.

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Appendix A: Additional figures

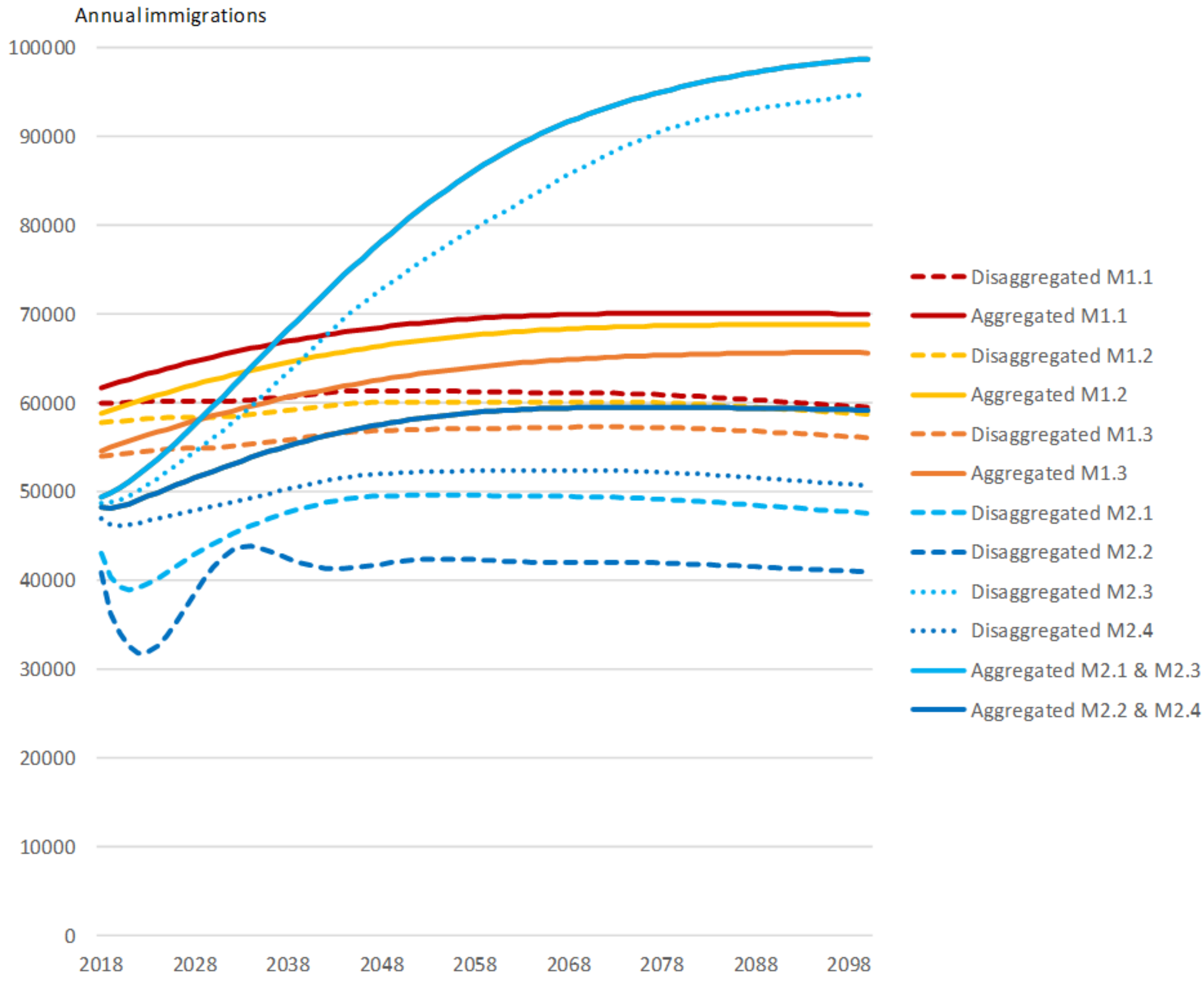

Figure A1: Projected immigration to Norway 2018-2100 by different methods (displayed by different colors), using disaggregated age groups in origin (dotted/dashed lines) or no age disaggregation (solid lines). Sum of the three origin country groups.

Figure A2: Difference between aggregated and age-dissagregated methods, by model and country group