Examining the role of migration, fertility, and mortality in driving population ageing and growth in Australia

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June 2026

Prepared for the Australian Bureau of Statistics and Reserve Bank of Australia Joint Conference 'Migration Matters', Sydney, June 2026

Abstract

What effect will alternative future trajectories of net overseas migration, fertility and mortality have on population ageing and growth in Australia over the next century? This question was carefully considered by researchers in the 1990s. This study updates and extends their analysis. An update is necessary because Australia's demography is quite different now: net overseas migration is much higher, fertility lower, life expectancy higher, and the population has grown substantially in size. It extends the earlier analysis by evaluating the impact of various demographic futures using a mixture of deterministic analytical projection variants, probabilistic projections, and conditional probabilistic projection scenarios. Projections using all three approaches were produced for the period from 2025 to 2125. The results demonstrate that a wide range of population futures are possible for Australia over the next 100 years. It is shown that the extent to which net overseas migration can retard population ageing very much depends on the timescale considered, and the levels of fertility and migration. It is argued that conditional probabilistic projection scenarios offer a useful way of exploring 'what-if?' scenarios to understand the outcomes of potential policy changes while explicitly accounting for uncertainty about the demographic future.

Key words

Population projections; Australia; overseas migration; conditional probabilistic scenarios; population ageing; population growth

1. Introduction

How much population ageing and how much population growth is Australia likely to experience over the next few decades? And what might happen further ahead in the early years of the 22nd century? How are demographic outcomes influenced by different trajectories of net overseas migration and fertility? Questions like these about the future size and shape of Australia's population have long been of interest to demographers, other social scientists, and policymakers (e.g. McDonald and Kippen 1999a; National Population Inquiry 1975; Wilson and Bell 2004; Withers 2002; Young 1990, 1994). They are, of course, of interest to the general public too, as shown by the fact that population growth and immigration are regularly the subject of media articles[1].

The policy importance of Australia's future demography is evident in government publications such as the annual *Population Statement* prepared by the Centre for Population (e.g. Centre for Population 2026), and the *Intergenerational Report* published by the Australian Government every few years (e.g. Australian Government 2023). A central concern of the intergenerational report is the impact of future population ageing, and demographic change more broadly, on the economy and the government's tax receipts and expenditure. Some State governments now also prepare intergenerational reports for their jurisdictions (e.g. NSW Government 2021).

The effect of high fertility and high net migration on total population growth is quite simple: they both increase it. But the impact on population ageing is less clear cut and more contested. It is often stated that net migration gains slow the progress of population ageing because migrants are generally young. This has long been a popular policy position (McDonald and Kippen 1999a; Young 1994). However, others believe that net migration makes little difference to ageing because migrants become older over time. Christabel Young (1990) examined this issue as part of her report 'Australia's Ageing Population – Policy Options' for the then Bureau of Immigration Research. She created several population projection variants from 1986 to 2046 with different fertility and migration assumptions. She concluded that "immigration has relatively little effect in retarding the ageing of the population" and "the best policy option to achieve a low proportion of elderly persons, consistent with an appropriate population target, is to maintain fertility near replacement and have a relatively low migrant intake" (p. 59).

[1] See, for example, https://www.abc.net.au/news/topic/immigration, and https://www.abc.net.au/news/topic/demographics

The issue was re-examined by Peter McDonald and Rebecca Kippen around the turn of the century in their report ‘The impact of immigration on the ageing of Australia’s population’ (McDonald and Kippen 1999a; see also McDonald and Kippen 1999b). That study examined the demographic consequences of different migration, fertility, and mortality scenarios for Australia from 1998 to 2098. The authors concluded that “annual net migration to Australia of at least 80,000 … makes a worthwhile and efficient contribution to the retardation of population ageing. Levels of annual net migration above 80,000 become increasingly ineffective and inefficient in the retardation of ageing” (McDonald and Kippen 1999a p 21).

What does the theoretical demographic literature say about migration and ageing? In a paper on stationary populations with low-fertility and immigration, Schmertmann (1992) concludes that, “although fertility increase and immigration are equally effective at halting population decline, immigration is inferior as a means of rejuvenating low-fertility populations” (p 595). “If one wishes to make a population younger, the important thing is to add inflows of young people – the younger, the better. … Adding immigrants to a population is inferior to increasing fertility as a means of rejuvenation simply because babies are younger” (p 611). Goldstein (2009) defines population ageing in terms of an increase in the mean age of the population. More births make a population younger because they occur at exact age zero which is always younger than the population’s mean age. With respect to migration, net migration gains are usually concentrated in the young adult ages. So long as this gain occurs at ages younger than the mean age of the population then the short-term effect of migration is to make populations younger. But in the long-term these migrants become older. In fact, “a steady stream of migrants almost always makes a population younger in the short-term but older in the long-term, as compared to the age structure in the absence of migrants” (Goldstein 2009 p 15). The exceptions to this include an ever-increasing amount of net migration or if migrants have very high fertility (which is not the case for Australia).

This paper revisits the issue and addresses the questions ‘How much population ageing and growth is Australia likely to experience over the next century?’ and ‘How would future population ageing and growth be affected by different levels of overseas migration and fertility?’ Population ageing is defined as an increase in the proportion of the population aged 65 and above. Overseas migration is key to Australia’s demographic future because it is the demographic variable most amenable to policy influence. Fertility is generally more resistant to policy intervention, though research has found that selected policies can increase fertility to some extent (Gray et al., 2022; Hart et al. 2023).

This study builds on earlier work in two ways. First, it updates the analysis to the present time. Australia's demographic situation has changed since the 1990s. The population has increased substantially, fertility is lower, net overseas migration much higher, and life expectancy has increased. Second, it draws strength from several types of projections, including standard deterministic variant projections, probabilistic projection methods (Keilman 2020; Wilson 2026) and, in particular, conditional probabilistic methods (Sanderson et al. 2004).

Probabilistic projections explicitly incorporate uncertainty about the demographic future by projecting a *distribution* of future populations rather than a single number. Importantly, the uncertainty in probabilistic projections is typically based on time series models which mimic the variability of demographic variables and/or observed forecast error distributions. Probabilistic projections provide far more reliable and consistent information about uncertainty than traditional 'high' and 'low' projection variants (Keilman et al. 2002).

Conditional probabilistic population projections (Sanderson et al. 2004) are probabilistic projections which are conditional on a specified assumption being fixed or constrained within a specified range. They combine the strengths of variant projection scenarios and probabilistic projections. They provide answers to questions such as 'What is the possible range of the future proportion of the population aged 65+ if net overseas migration remains between 200,000 and 300,000 per year?'. The conditional probabilistic projection incorporates uncertainty about net migration within the specified range and full uncertainty for all remaining variables (fertility, mortality, the initial jump-off population, and migration age profiles). Equivalent deterministic projection scenarios would typically vary the levels of net migration but use the principal projection assumptions for fertility and mortality in each case. The limitation of the deterministic approach is that it does not reveal the possible range of the proportion of the population aged 65+ under alternative net migration levels.

2. Data and Methods

2.1. Probabilistic model

Probabilistic population projections were produced to answer the question about likely future population growth and ageing. Deterministic population projections for Australia were prepared first, with the results then fed into a probabilistic projection model. Deterministic projections were created using a standard national-scale cohort-component model (Wilson and Rees 2021). This model produces projections of population for 30th June each year by sex and single years of age up to a final age group of 100+. It projects births, deaths and emigration via occurrence/exposure rates while immigration is projected directly as numbers. Immigration and emigration are adjusted proportionally during the projection calculations to ensure they match the set annual net overseas migration (NOM) assumption. All projections are based on 30th June 2025 Estimated Resident Populations published by the ABS (2026) and extend out 100 years to 2125. The projections assume a total fertility rate (TFR) of 1.40 from 2027-28 onwards, life expectancy at birth which gradually increases to age 94 for females and 92 years for males by 2124-25, and NOM at 250,000 per year from 2027-28 onwards. Immigration and emigration rate age profiles use values averaged over the years 2011 to 2019.

The probabilistic projection model takes the deterministic projection output and estimates the forecast uncertainty around it. It does so by producing 5,000 simulations using a cohort-component model based on the deterministic model's fertility, mortality, and migration rates but with random variation applied around those rates. Output at the greatest level of detail (by variable, age, sex, year, and simulation) is written out into a large dataset. Projections for selected variables (e.g. total population; the proportion of the population aged 65+) are then extracted from the output dataset and sorted in size order to create predictive distributions.

The main projection assumption indicators comprise the TFR, life expectancy at birth, and gross migraproduction rates (GMRs) for immigration and emigration. These are projected using time series models, with the TFR and GMRs projected with ARIMA(1,0,0) models, while life expectancy is modelled using a simple random walk with drift model. Random errors are correlated for immigration and emigration GMRs, and between male and female GMRs, and male and female life expectancy. For practical purposes, fertility, mortality, and migration are assumed to be independent, although this is an imperfect assumption. Time series models were fitted to past data for Australia, but judgement was used to refine parameters. The autoregressive coefficient for the TFR was increased slightly so that the distribution would span the range of TFRs recorded in high-income countries over the last decade (giving a 95% interval from about 0.80 to 2.00 over the long run). The variance of life expectancy error was slightly increased so that the lower 95% boundary of the life expectancy distribution showed almost no improvement in the future – a possibility that cannot be excluded. The variance-covariance matrix of GMR errors was adjusted slightly so that the 95% interval of NOM 50 years ahead approximately covered the range of values over the last two decades. The assumed distributions of the TFR, life expectancy at birth (for males only to maintain clarity), and NOM are shown in Figure 1. The initial jump-off population was also subject to random error because ERPs are not perfectly accurate. Probabilistic age-specific rates consistent with the main indicators were then added, including randomly varying age profiles for immigration and emigration. Once 5,000 sets of age-specific rates had been prepared, the probabilistic cohort-component model was run.

2.2. Analytical projection variants

To reveal the effects of alternative migration and fertility levels on Australia's population, a series of 49 analytical projection variants was prepared using the deterministic projection model. They assumed various combinations of long-run TFR and NOM levels, which are summarised in Table 1. The range of values was chosen to approximately cover the 95% prediction intervals of the TFR and NOM in the probabilistic projections. The alternative assumptions were trended in over the first 10 years of the projections and then held constant for the following 90 years.

For the NOM variants, preliminary projected migration, based on immigration flows and emigration rates, is scaled to the required NOM assumption during the projection calculations. For all NOM variants, NOM is fixed from year 10 of the projections, but immigration and emigration still volumes vary over time in response to changing population size and age structure. In the 0k NOM scenarios immigration and emigration both take positive but identical values in total (to give total NOM of zero), but not across age groups, so that NOM by age consists of a mix of positive and negative values. The same mortality assumptions were used in all variants to avoid the complexity of adding another variable.

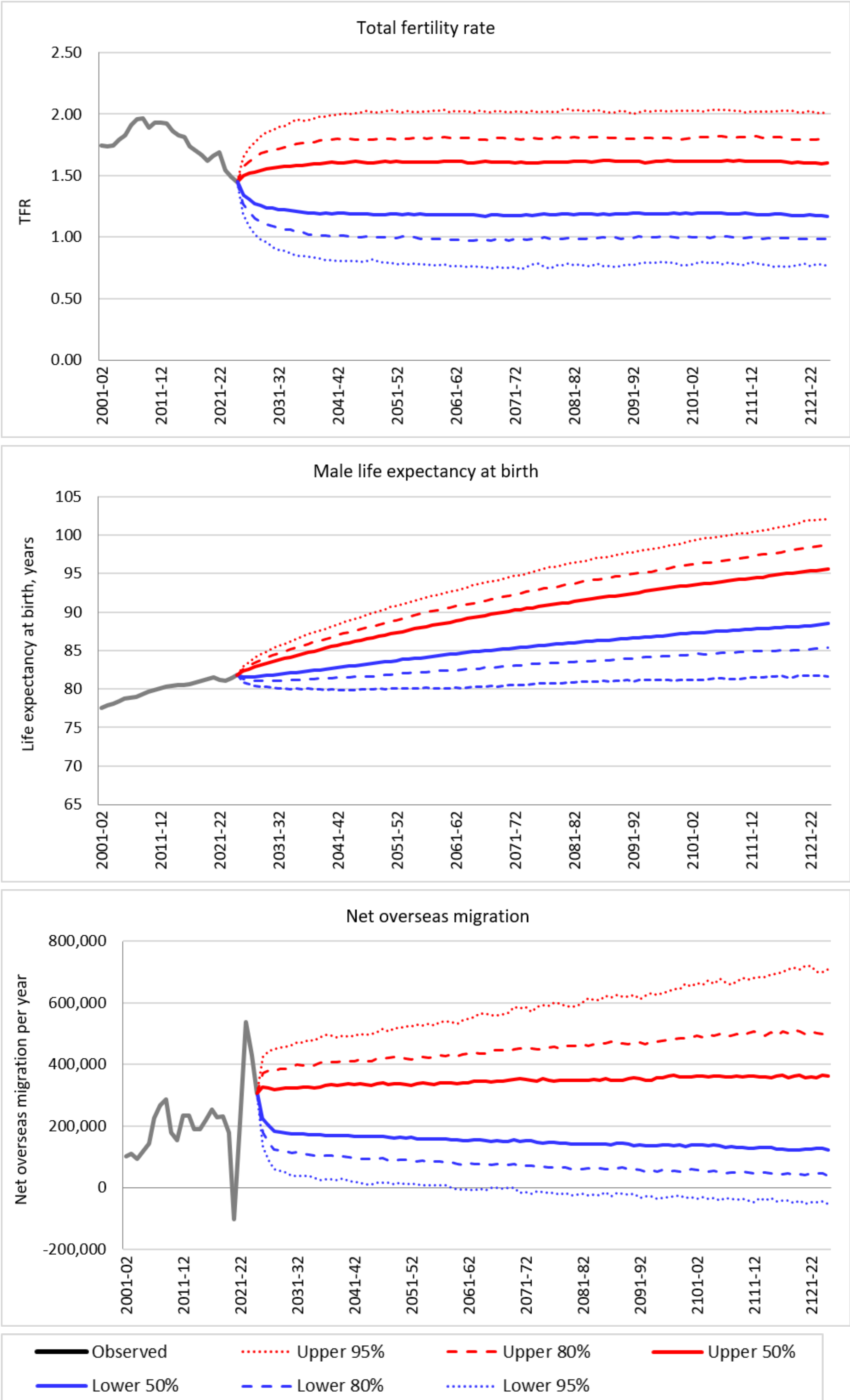

Figure 1: Summary of the probabilistic projection assumptions

Source: author's calculations based on ABS data up to 2025; author's projection assumptions thereafter.

Note: the distribution for female life expectancy at birth is very similar to that of males, but with slightly higher life expectancy throughout the projection horizon.

Table 1: Long-run TFR and NOM assumptions in the analytical projection variants

		Annual NOM						
		0k	100k	200k	300k	400k	500k	600k
TFR	0.80	0.80 & 0k	0.80 & 100k	0.80 & 200k	0.80 & 300k	0.80 & 400k	0.80 & 500k	0.80 & 600k
	1.00	1.00 & 0k	1.00 & 100k	1.00 & 200k	1.00 & 300k	1.00 & 400k	1.00 & 500k	1.00 & 600k
	1.20	1.20 & 0k	1.20 & 100k	1.20 & 200k	1.20 & 300k	1.20 & 400k	1.20 & 500k	1.20 & 600k
	1.40	1.40 & 0k	1.40 & 100k	1.40 & 200k	1.40 & 300k	1.40 & 400k	1.40 & 500k	1.40 & 600k
	1.60	1.60 & 0k	1.60 & 100k	1.60 & 200k	1.60 & 300k	1.60 & 400k	1.60 & 500k	1.60 & 600k
	1.80	1.80 & 0k	1.80 & 100k	1.80 & 200k	1.80 & 300k	1.80 & 400k	1.80 & 500k	1.80 & 600k
	2.00	2.00 & 0k	2.00 & 100k	2.00 & 200k	2.00 & 300k	2.00 & 400k	2.00 & 500k	2.00 & 600k

2.3. Conditional probabilistic projections

Analytical projection variants are very useful for assessing the outcomes of hypothetical levels of fertility and migration, especially the extent of population growth and ageing, and how outcomes vary over time. But their limitations include the assumption of smooth trends of fertility and migration, the fixed relationship between them, and in this case the exclusion of mortality variation. To complement the analysis, exploratory policy-focused projections can be created with conditional probabilistic projections. These projections include restricted ranges for one or more demographic variables based on potential policy decisions, but fully account for uncertainty in the remaining variables. No policy would ever be able to deliver a constant fixed level of a demographic variable, as would be projected in a deterministic projection. Setting policy-based variables as ranges is more realistic.

Two example conditional probabilistic projections were created for this study associated with specific policy scenarios. They envisage a much more tightly controlled overseas migration system where a planning range for annual NOM is set, and an assumption that the TFR remains within a specified range due to family policy. I leave aside the issue of whether or not a NOM planning range, and a specific fertility range, could be achieved. The two scenarios are:

- Scenario A with NOM in the range 100,000 – 200,000 per annum and the TFR between 1.60 and 1.80 (Australia in the early 2000s)
- Scenario B with NOM in the range 300,000 – 400,000 per annum and the TFR between 1.40 and 1.60 (recent experience).

The scenarios were operationalised by adjusting the probabilistic model parameters so that the migration and TFR sample paths produced a 95% prediction interval that just fell within the planning range. The parameters for mortality remain the same as those in the standard probabilistic projection.

3. Results

3.1. Probabilistic projections of population growth and ageing

Selected outputs from the probabilistic projection are shown in Figure 2. The upper graph presents projected total population, while the bottom graph illustrates the percentage of the population aged 65 and over. In each graph, the highest and lowest dotted lines shown in red and blue represent the upper and lower bounds of the 95% prediction interval (2.5th and 97.5th percentiles), the dashed lines show the bounds of the 80% interval (10th and 90th percentiles), while the thick lines mark out the upper and lower bounds of the 50% prediction interval (25th and 75th percentiles).

In 2025, Australia's population was estimated to be 27.6 million. By 2050, it is projected to be between 33.0 and 38.8 million (80% prediction interval). By 2125, the 80% interval spans 36.1 to 72.3 million, with the 95% interval ranging from just 29.3 million to a massive 84.9 million. In terms of population ageing, the percentage of the population aged 65 and over in 2025 was 17.5%. By 2050, it is projected to be between 19.6% and 23.5% (80% interval). By the end of the projection horizon in 2125, it is projected to be between 24.1% and 37.7% (80% interval) or 21.3% and 42.6% (95% interval).

An important strength of probabilistic projections is their ability to estimate the extent of uncertainty, providing information about when the demographic future is relatively more certain and when it is far more uncertain. They show that the further we look to the future, the more uncertain the demographic outlook becomes. Over the next few years, we have a fairly clear picture of how Australia's population will grow and age, but many decades into the future relatively little idea about the size and shape of the population. A century ahead, the uncertainty is huge – but also not endless. It is very unlikely that total population in 100 years' time will be lower than it is today, and also very unlikely that the share of the population aged 65+ will be lower than it is today.

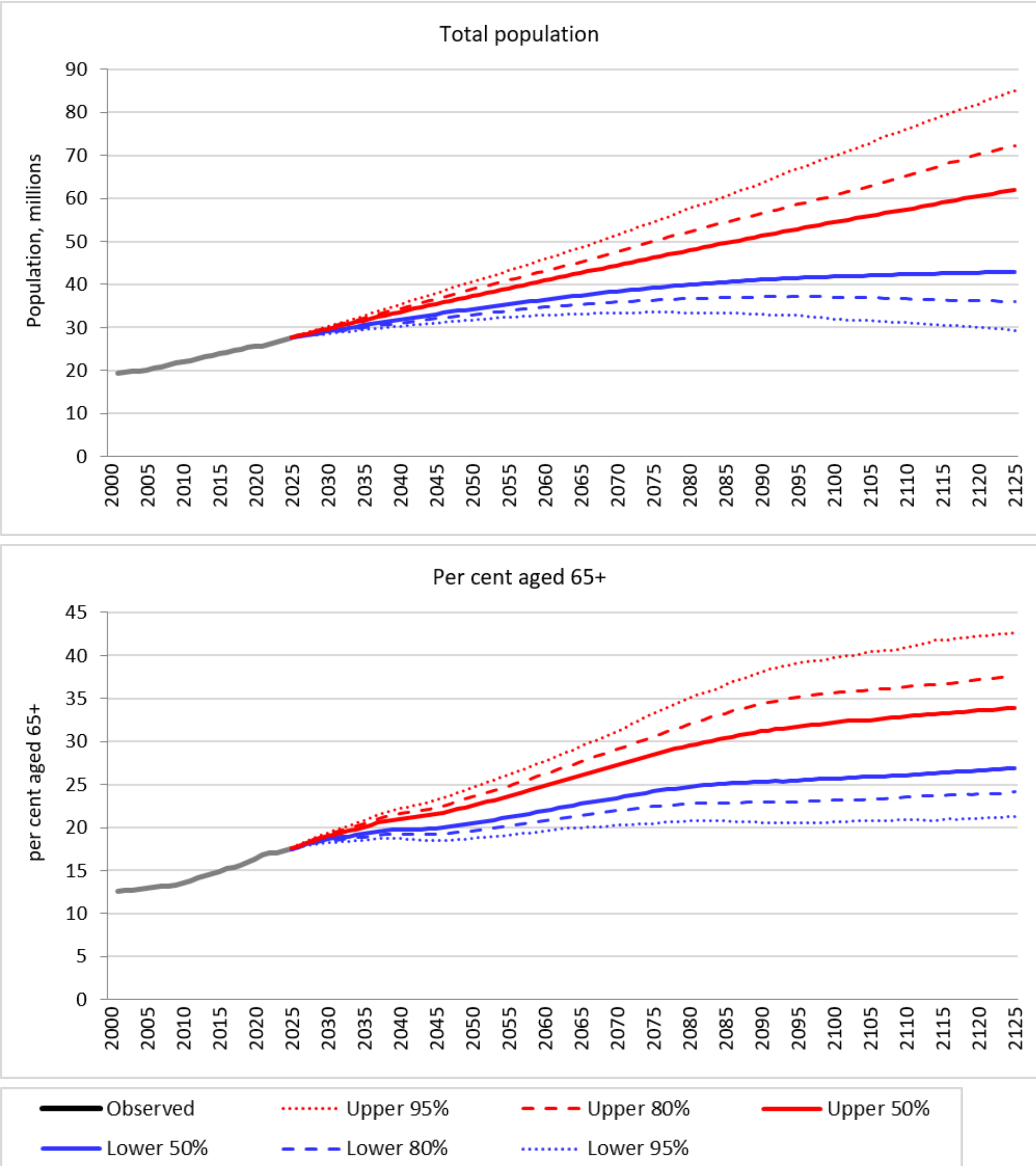

Figure 2: Probabilistic projections of total population and the percentage of the population aged 65+, in Australia, 2025-2125

3.2. Effects of different levels of migration and fertility

Summary results of the analytical projection variants are presented in Tables 2 and 3. Table 2 contains projected total populations and the percentage aged 65+ for all projection variants in 2050. The upper half of Table 2 contains total projected populations. Not surprisingly, the higher the TFR and the higher the level of annual NOM, the greater the projected total population of Australia in 2050.

The lower half of the table shows the share of the population aged 65+. The percentage of the population aged 65+ varies moderately across different levels of TFR for each NOM assumption, but it varies more between NOM values for any specific TFR. The results also show that the first 100,000 NOM reduces the percentage aged 65+ more than successive additions of 100,000. Over the first 25 years of the projection horizon, higher TFRs increase the size of the population at the youngest age groups at the bottom of the population pyramid, and because NOM is concentrated in the young adult ages, higher NOM also increases the size of the population below age 65 (especially the childbearing age population). The population above age 65 experiences barely any impact from the migration and fertility assumptions after 25 years. We can therefore conclude that the level of NOM has a substantial impact on population ageing over the medium-term: higher levels of NOM slow the progress of ageing.

Table 2: Projected total population and percentage aged 65+, 2050

		Annual NOM						
		0k	100k	200k	300k	400k	500k	600k
Total population, millions								
TFR	0.80	27.6	29.9	32.1	34.4	36.6	38.9	41.1
	1.00	28.4	30.7	33.0	35.4	37.7	40.0	42.3
	1.20	29.3	31.6	34.0	36.3	38.7	41.1	43.5
	1.40	30.1	32.5	34.9	37.3	39.7	42.2	44.6
	1.60	30.9	33.4	35.8	38.3	40.8	43.3	45.8
	1.80	31.7	34.2	36.8	39.3	41.8	44.4	47.0
	2.00	32.5	35.1	37.7	40.3	42.9	45.5	48.1
Per cent aged 65+, %								
TFR	0.80	26.3	24.9	23.7	22.7	21.7	20.8	20.1
	1.00	25.5	24.2	23.1	22.0	21.1	20.3	19.5
	1.20	24.9	23.6	22.5	21.5	20.6	19.7	19.0
	1.40	24.2	23.0	21.9	20.9	20.0	19.2	18.5
	1.60	23.6	22.4	21.3	20.4	19.5	18.7	18.0
	1.80	23.0	21.8	20.8	19.9	19.0	18.3	17.6
	2.00	22.4	21.3	20.3	19.4	18.6	17.8	17.2

Table 3 presents long-term results for the end of the projection horizon in 2125. In terms of total population, a similar pattern to Table 2 is shown except that variations in total population are much greater after 100 years, ranging from 12.5 million to 136.7 million. The combination of sustained high fertility and high migration results in massive population growth, while at the other end of the scale, low fertility and zero NOM results in huge population decline.

Table 3: Projected total population and percentage aged 65+, 2125

		Annual NOM						
		0k	100k	200k	300k	400k	500k	600k
Total population, millions								
TFR	0.80	12.5	21.3	30.2	39.2	48.2	57.3	66.4
	1.00	15.5	25.2	35.0	44.9	54.8	64.8	74.8
	1.20	19.0	29.7	40.6	51.5	62.4	73.4	84.4
	1.40	23.2	35.0	47.0	59.0	71.1	83.2	95.3
	1.60	28.1	41.2	54.3	67.6	80.9	94.2	107.5
	1.80	33.8	48.2	62.7	77.3	91.9	106.6	121.3
	2.00	40.3	56.2	72.2	88.3	104.4	120.5	136.7
Per cent aged 65+, %								
TFR	0.80	41.0	37.8	36.5	35.8	35.4	35.2	35.1
	1.00	38.4	35.7	34.5	33.9	33.6	33.3	33.2
	1.20	35.8	33.6	32.6	32.0	31.7	31.4	31.3
	1.40	33.3	31.5	30.6	30.1	29.8	29.6	29.4
	1.60	30.9	29.4	28.7	28.2	27.9	27.7	27.6
	1.80	28.7	27.5	26.8	26.4	26.2	26.0	25.9
	2.00	26.6	25.6	25.1	24.7	24.5	24.3	24.2

The lower half of Table 3 presents the projected share of the population aged 65+ in 2125. For any level of fertility, the variations in the percentage of the population aged 65+ are moderate. As before, the first 100,000 NOM reduces the percentage aged 65+ more than successive additions of 100,000. But the reduction in effect with successive additions of 100,000 is much greater by 2125 compared to 2050 so that there is little change in the percentage aged 65+ between NOM levels of 500,000 and 600,000 per annum by this time. For any amount of NOM, the variations in the share of the population aged 65+ as fertility varies are much larger. This is clearly different from the pattern shown in the lower half of Table 2 for 2050. After 100 years of changed fertility, the smaller/larger birth cohorts born in the early years of the projection horizon will have aged into the 65+ population, as will the net gain in population at the young adult ages from NOM. Over the very long-run, therefore, we can conclude that while higher levels of NOM do indeed slow the progress of ageing, higher fertility is more effective at doing so. The higher levels of NOM slow ageing with diminishing returns, and ultimately at the cost of huge population growth.

Note the range of populations in Tables 2 and 3 exceed the 95% predictive interval of the probabilistic projections. This is because the variant projections producing the highest and lowest populations assume fixed low or high TFR and NOM values for the entire projection horizon, which the probabilistic projections do not.

The influence of alternative levels of NOM and fertility can be illustrated in graphs which take the middle values of the TFR (1.40) and NOM (300,000 per annum) and show the effects of variations in the other variable. Figure 3 shows the results of different levels of NOM with a long-run TFR of 1.40. The hugely varied effects on total population are illustrated in the top graph. Zero NOM leads to long-run decline, with the population falling to 23.2 million by 2125. Unsurprisingly, NOM of 600,000 per year generates extremely high growth, with the total population soaring to 95.3 million by 2125.

The impact on the share of the population aged 65+ is shown in the bottom graph of Figure 3. Over the initial few years of the projection horizon, different levels of NOM have little impact on population ageing. After a few decades, however, the varying levels of NOM produce substantial differences in the extent of population ageing. The greatest range of values for the percentage aged 65+ occurs in 2069 when the zero NOM variant results in 30.0% of the population aged 65+ while the 600,000 NOM variant produces 21.2%. However, as the graph reveals, differences in the percentage aged 65+ across variants converge further into the future. By the end of the projection horizon, the percentages only range from 29.4% with 600,000 NOM per annum to 31.5% for 100,000 NOM per annum and 33.3% for zero NOM (though total populations vary hugely). In examining these analytical variant projections, the time frame considered makes a major difference. The short-term and very long-run effects of different levels of NOM on population ageing are small, although the ageing pathways between the short-term and very long-term vary substantially.

Figure 4 shows the effects of varying the TFR using the 300,000 annual NOM assumption. Total population, shown in the top graph, increases as would be expected, with higher fertility leading to much greater population growth. By 2125, the population ranges between 39.2 million for a TFR of 0.80 to 88.3 million for a TFR of 2.00.

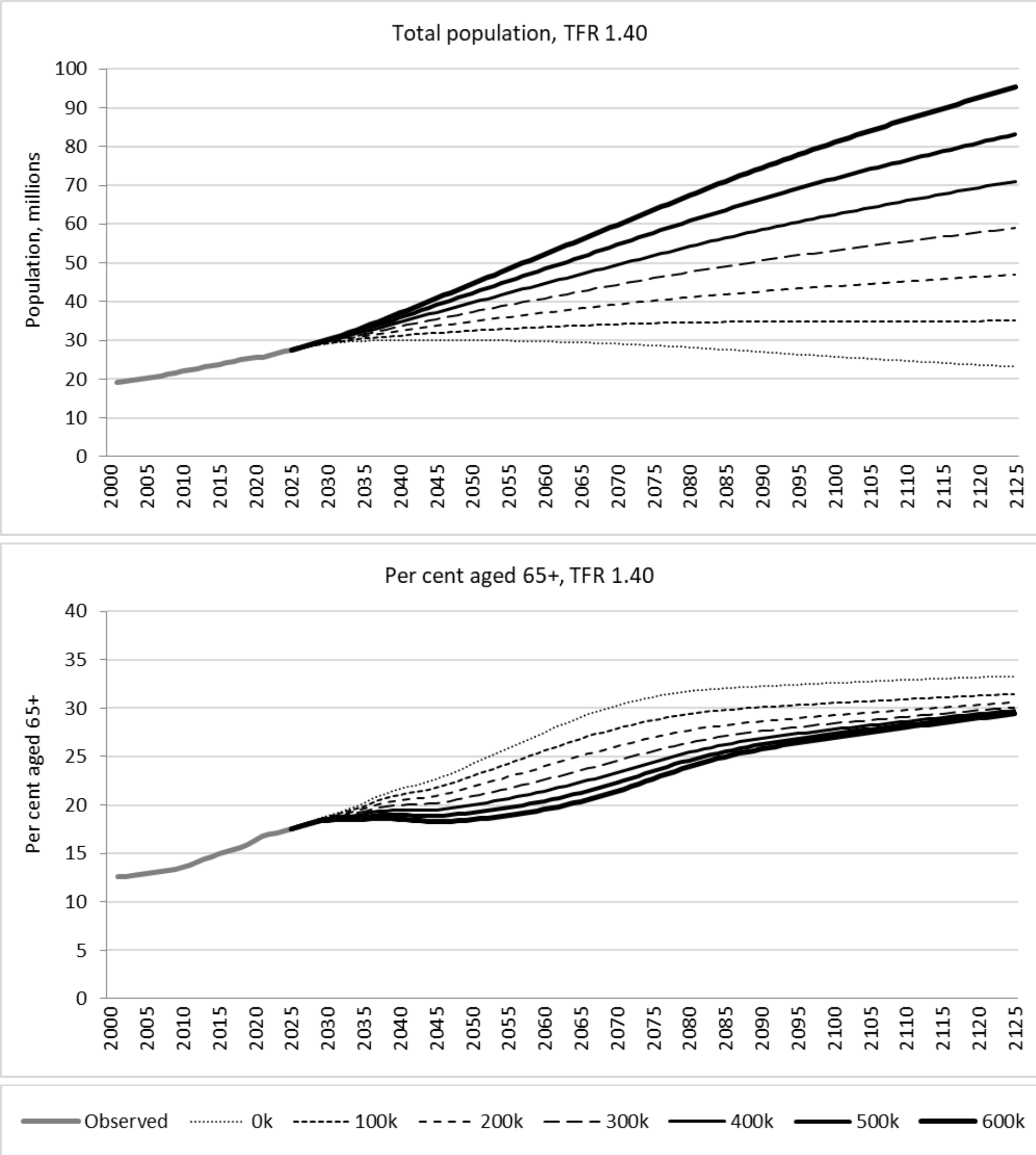

Figure 3: Demographic consequences of alternative NOM levels with a long-run TFR of 1.40

The bottom graph in Figure 4 displays the percentage of the population aged 65+ for each of the fertility variants. Over the first few years of the projection horizon, there is little difference in the percentage between fertility levels. But the differences increase over the next few decades up until nearly the end of the century. They reach a maximum in 2096, varying between 22.6% aged 65+ for the TFR 2.00 variant and 35.3% for the TFR 0.80 variant. Thereafter the range of values only reduces very slightly. Thus, the effects of alternative levels of fertility on population ageing for any given level of NOM are large in all but the short-term and are remain substantial over the very long-run.

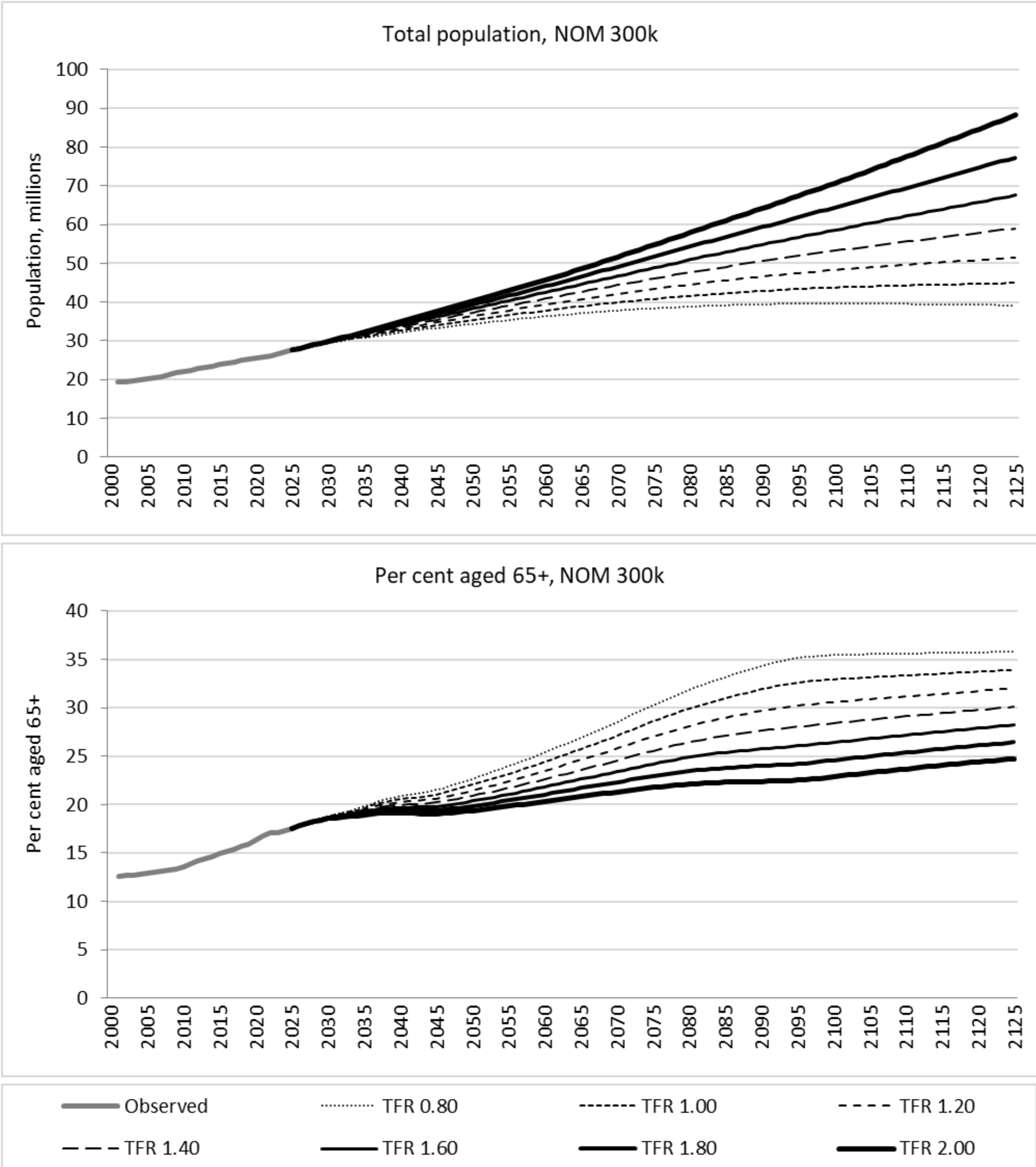

Figure 4: Demographic consequences of alternative TFR levels with a long-run NOM of 300,000 per annum

3.3. Conditional probabilistic projections

The outcomes of the conditional probabilistic projections are summarised in Figure 5. This shows the 80% prediction intervals for projected total population (top graph) and percentage of the population aged 65+ (bottom graph) for scenarios A and B. Under Scenario A (100,000-200,000 NOM per annum; TFR 1.60-1.80) total population increases to 46.7-56.0 million by 2125 (80% prediction interval), while under scenario B (300,000-400,000 NOM per annum; TFR 1.40-1.60) the higher NOM means that the population grows at a faster rate, reaching 63.8-74.4 million by 2125 (80% prediction interval). The width of the 80%

prediction intervals is influenced by the specified range of migration and fertility levels, and also by the full extent of uncertainty about mortality.

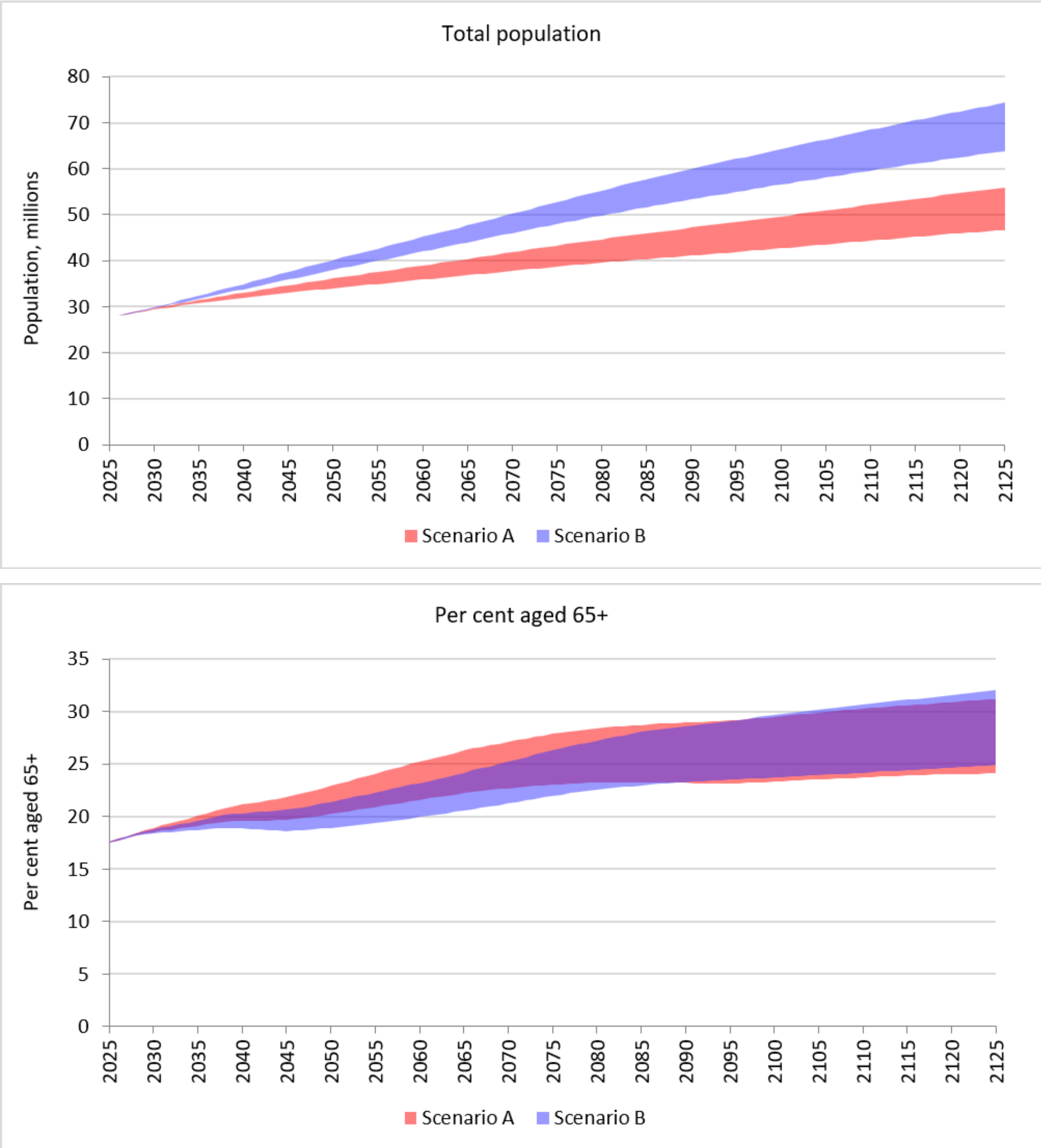

Figure 5: Scenario A and B conditional probabilistic scenarios of total population and percentage aged 65+ (80% prediction intervals)

Note: Scenario A has NOM of 100,000-200,000 per year and a TFR of 1.60-1.80; Scenario B has NOM of 300,000-400,000 per year and a TFR of 1.40-1.60.

Projections of the percentage of the population aged 65+ (Figure 5, lower graph) indicate that the progress of population ageing is slower under Scenario B for the first few decades of the projection horizon compared to Scenario A. However, further ahead in the 2060s, the rate of population ageing in Scenario B overtakes that of Scenario A. The large additions to population from net migration gains in the young adult ages have started to enter the 65+ age group. In the long run, towards the end of the projection horizon, differences between the two scenarios in the percentage aged 65+ are relatively small. By 2125, the median of the projected distribution under Scenario A is actually slightly lower than that of Scenario B (27.9% aged 65+ compared to 28.8%). As the analysis of the analytical variants in the previous section demonstrated, different levels of NOM have only a modest impact on ageing in the very long run, while higher fertility has a lasting effect on population ageing.

4. Summary and conclusions

4.1. Main findings

The main findings of this study are:

- Australia could experience a wide range of potential population totals and age structures over the next century depending on how rates of fertility, mortality, and migration evolve (Figure 2).
- Higher NOM can slow the progress of population ageing over the new few decades by a substantial amount, but in the very long term, different levels of NOM have only a modest effect on the percentage of the population aged 65+ (Figure 3; Table 3). The timespan of the analysis is crucial for answering the question the ability of net migration to retard ageing.
- For each additional 100,000 in annual NOM, the slowing of population ageing becomes less effective (Tables 2 and 3), especially towards the end of the projection horizon.
- In addition, the slowing of population ageing over the next few decades from high NOM is reversed later. There is an increase in the rate of population ageing for a period further into the future (Figures 3 and 5).
- In the long run, modest levels of net migration are effective in retarding ageing if the TFR is very low, but less effective if the TFR is high (Table 3).
- High NOM also results in large population increases in the long run (Tables 2 and 3).
- Higher fertility slows the progress of population ageing, and its influence is largely maintained over the very long run (Figure 4).
- The conditional probabilistic projection scenarios demonstrate the effects of maintaining migration and fertility within specified ranges. Under Scenario B, with higher NOM and lower fertility, total population increases at a faster rate than under Scenario A. The percentage of the population aged 65+ takes different pathways in the two scenarios, but they end up similar by the end of the projection horizon (Figure 5).

4.2. Conclusions

The main focus of this paper has been on the effects of different fertility, mortality, and migration rates on Australia's total population and population ageing. A very long-term perspective is necessary because the results of different fertility, mortality and migration assumptions differ throughout the course of a century. The results demonstrate that the two contrasting beliefs on the impact of net migration on population ageing (only a small effect;

or a substantial effect) are too simplistic. The effects of net migration on ageing depend on the timespan considered (a few years ahead, several decades ahead, a century or more ahead) and on the levels of net migration and fertility.

The paper has also extended earlier analysis through the application of conditional probabilistic scenario projections. These illustrate the uncertainty of future demographic change subject to certain conditions, such as NOM and fertility within specified planning or aspirational ranges. Surprisingly, conditional probabilistic methods have received very little attention by demographers, but I believe they offer considerable potential in discussions of possible demographic futures when policy interventions or changes are being considered. They are the probabilistic equivalent of 'what-if? projection variants because they show what would happen if specified policy-based ranges for selected variables were achieved, but explicitly account for uncertainty about the demographic future.

If a policy objective was to prevent Australia's population becoming extremely large over the very long run, while also cushioning the progress of population ageing, it would be beneficial to implement policies to encourage a slightly higher fertility rate than currently exists, and also increase control over the migration system to achieve lower NOM. There are, of course, many other factors that can be considered in arguing for higher or lower fertility and migration. These include: labour shortages, economic growth, nation-building, international relations, the infrastructure-population relationship, urban congestion, social cohesion, food security, environmental degradation, and pollution. But from a purely demographic perspective – focusing on total population growth and population ageing – NOM at around 100,000 per year would be effective at retarding population ageing to some extent and would result in modest population growth. But NOM at this level is probably unrealistic nowadays. A reasonable compromise, therefore, involving moderate population growth and moderate population ageing is offered by Scenario A.

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